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A Consolidation of Engineering News and Engineering Record

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A Consolidation of Engineering News and Engineering Record

McGraw-Hill Company, Inc.—JAMES H. MCGRAW, *President*

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN *Editor*

Volume 85 | NEW YORK, THURSDAY, JULY 1, 1920 | Number 1

New School of Cost Estimating

LIKE the recent articles on estimating plant rental, on concrete road costs and on the cost of construction trestles (*Engineering News-Record*, Jan. 15, p. 125; Feb. 5, p. 261; and April 29, 1920, p. 844), the article by G. C. D. Lenth on p. 22, containing diagrams for computing sewer costs, is a product of the new school of estimating contract prices. Incidentally the new practice has its origin in conditions created by the war. It is more truly, however, a reflection of the advent of the engineer-manager into contracting. Scientific appraisal is being substituted for the ancient art of predicting costs from data secured by past experience. In sewer construction the time is not far past when current bidding prices, carefully analyzed, gave a fairly reliable basis on which to estimate new work. In those days also the engineer or contractor who had a comprehensive tabulation of classified unit costs considered himself as perfectly equipped to build up a cost estimate. Post-war conditions have overturned these old bases. Bidding prices and unit costs are as mercurial as the temperament of a prima donna. A construction workman establishes his pay and his output in a spirit of independence which even a queen of the opera must despair of achieving. What has been, in costs, is no assurance of what will be. A cost predicting basis more reliable than those which sufficed in the past is being sought in the articles to which reference has been made.

New Facts on Stored Cement

THAT caked cement is low in strength has been known for a long time. As far back as 1906 *Engineering News* published a symposium of tests which show marked reductions in strength of cements which contained obvious cakes, even though these cakes were reduced to powder before mixing. But that stored cement in which the pulverization is complete loses its strength in proportion to the length of its storage has not been generally appreciated. The tests by Professor Abrams, noted last week on p. 1263, are therefore of great importance. The seriousness of the situation is lessened by the facts that the losses are in early strength and that design stresses are based on tests from cement of about the usual period of storage for construction work. The studies show, however, how wide a range of possible values must be taken care of in factors of safety and indicate, too, some additional reasons why test results vary so widely. The practical application is not so evident, except perhaps that long storage is undesirable and bulk storage more worth looking into than ever before. Some storage is necessary for seasoning purposes. Just where the benefits of seasoning stop and the dangers of strength loss begin is not well defined.

A Water-Works Standardization Council

AT FIRST thought, the Water-Works Standardization Council, provided for at the Montreal convention of the American Water Works Association last week, seems over-ambitious. The resolution creating the council is broad enough to enable the council, if a resolution alone were sufficient, to set up standards for not only the character of potable and industrial water-supplies, purification plant design, operation and records, but also for all the materials and supplies entering into water-works construction and operation. To undertake so much would be as impracticable as unnecessary. Other associations have done or are doing much of this work. Duplication would be most unfortunate. However, the resolution originally introduced provided for co-operation with other associations and was so broadened by amendment as to provide that before undertaking any particular line of work there should be consultation with the Engineering Standards Committee. Moreover, in supporting the resolution a member urged that educational work as well as research is needed. There is reason to hope that the council will do as much or more in the way of bringing worthy standards already adopted by other associations before its own organization for adoption as in setting up standards of its own. It seems to be felt that the American Water Works Association needs a new rallying point for committee work. It is to be hoped that the Standardization Council will be an abundant means to that end.

A Spur for Committee Work

NOW to get committee members to do committee work is a problem in many engineering societies as well as in technical and civic associations. Membership conditional upon service rendered is the solution adopted by at least two organizations. Appointment to a committee is accepted frequently as a courtesy involving no responsibility. The chairman is likely to be more conscientious and to prepare some kind of report, which the members may sign offhand or authorize the chairman to sign for them. Thus the report may represent the work and views of one man, while the list of names appended appears to give it the weight of many. The Railway Accounting Officers' Association has adopted a rule that any member of a committee (except the executive committee) who fails to attend three consecutive meetings shall forfeit his membership on that committee. The traffic committee of the Kansas City Engineers' Club has a similar rule in regard to its monthly meetings. It may be objected that this is only negative action, as it provides for penalizing members who do not work. In practice, however, it seems likely to have a positive effect. In the first place the rule serves to remind the member of his duties. In the second place he is likely to be spurred by the knowledge that neglect will result in his losing the prestige of committee membership and that there may be announcement or publication of the fact, which he would desire to avoid.

License Laws Begin to Restrict

WHERE is the licensing problem leading us? Consulting engineers are beginning to find the registration and license law requirements for engineers burdensome. Eleven states regulate the practice of engineering, but New York alone follows closely the model law of Engineering Council's committee on licensing of engineers. The principal difficulty seems to be over the reciprocity features and arises during the early period when the "grandfather" clause is in operation. Other states having taken in their own quota of "grandfathers" object to legalizing those of adjoining states who are slower in obtaining legislation. Illinois has had a structural engineer's license law in effect since 1915. Its own engineers can get a license by one means only, examination, and its attorney general has ruled that no one from outside can get a license in any other way unless he has passed an examination in some other state having equal requirements.

Few, if any, other states have "equal requirements." Efforts are being made to have this ruling in Illinois changed, with reference to what constitutes an examination. It is hoped that evidence of technical qualifications, submitted under oath with the application, will be accepted in lieu of all or a portion of a written or oral test. While there have not been many outside engineers seeking to practice in Illinois, a large number of consultants having offices in Chicago are doing work in surrounding states. To spend three days at an examination, plus the expense, entails no small hardship. As an example, a Chicago engineer desiring to serve clients in Michigan has no other alternative than to go to Lansing and pass an examination. In the article on p. 38 stress is laid on the clause relative to the *submission of evidence satisfactory to the board* as being one of the best ways for an examining board to determine the fitness of an applicant. If this evidence is not sought further proof, which might include the results of an examination, may be submitted.

Mr. Condron, who is chairman of Engineering Council's committee, explained the general situation, June 21, to a joint session of the Western Society of Engineers and the Illinois Structural Engineers' Society, at which he pleaded for a uniform law. As he stated, "it seems to make very little difference whether individual engineers are in favor of license legislation or not. Eleven states already have enacted such laws, and it is now important that the engineering profession unite in demanding uniformity of legislation and the elimination of unnecessary burdensome requirements."

It is decidedly against public policy to bar experienced engineers from practising in as wide a field as possible. Closed-shop methods should operate against the incompetent only, but since restrictions always restrict, there is no other way for the competent man to do than to abide by the rules. That is the price that must be paid to obtain a profession worthy the name. During the transition period the price will be higher than later. If engineers act as a unit the period will be shortened. If they are able to get action from the National Conference of Commissioners on Uniform State Laws, before which Engineering Council has laid the problem, one more progressive step will be taken. Organized engineers in every state should lose no time in bringing forth the model law before some other bill is prepared and receives support.

A Forecast of New Activity

LOOKING into the future and weighing its possibilities by present needs, J. A. Capp, the retiring president of the American Society for Testing Materials, forecasts for that body a new field of work, rich in promise. In his presidential address last week, he declared that there are demands which the society is not now satisfying—demands for increased knowledge of the properties of materials and test methods for measuring these properties. By entering into intensive study of materials and tests, with a strength of purpose equal to that exhibited in the drafting of specifications, the society can do important service to industry and technology. The significance of Mr. Capp's proposal lies in the fact that it touches the lifesprings of the society's vigor.

In taking up the suggested new work the society will in a sense turn back a generation, to the days of its origin. At that time, if our memory serves us, two aims competed for control of the society's activities: the standardizing of specifications, and the study of tests and properties of materials. Under the conditions of that time the choice could not remain in doubt. What industry and engineering—producer and consumer—most urgently needed was a supervisory agency to regulate the delivery and acceptance of material at the point of interchange between the two parties, by means of standardized specifications and test methods, limited to expressing average commercial practice. Accordingly the first of the two stated aims was chosen. The functions which the society could perform in this field were so important that they have been the dominant motives of its work for twenty years, and at no time has there been a suggestion of a change in this respect. But now Mr. Capp draws

the balance sheet, and while he finds ample credits on the side of specifications there is a grave shortage on the side of knowledge of materials. It is time to cultivate the neglected work.

This impulse toward a new kind of productive activity by one of the strongest of American technical societies is to be welcomed. The proposed work will be certain to increase the society's strength. This is said without undervaluing specification-making, an activity both important and difficult; it brings into play abilities of high order, among them a well-balanced judicial temper of arbitrating between production possibilities and users' demands, and a sure appraisal of economic values, but on the other hand it gives little scope for originality. Creative thought might easily atrophy without other opportunity to exercise its powers. Research in materials and study of testing instruments and methods, however, are truly scientific pursuits, in which observation of fact and originality of thought are brought to highest development. Can a society, however strong, fail to gain through the stimulative reaction of such activity?

In the work of standardizing specifications as now conducted, commercial practice is the governing consideration. The objective of the committees engaged in drafting the various specifications is to summarize existing practice in definite form. This applies to test methods as well as to materials. In consequence there is sometimes an obvious failure to realize progress by improving upon established practice. Mr. Capp himself refers to this conservatism of procedure, in more or less veiled terms. It is not far from the truth to say that in some fields of work the society has virtually reached a limit, a stopping point, through restricting itself to following practice rather than leading it.

Beyond doubt research in materials and tests would exert a marked influence upon the attitude toward specification-making. If Mr. Capp's suggestions are adopted, a broader spirit within the society, born of the opportunity to engage in broader work, will pervade its work. Thus the new activity promises to open the door to increased service in the field of specifying and testing for acceptance as surely as it will increase our knowledge of materials.

Factory-Made Roads

A DECIDED innovation in concrete-road construction, noted in *Engineering News-Record*, May 6, p. 890, is the experiment to be undertaken this season in Wyoming of building a road of precast reinforced-concrete slabs made at a stationary plant convenient to the site of the material rather than to mold the slab in place with aggregate hauled 40 miles and water piped 20 miles. The proposed road is 34 miles long and runs north from Casper, Wyo., to the Salt Creek oil fields. The proposal by the State highway engineers to construct an experimental stretch one mile long in this manner has been approved by the U. S. Bureau of Roads.

As the work is now planned, the slabs will be laid on a sand cushion in two sections, each 9 ft. wide. Each slab is to be 9 ft. long with the joints at a small angle with the transverse. The slabs are to be hauled to place by motor trucks and trailers, thus requiring a minimum of labor on the job. Though few details are given, the scheme recalls one proposed in an editorial in *Engineering Record*, April 18, 1914, p. 434. The principal idea there advanced was to use precast slabs on narrow congested city streets where the width between car tracks and curb did not exceed 12 ft., and where there was repeated tearing up of the pavements by public utilities to get at their conduits and service lines. It was recommended also that both sides of the slab should be surfaced so that two wearing surfaces would be available. As noted on p. 20, small slabs have been used with success in repair work in California for several years.

Undoubtedly one of the greatest tasks in the Wyoming work will be to obtain a uniformly smooth subgrade so as to get even joints, but with the present subgrading machines, which can trim to within a fraction of an inch of a predetermined grade, there should be little difficulty in making a smooth foundation. If the slabs were laid on a sand cushion perhaps the double templet used in laying a monolithic brick pavement might spread a thin even sand top similar to the dry cement top on which the brick are placed. A. N. Johnson, chief engineer, Portland Cement Association, suggests trimming out a small portion of the sand from the area under the central protion of the slab so as to insure bedding around the edges. Possibly cast-in-place or precast sills well bedded might be found advantageous, these being placed longitudinally or under the joints. Assumption in the calculations for bridgeing over hard spots or depressions would at once become definite if sills were used. Making the slabs reversible, as suggested in the *Engineering Record* editorial, might not be worth while in Wyoming where temperature probably will be the greatest disintegrating factor.

The procedure of placing the slabs will require the development of special crews, but they need be no more skilled than are steel bridge erectors. A locomotive crane mounted on caterpillar tractors and operating from the road already laid would be practically all the new equipment required. However, for the Wyoming work a simple gantry crane is proposed. Motor trucks with trailers carrying the slabs would run over the contemplated road at normal city speed, losing little time loading and unloading. The slab factory would of course require no equipment not familiar to engineers who have been using for a decade concrete lumber, blocks and precast floor slabs for railroad bridges.

While the presrent monolithic method will always be standard for the major portion of road work, there will continually arise special cases, of which the Wyoming case is an example, where another method may work out to advantage. First cost is not always the criterion. Time which a heavily traveled road not easily detoured can be kept out of service may justify much extra expense. Should the precast slab method be attempted in the Middle West the factory probably would be located adjacent to a stone crushing plant or gravel pit so that the rail and truck transportation would handle finished product only. The method would eliminate much of the unskilled labor which sometimes is all that can be had in out-of-town localities where transient housing is difficult to obtain. Night-and-day, rain-or-shine, winter-or-summer operations could be carried on almost continuously by the precast method. Valleys in the progress chart would come from something else than summer showers.

Motor Vehicle Instead of Gasoline Tax Probable in Great Britain

Special Conditions Incident to Need for £7,000,000 for Road Work Lead Committee of Thirteen to Recommend Temporary Change in Taxation Clauses for New Budget

By E. J. Mehren
Editor of *Engineering News-Record*

At the last annual meeting of the American Association of State Highway Officials, at Louisville, Ky., three of the states reported that they had laws taxing gasoline used in motor-propelled vehicles. These laws are the culmination of a growing sentiment in favor of some form of tax that would assess motor vehicles in proportion to the extent of the service they demand from the road. The theory has been generally accepted as sound and its advocates have cited Great Britain as an example of its success.

On this account it is interesting to know that the United Kingdom will probably abandon the gasoline tax—the "motor-spirit" or "petrol" tax, as it is called here—temporarily at least, and will substitute a vehicle tax instead. This does not mean that they have changed their minds as to the soundness of a motor-fuel tax. The proposed change is due to conditions of the moment. Nevertheless, the fact that the tax will be abandoned, even temporarily, is worthy of the careful consideration of those in America who are proposing that we should adopt a similar measure. The proposed change is provided in the budget already introduced in Parliament. It is generally conceded that the measure will pass, though the motor-manufacturing and motor-using interests will attempt to secure some abatement of the high taxes proposed.

At present there are motor-vehicle license fees in Great Britain higher than our license fees, but less than our total vehicle taxes if we remember that motor vehicles are subject in the United States to personal-property taxes. The motor-spirit tax is, of course, in addition to these existing vehicle taxes and amount to 6d. (about 12 cents) per imperial gallon, this tax being levied as an import duty on foreign-produced gasoline or motor spirit. Motor spirit used in vehicles employed for industrial purposes is subject to certain rebates, reducing the tax in such cases.

Need £7,000,000 For Highways

The present task of the Government is to raise, independently of the ordinary revenues, £7,000,000 net, these moneys to be used in the inauguration of a new policy of Government aid for *highway maintenance as well as construction*. Until now grants from the Government to local road authorities have not been on a fixed basis, but have been dependent upon the Road Board's view of conditions. Now it is proposed to classify roads in accordance with the extent to which they carry through and local traffic. Those carrying a large proportion of through traffic would be termed first-class roads; those carrying less through traffic, second class roads; while those carrying only local traffic would have some other suitable designation. If the revenues are sufficient, under the proposed plan the Imperial Government hopes to bear annually 50 per cent of the cost of maintaining first-class roads, and 25 per cent of the cost of maintaining second-class roads. In addition, the Imperial Government desires to have available about £1,250,000 annually for road-improvement purposes.

The Chancellor of the Exchequer definitely stated that the Government would not be able from its ordinary sources of revenue to supply the funds needed for this new road program. The vehicle and petrol taxes together now produce about £3,000,000 annually. The additional revenues to be raised, therefore, amount to about £4,000,000.

Committee's Report

That the Government might have the benefit of the widest experience in formulating the new taxes, the Roads Department of the Ministry of Transport appointed a committee of thirteen, composed of representatives of the Ministry, of the Royal Automobile Club, local authorities, the treasury, and of motor manufacturers and users. This committee reported at the end of March and upon their report the taxation clauses in the budget were drawn up.

The report makes it plain that a majority of the members still believe that the motor-spirit tax is the most equitable means of assessing against motor vehicles the charge that they should properly bear for the facilities afforded them by the road. They have agreed to a report recommending the abolition of this tax because of the special conditions of the moment, and recommend that when these conditions have passed, the resurrection of the motor-spirit tax be considered again.

The principal objections to the motor spirit tax, the committee finds, are these:

1. Difficulty of collection, occasioned by the system of rebates.
2. Failure to cover all liquid fuels for mechanical traction.
3. Application to imported fuel only.

These objections, the committee believes, could be remedied by the withdrawal of rebates, by the imposition of special license duties upon those forms of mechanical traction not dependent upon petrol, and by the reimposition of an excise duty on home-produced fuel. The most serious of the difficulties apparently is due to the introduction of so many substitute fuels, home-produced.

More important, however, than these reasons was the objection made by the Chancellor of the Exchequer to an import duty. Being the fiscal officer of the Government, his view necessarily had great weight, and was the determining factor in the committee's decision.

The committee recommended that all motor-spirit duties be done away with and that the revenue be raised solely by vehicle taxes. Motor cycles are given an arbitrary rating; passenger cars are to be assessed £1 per unit of horse power; motor buses on seating capacity, ranging from £15 for five-seated vehicles to

£84 for those seating more than 32, while motor trucks, tractors, and road locomotives would be assessed as follows:

Motor Trucks

	£
Not exceeding 12 cwt. unladen weight	10
Exceeding 12 cwt. but not exceeding 1 ton unladen weight	16
Exceeding 1 ton, but not exceeding 2 tons unladen weight	21
Exceeding 2 tons, but not exceeding 3 tons unladen weight	25
Exceeding 3 tons, but not exceeding 4 tons unladen weight	28
Over 4 tons unladen weight	30
Any of the foregoing with the right to draw trailer	2 (additional)

NOTES:

(1) In ascertaining the unladen weight of electrically propelled vehicles, the weight of the accumulators is to be excluded.

(2) Quarterly licenses to be permitted on payment of 20 per cent above one-fourth of the annual duty.

Other Commercial and Agricultural Vehicles

	£
*Motor Tractors (classed as heavy motor cars)	21
*†Road Locomotives and Agricultural Engines:	
Not exceeding 8 tons unladen weight	25
Exceeding 8 tons, but not exceeding 12 tons unladen weight	28
Exceeding 12 tons unladen weight	30
*†Agricultural Tractors used on roads for haulage solely in connection with agriculture:	
Exceeding 2½ tons, but not exceeding 5 tons unladen weight	6
Exceeding 5 tons	10

A "Tractor" means a mechanically or electrically propelled engine which draws but does not itself carry any load except such as is necessary for its propulsion and equipment.

Quarterly licenses to be permitted on payment of 20 per cent, above one-fourth of the annual duty, except in respect of vehicles only liable to duty at 5s.

These taxes will make the American user of automobiles and motor trucks gasp. That has been their effect also in Great Britain, and efforts to secure the modifications of the proposals, as before noted, are under way. In connection with motor trucks, the committee points out that the owners can pass the heavier taxes to the shipper, but for privately owned passenger cars, the committee works out in detail the difference between the new taxes and the old. This calculation shows that if both the present vehicle and petrol taxes are considered practically, all cars which are run 10,0000 mi. or more per annum will carry a lower tax under the new scale. If run only 5,000 mi. per annum, the 22-hp. car will be taxed about $30 a year more than before. The 35-hp. car will pay $65 a year more, while the 60-hp. car will pay $120 per year more. For runs of only 2,500 mi. per year the excess of the proposed over the present taxes is very much greater, amounting for the 35-hp. car to about $90 per annum.

While these are high taxes compared with those that we have in the United States, the Imperial Government will offer to its motor users a highway system so far superior to our own that comparison between them is ridiculous. I have had the privilege during the last month of riding over many miles of highway in both England and Scotland, and nowhere in the United States, except in small areas here and there, have I found such excellent roads. Not only are the main highways in first-class condition, but the subsidiary roads would put ours to shame. This is the condition to day. Under the policy that will be inaugurated with the raising of the new revenues, it will probably be impossible to find on the first and second-class roads of Great Britain any highway that cannot be honestly classed as "excellent."

*Inclusive of the legally permitted trailers.

†Locomotive ploughing engines, agricultural tractors not exceeding 5 tons unladen weight, or other agricultural engines, drawing necessary gear, threshing appliances, farming implements or supplies of fuel or water, shall pay a duty of 5s. per annum only, if not used on roads for other haulage work.

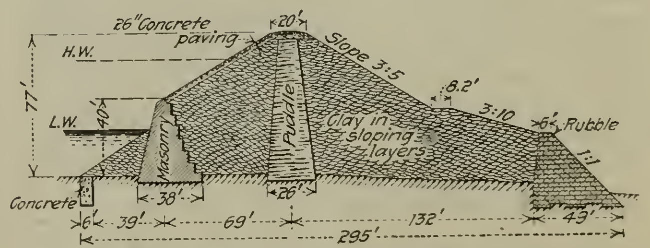
The Committee's Attitude

I cannot close this statement on the proposed taxation of motor vehicles in Great Britain, without reporting the fact that the Committee of the Ministry of Transport did not acquiesce in the principle that might be inferred from its report—that all Imperial grants for road work should be paid out of revenues raised by assessment upon vehicles or on the fuel of self-propelled vehicles. The committee specifically states that many of its members think "that having regard to the importance of cheap transport facilities to the prosperous economic life of the people, it is unsound in principle to place any special tax upon transport agencies which in the nature of things must largely be passed forward in higher rates of fare or charge." The report says, further, that when the present financial situation changes there should be a reconsideration looking to an equitable adjustment of the increased cost of improving and maintaining roads between: (1) the local taxpayers; (2) the Imperial Exchequer; and, (3) the users of the roads.

Edinburgh, May 26.

Combination Earth and Masonry Dam

An earth filled dam with masonry marginal retaining walls has been built in the Enza Valley near Parma, Italy, for an Italian hydro-electric project. The dam, as shown in the accompanying cross-section, has a number of points of novelty to the American engineer. It is 560 ft. long on top, has an extreme bottom width of 295 ft., and a height of 77 ft., the maximum depth of pond behind it being 69 ft. According to an article in the *Annales des Ponts et Chaussees*, Vol. 1, 1920, local conditions did not permit of the construction of a mas-



PAQULI DE LAGASTRELLO DAM IN ITALY

sonry dam, but there was a quantity of excellent clay nearby so an earth dam was decided upon. However, the masonry marginal retaining walls were used for an additional precaution. The upstream face above the wall is paved with hand placed stone and a 26-in. layer of concrete. The main section of the dam is laid in thin clay layers inclined, as shown in the sketch, upward from the center puddle wall. The dam is known as the Paquli de Lagastrello dam.

Convention of American Water Works Association

Standardization Council Created—Controversy Over Secretaryship Results in Failure of Proposed Constitutional Amendment—Presidential Address and Abstracts of Papers

MONTREAL being the meeting place for the fortieth annual convention of the American Water Works Association, held June 21-25, it was fitting to give ample and prominent place on the program to Canadian waterworks, which were described in papers by Thomas W. Lesage, F. H. Pitcher, J. O. Meadows, C. P. Cosgrove, T. J. Lafreniere. Two detailed papers on the design and the construction of the new water-supply of Winnipeg, with its 97-mile reinforced-concrete aqueduct, were presented in abstract by James H. Fuertes, consulting engineer, New York City, and W. G. Chace, chief engineer.

Individual water-works plants south of the Canadian line were also a feature of the program. A five-year campaign to effect pumping station economies at St. Louis, described by Leonard A. Day, was one of the most valuable papers on the program. Construction difficulties overcome in building a new pumping station for Louisville were described by James B. Wilson. A rich variety of experiences in water-works operation at Rochester, N. Y., was laid before the convention by Beekman C. Little, the association's new president. More general papers of large import were submitted by George W. Fuller and Leonard Metcalf, who dealt with "Cost Plus Contracts" and "War Burdens of Water-Works," respectively.

The superintendents again had their "day"—now a feature at each convention—and the chemical and bacteriological section had a long session on "Quality of Water" with no less than seven numbers on the program.

Committee reports were for the most part of either the routine or "progress" type. Among the important actions taken by the convention were the creation of a Standardization Council, a committee on standardization of brass fittings, and a committee on proper sizes of meters for multi-family houses.

Ample entertainment was provided by the Water Works Manufacturers' Association, including a boat trip down the Lachine Rapids. An extensive exhibit was also due to the efforts of the associate members.

Amendments to Constitution—Of two proposed amendments to the constitution one was adopted and one defeated by the convention. The one adopted permits the nominating committee to meet and select candidates before the convention adjourns instead of having to come together subsequently, at an expense of $500 to the association. Opportunity for nomination by petition prior to sending out the letter ballot is retained.

Controversy Over Secretaryship

The defeated amendment was designed to take the selection of the secretary away from the Executive Committee and make it an elective office. This amendment was proposed by a petition signed by eight members; the Executive Committee advised its rejection. The amendment was defeated by a vote of 53 to 5. On reconsideration the motion was laid on the table and it was voted as the sense of those present that the incoming Executive Committee should re-elect John M. Diven secretary for another year.

The discussion brought out statements to the effect that there had been lack of co-operation between Secretary Diven and the Executive Committee, and also between Mr. Diven and John M. Goodell, editor of the *Journal*. A plan to make Mr. Diven honorary paid secretary, with the special duty of maintaining relations with the superintendent-members, and to make Mr. Goodell both active secrctary and editor, did not appear to suit Mr. Diven or his supporters.

Before the convention adjourned the new Executive Committee reappointed Mr. Diven as secretary and Mr. Goodell as editor.

Finances—Notwithstanding heavy increased costs the association showed a balance of only $127 less than last year, according to the report of the Finance Committee, George A. Johnson chairman. The expenses for the year were about $13,800. The balance is $2,000 and there is $12,000 in the permanent investment fund. To meet a proposed budget increase designed to expand the work of the association, the Finance Committee recommended increases in dues as follows: Corporate members, from $5 to $10; associate members, $10 to $15; active, $5 to $6. The convention voted to send to letter ballot a proposal to raise the dues as just stated, except that the dues for active members would be $7, and that the increase would be retroactive for one year.

Next Meeting Place—Cleveland was tentatively chosen as the place for the next convention, subject to final approval by the Convention Committee.

New Officers

With the single exception of the treasurer, the 1920-21 ticket proposed by the nominating committee was elected. The vote stood: President, Beekman C. Little, Rochester, N. Y., 467; Capt. M. L. Worrell, Camp Dix, N. J., 314. Vice-president, Edward Bartow, Urbana, Ill., 448; W. S. Cramer, Lexington, Ky., 320. Treasurer, James M. Caird (re-elected), Troy, N. Y., 416; J. W. Ackerman, Watertown, N. Y., 351. Trustees (two to be chosen, no contest), Harry F. Huy, Buffalo, N. Y., 575, and Robert J. Harding, San Antonio, Tex., 557.

New Nominating Committee and Its Nominees—The six geographical districts, through such of their representatives at the convention as got together for the purpose, chose the following nominating committee: (1) T. J. Lafreniere, Quebec, P. Q.; (2) George C. Andrews, Buffalo, N. Y.; (3) Herman Rosenstreter, Newark, N. J., (4) H. E. Keeler, Chicago; (5) E. L. Fulkerson, Waco, Tex., (6) Thomas Maloney, Council Bluffs, Iowa. Acting with these was the latest past-president attending the convention, Theodore Leisen, Detroit. The committee submitted the following ticket for 1921-22: President, Edward Bartow, Urbana, Ill.; vice-president, W. S. Cramer, Lexington, Ky.; treasurer, W. W. Brush, New York City. Trustees, third district, George C. Gensheimer, Erie, Pa.; sixth district, J. Chris. Jensen, Council Bluffs, Iowa.

The committee on official standards of water analysis, through Jask Hinman, Jr., chairman, Iowa City, Iowa, reported that in the light of present knowledge "the difficulties in the way of a fully successful general standard, based upon the results of analyses alone, seem to your committee to be insurmountable."

On motion of George A. Johnson, it was voted to create a Council on Standardization, to consist of five members appointed by the president, the council to have authority to establish sub-committees composed as it sees fit. The original resolution was amended, on motion of John H. Gregory, so as to instruct the council to confer with the Engineering Standards Committee before adopting a program. The council will also have power to co-operate with other organizations. According to Mr. Johnson's resolution, the council is expected to enter upon a wide range of standardization work, including methods of water analysis, design, operation and records of water purification plants; standards of water purity; and water-works materials and supplies of various sorts.

Electrolysis Committee—The association's representatives on the American Electrolysis Committee reported through Edward E. Minor, New Haven, that the Bureau of Standards agreed for a year to concentrate its electrolysis studies on work in co-operation with the research sub-committee of the American Electrolysis Committee. Studies along eight or nine lines are being made. The convention referred to the Executive Committee the question of further co-operation with the American Electrolysis Committee. Later, the Executive Committee endorsed and the convention approved a recommendation in the report to the effect that transformer secondaries be grounded to water pipes, in accordance with standard rules.

Superintendents' Day—Superintendents' Day met its usual fate. A promising program, with a number of good topics and chosen speakers, started off well and then collapsed. The controversy over the election of the secretary arose and topics not on the program were introduced. The combined result was the elimination of what promised to be useful discussion on several practical subjects.

Meters for Multiple-Family Houses

Short papers introducing this subject were presented by H. P. Bohmann, Milwaukee; G. A. Elliott, San Francisco; D. W. French, Hoboken, N. J., and W. R. Edwards, Paterson. Mr. Bohmann said that under a rule in force many years, the city of Milwaukee requires that all meters must be the same size as the corporation cock. The city permits consumers to set nothing smaller than ⅝-in. meters and the city itself sets none less than ¾ in. Mr. Elliott stated that the Spring Valley Water Co., which has been metering domestic consumers only a short time, uses ⅝-in. meters for houses with one to six families and ¾-in. for seven to ten families, and so on. Studies show no close connection between the number of families and the total water consumption in a given house. With a pressure of 40 lb., Mr. Elliott thought, it would be safe to use ⅝-in. meters for one to nine families; ¾-in. for ten to fourteen; 1-in. for fifteen to twenty-four, and 1½-in. for twenty-five to forty.

Mr. French said that the Hackensack Water Company had got along well for several years with ½-in. meters and ¾-in services for two-family houses. With pressures of 50 to 60 lb. the company had used with moderate satisfaction ¾-in. meters for five to ten families and had had sixteen to twenty families on a 1-in. meter. W. R. Edwards reported for his company that of 28,000 meters in use, 26,500 were on ⅝-in. meters. The company uses ⅝-in. meters for houses with up to six families; ¾-in. for from seven to twelve; 1-in. from thirteen to twenty-four. Up to this point satisfaction seems sure. On motion of W. W. Brush, it was voted to create a committee to report on the subject under discussion.

Standardization of Brass Supplies—Adolph Mueller, Decatur, Ill., pleaded for co-operation between the American Water Works Association and a standardization committee of the Brass Moulders' Association. It was voted to appoint a committee to co-operate with the one just named and also with a committee of the New England Water Works Association. Mr. Mueller gave statistics for states and groups of states which show that 128 cities have 332 different styles of corporation cocks. It appears that only three types (for iron threaded pipe, for tapping machine practice, and for wood pipe) are needed, with seven sizes in all, making 21 kinds, including size variations. The tendency now is to use larger corporation cocks than formerly. The minimum size under consideration by the Brass Founders' Committee is ⅝ in., but some as small as ⅜ in. are being made. The committee just named has already agreed on standards for a variety of plumbers' fittings.

Water-Waste Prevention on Railways—C. R. Knowles, Superintendent Water Service, Illinois Central Railway, traversed some of the same ground covered in a paper by him abstracted in *Engineering News-Record* a few weeks ago.

Ice Formation—In a volunteer paper illustrated by both lantern slides and moving pictures, John Murphy, Ottawa, Ont., showed how both anchor ice and frazil ice are formed. Ice formation with adherence to intake racks is a matter of 0.001 or even 0.0001 degree change in temperature, and may be prevented by a fuel expenditure that is only a small percentage of the cost of coal for steam power.

Standard Water-Works Contract Forms—An appeal for co-operation in reforming and standardizing contracts for water-works construction was presented in a paper submitted by the Association of General Contractors of America. The convention referred the appeal to the newly created Standardization Council of the association.

Chemical and Bacteriological Section—Co-operative research by water laboratories to solve all of the technical problems confronting the water-works field will be effected if a resolution of the Chemical and Bacteriological Section is put into effect by the newly-created Standards Council. The action followed Abel Wolman's paper on "Co-operative Research in Water Purification," abstracted elsewhere. John M. Goodell, speaking for the publication committee, indicated that this section and its activities would furnish the impetus to make the Council a success. The superintendents are in great need of scientific and technical men and their knowledge.

Jack Hinman, Jr., discussed standards and the present chaotic conditions the water-works officials are in with respect to them, particularly limit standards by which various Federal, State and municipal health regulating bodies judge of the acceptability of a water. Stress was laid on the sanitary survey as an adjunct to analysis.

W. J. Orchard, in his paper on "Recent Progress in the Fight Against Typhoid Fever," gave practically an extension to data in George A. Johnson's paper on "Typhoid Toll' presented to the Association in 1913. MacH. McCready, indicated how purification plants were controlled in Quebec.

Abel Wolman read by title Part II of a paper already in print in the Journal on "Index Numbers and Scoring of Water Supplies." It dealt mainly with the frequency distributions of B coli, whereas Part I referred to total bacterial content.

A volunteer paper on "Problems of the Dallas Filter Plant," presented by Helmen Rosenthal, chemist and bacteriologist, described the present difficulties being experienced in so many cities where ultimate capacities have been reached.

[*Extracts from the President's address and abstracts of two of the papers read at the convention follow.*—EDITOR.]

United Action in Water-Works Field

FROM PRESIDENTIAL ADDRESS BY CARLTON E. DAVIS
Chief of Bureau of Water, Philadelphia

I feel that the widest future opportunity for the American Water Works Association lies in a change in the relationship between the sections and the central organization. The sections must be developed. Those already in existence must be strengthened, new sections must be created, all with a view of a final amalgamation in one central organization of the entire water-works interests of the country. This process, carried to a logical end, will not destroy our existing organization but perhaps change its character, opening up to it a much wider field of usefulness along somewhat different lines. To meet the situations that are before us today and that will arise in the years to come, to prevent lost motion and eliminate unnecessary duplication, all the water-works of the country should function for their common interests through a central body which will be representative of all localities and which should be organized to meet all conditions and needs.

The American Water Works Association, when it adopted its name, expressed the intention to serve as this central body. The question before us today is whether we propose to grasp the opportunity to act or whether we shall let the opportunity pass us by. Acceptance of the present as we find it and committing the future to our successors is the easiest course. I believe our association will elect to follow the more difficult but more fruitful path.

Field for Co-operative Work

The majority of our members are restrained in their activities by regulations imposed upon them by public service bodies or by the restrictions of legislative enactments or by the limitations of city laws and ordinances. Many of these restraints are irksome and are not accepted calmly or without chafing under the restraint. Along the field of organization work we have a relatively free hand to organize and develop. We have an opportunity to demonstrate that the water-works engineer and operator is a capable organizer and when given the opportunity can conduct his own affairs with efficiency and at the same time with due regard for the interests and welfare of the public, with an eye to the future and an alertness for the present. Necessary protests against undue outside restraint will come with much greater force if supported by the weight of a compact, comprehensive, well-organized and conducted association.

It is stated on good authority that the investment in water-works represents the largest total in the entire field of comparable utilities. Water-works officials know that their plants, of all utilities, supply one universally, indispensable commodity, vital for human existence and basic for all community life. We have common interests, and that we are grasping for methods of expressing this interest by working together for a common end is shown by the number of water-works organizations. The next step forward is the affiliation of the several organizations to handle matters of mutual interest with the power and weight that come from large numbers, unity of purpose and harmony of ideas.

Organization is the dominant note heard throughout engineering and allied fields at the present time. The American Water Works Association, through accredited representatives, recently attended the Organizing Conference in Washington of engineering societies concerned with public utilities like our own, seeking to co-operate offensibly and defensibly in matters vitally affecting the interests, personal and official, of their members. Whatever may be the final outcome of such efforts, or whatever may be the path the council of affiliated societies may elect to follow, self-respect demands that the water-works of the country shall be able to speak as a unit at such councils and with the weight attaching to full and not partial numbers.

There is need for joint action and co-operation and it is for our association to decide whether it will be the leader among all water-works interests, and whether it will so conduct itself and its affairs that other water-works organizations will feel the call to join it without undue proselyting or the need of exerting pressure. I speak of proselyting as applying to associations and not to individuals, for no one can question the importance of increasing the membership in our own body.

What the Association Now Offers

Considered dispassionately, in cold blood, what does the American Water Works Association as now conducted offer to its members?

First, the *Journal*, which in my opinion is serving more and more to develop the association, bind its members together, and attract increasing membership. Second, the privilege of attending once a year a convention which of necessity is geographically inaccessible to a large portion of its membership. Third, the opportunity of voting by letter ballot for officers. The association is likewise the medium for the production of various standard specifications and standards of practice and custom, a matter which I would like to refer to later.

All of these openings and results are admirable but the scope is limited and most of us must conclude that the association as now conducted is not the active help to water-works men that it should be and that it can be. Membership in it does comparatively little to promote the standing of the individual member in the community, protect him in a personal way, or place the utility which he conducts on the high level in the public mind to which it is entitled. The recognized official machinery of the association is too remote for the individual member and functions in too cumbersome a manner to respond to his needs or to be in his mind a tangible asset for his personal help.

The association naturally thinks of itself as a parent organization and the development of the sections may appear as the breaking up of the family tree and weakening of the main stem. I feel that the contrary will be the case, provided the central organization is willing to look upon itself not as a major factor but as a clearing house. Service rendered must be the underlying principle of the organization which attempts to weld into one functional activity the entire water-works interests of the continent.

We do not realize our strength because we have never attempted to exert it as a unit. Unorganized society is helpless against attacks and demands of relatively small but effective, because organized, groups working together. The existing lack of cohension among water-works men places them relatively in the position of the present unorganized public, powerful but helpless because of the inability to work together.

Standards of practice and procedure must be handled through committees, and committee work will become of increasing importance. The path of the committees must be smoothed as much as possible. When the authority for committee work can emanate from a central body, representative of all the water-works of the country, when co-operation comes logically and as a matter of course and not under option of possible rival organizations, as at present, the desired end will be in sight.

The War Burden on Water-Works Continues

By Leonard Metcalf
Consulting Engineer, Boston, Mass.

THROUGH the courtesy of their managers it has been made possible to extend to Jan. 1, 1920, the data submitted in 1918 and 1919 to this association, upon the trend of prices in the water-works construction and operating fields, based upon the actual experiences of about 50 water-works in various parts of the United States, having a gross annual revenue of about $34,000,000 and serving an aggregate population of upwards of 9,000,000.

Labor Costs—Unskilled labor costs (Table 1 and Fig. 1) continued their advance during the year 1919 and are yet higher to-day. The percentage of increase in cost per hour over pre-war (1915) prices averaged about 80 per cent—approximately 70 per cent in the western and central groups and 90 per cent in the eastern and southern. The average increases for the year 1919 over 1918 is about 12½ per cent. While the efficiency of labor is probably slightly better than during the war period, it is still far below pre-war standards. It is conservative to say that, taking productivity into consideration, as well as the price paid per hour, the cost of unskilled labor is more than double its pre-war cost.

Cast-iron pipe prices are today practically three times normal pre-war prices; the cost of *valves and hydrants* slightly less than double. *Coal* prices have receded somewhat, more nearly approaching the conditions of 1917 than 1918.

Wages paid unskilled labor by water-works in the vicinity of Boston in March, 1920, compared with 1919, show a nominal increase in rate per hour of from 43.2 to 50.6c. The actual increase, including allowance for holidays and vacation leave, is from 46.1 to 56.7c. per hour, or 21 per cent. Holiday leave under full pay is granted by 14 out of 20 works, while 17 out of 20 give two weeks' vacation annually under pay.

Table II shows the increases from 1915 to 1919 in (1) gross annual revenue, operating expenses, including taxes, and net annual revenue applicable to depreciation, interest, dividends and surplus of 46 works arranged in four geographical groups. The *net revenue* (see also Fig. 2), without deduction for and therefore applicable to depreciation, interest, dividends and surplus, has increased over the pre-war (1915) basis by 3.4, — 0.4, 4 and 8.5 per cent. This increase is less than half of what would be expected for such works in normal times. These figures indicate that in spite of the advances in rates, which have been granted in many places, the net revenue of the works is not adequate to command capital for their betterment over a long period of time. They indicate further, as will be seen from the diagram, that of the net burden resulting from war conditions about half has been borne by the works; the other half by the public which they serve.

A segregation of the records submitted, as between municipally and privately owned works, indicates that the increase in gross revenue for both of these has been approxi-

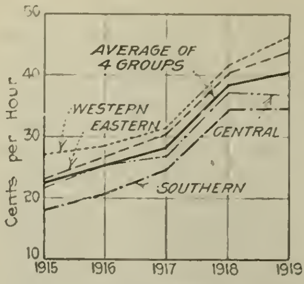


FIG. 1. INCREASED COST OF UNSKILLED WATER-WORKS LABOR

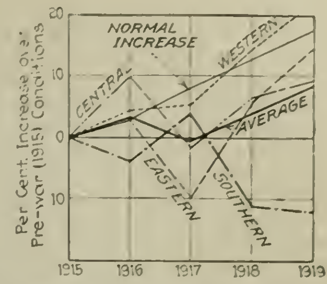


FIG. 2. PER CENT CHARGES IN NET WATER-WORKS REVENUE

TABLE II. PER CENT INCREASE OF GROSS REVENUES, OPERATING EXPENSES AND NET REVENUES OF FORTY-SIX WATER-WORKS, SINCE 1915

Group	1916	1917	1918	1919	1919* Revised
Gross Annual Revenue					
Eastern	10.1	12.8	20.6	23.3	23.3
Central	9.1	11.4	26.4	(33.7)*	23.3
Southern	7.5	20.3	26.3	26.3	26.3
Western	7.3	9.5	17.5	25.0	25.0
Average	8.5	13.5	22.7	(27.1)*	24.5
Operating Expenses, Including Taxes					
Eastern	21.9	41.1	49.7	47.1	47.1
Central	9.3	37.3	62.3	(75.5)*	63.1
Southern	9.7	34.6	65.9	71.5	71.5
Western	9.9	17.4	28.0	36.1	36.1
Average	12.7	32.6	51.5	(57.5)*	54.4
Net Revenue Applicable to Depreciation, Interest, Dividends and Surplus					
Eastern	3.0	—9.6	5.8	14.5	14.5
Central	10.0	—1.5	6.5	(36.5)*	9.3
Southern	—3.7	4.0	—10.9	—12.0	—12.0
Western	4.3	5.3	14.4	22.1	22.1
Average	3.4	—0.4	4.0	(15.3)*	8.5

*The figures within brackets cover all records received. The figures beside them are believed to be more characteristic however. They result from the exclusion of two very abnormal records. Those of Detroit, Mich., and Mingo Junction, Ohio.

TABLE I. INCREASE IN COST OF UNSKILLED LABOR AND MATERIALS TO FORTY-SIX WATER WORKS IN THE UNITED STATES, FROM PRE-WAR BASIS, 1915 TO JAN. 1, 1920

Item	Number of Records on Diff. Years	Prices per Unit, Cents 1915	1916	1917	1918	1919	Per Cent Increase Over 1915 (Pre-war Basis) 1916	1917	1918	1919
Unskilled labor, per hour:										
Eastern group	15–18	23.0c.	26.7c.	30.4c.	40.2c.	43.8c.	16	32	75	91
Central group	10–12	21.7c.	25.3c.	26.9c.	37.2c.	36.8c.	17	24	71	70
Southern group	9–12	17.9c.	20.6c.	24.5c.	34.3c.	34.4c.	15	37	92	92
Western group	7–8	27.0c.	28.5c.	31.4c.	41.8c.	46.4c.	5	16	55	72
Average of groups		22.4c.	25.3c.	28.3c.	38.4c.	40.4c.	13	27	71	80
Cast-iron pipe per 2,000 lb., approx	17–21	$24.23	$30.70	$51.60	$67.74	$69.20*	27	113	179	184
6-in. valves	11–38	11.18	12.64	19.13	19.13	20.73	13	71	71	85
12-in. valves	3–38	34.78	41.53	65.22	65.02	59.66	19	88	87	72
2-way hydrants	6–38	26.69	32.04	43.13	51.80	47.16	20	62	94	77
Coal per 2,000 lb.:										
Eastern group	13–15	$2.98	$3.80	$5.96	$6.00	$5.41	27	100	101	82
Central group	11–12	2.41	2.77	3.75	4.53	4.55	15	56	88	89
Southern group	12–9	1.92	2.01	3.03	3.89	3.78	5	58	102	97
Western group†	5–4	3.97	4.37	6.31	7.92	4.70	10	59	99	18†
Average of groups		$2.82	$3.24	$4.77	$5.57	$4.61	15	69	97	63
Fuel oil, per gal., South	1	1.80	1.80	2.00	4.28	....	0	11	138	..
Fuel oil, per gal., West	1–4	1.38	1.50	2.57	4.05	4.09	9	86	193	197
Alum, per lb.:										
Eastern group		$1.12	1.72	1.48	1.45	1.66	54	33	29	48
Central group		0.91	0.91	1.25	1.50	1.40	0	37	65	54
Southern group		1.08	1.38	1.48	1.78	1.56	28	37	65	44
Western group		1.14	1.21	1.51	1.53	1.79	6	32	34	57
Average of groups		1.06	1.30	1.43	1.56	1.60	22	35	47	51
Average N. Y. price		2.08	4.63	3.57	......	......	...	...	...	..

* Range $50.60 to $83.50 per ton. † Small number makes record of doubtful value.

mately the same; that the increase in expenses has been more than twice as great for the privately owned group as for one municipally owned; and that the net revenue of the privately owned group has practically stood still while the municipally owned group has been increased approximately 40 per cent. This comparison cannot be carried too far, however, as the list of municipally owned works is not sufficiently large to be thoroughly characteristic. Moreover, in the case of the municipally owned works, the records of which are included, a much greater proportion have gravity supplies than in the case of the privately owned group. This has served to minimize the increase in expenses which would otherwise have been felt. It may be that the decrease in available labor during the war period had a more material effect upon the municipal works than upon the private works and resulted in economies which would not have been possible in those public works under normal conditions. More important yet, it is to be observed that in the case of the municipal works substantially no taxes are paid, whereas in the privately owned group the taxes generally amount to about one-eighth of the entire gross revenue, and these taxes have, of course, been burdensomely increased since the war burdens began to make themselves felt. In fact, excluding the returns from water-works located in the State of Pennsylvania, because the basis of taxation is quite different there and incomparable with that prevailing in other states, it appears that the increase in taxes paid by privately owned works in 1919 over 1915 was 68 per cent.

Summit of High Prices Reached—It is generally conceded that the summit of the high prices has been reached, where it has not been passed, and that, as to materials at least, and probably in lesser degree as to labor also, some recession in price is to be looked for. There is still, however, so marked a shortage of materials and labor, comparable with the demand, that construction costs are certain to remain high during the year 1920.

The financial outlook for existing water-works is not encouraging. It is evident that the earnings during the war period have not been adequate to maintain the properties and pay a fair return upon their value. Such a condition cannot long continue without serious future embarrassment. The position that may be taken by the public service commissions will be reflected later in the character of the service rendered. If fair advance in rates be granted, first class service can be maintained. If this advance be retarded or be not adequate, a declining service must result. The increase in rates in the face of the present high cost of living will be very distasteful to the public and in some cases induce active opposition. Therefore it is important that in making application for relief, the evidence should be clearly presented by the water-works authorities, so that the facts may speak for themselves and the difficulties of the commissions be minimized.

Co-operative Research in Problems of Water Purification

By Abel Wolman
Division Engineer, Division of Special Investigations, Bureau of Sanitary Engineering, Maryland State Department of Health, Baltimore, Md.

SCIENTIFIC investigation in the field of water purification has progressed for a number of decades, but the study of problems has been, for the most part, intermittent, sporadic and disconnected. The development of data has been the result of local efforts in the laboratories of individual colleges, states, municipalities, or private corporations. What co-operation has existed has been localized and not national. It seems hardly necessary to emphasize the abstract desirability of solving the problems of water purification by a more constructive system of co-operative effort than now exists. It should not be a difficult matter for the American Water Works Association to plan the attack on a series of problems by the proper organization of a research committee. As far as I am aware, no other organization is at present so well suited to undertake its development and no other has yet deemed it desirable to assume this responsibility.

Granting the abstract desirability of developing such co-operation, what are some of the problems which to-day remain to be solved? Although considerable advance in the practical methods of water purification has taken place in the United States, may we state definitely that the fundamental laws of coagulation, filtration and chlorination are accurately known? If so, are these laws applied in everyday operation? Some of us, perhaps, are not so sanguine about our complete understanding of the processes involved in the above mechanisms of purification. An opportunity to engage in a co-operative attack upon such problems will be welcomed.

Unsolved Problems in Water Purification

Coagulation and Sedimentation—The factors determining effective coagulation and sedimentation of waters differ in degree with different waters, but their characteristics in general are the same, regardless of the nature of the water. The effects of time, temperature, agitation, and hydrogen-ion concentration upon coagulation have been studied only superficially. The material for such study has been accumulated in a number of different fields in allied sciences, but has not yet been adapted to water purification problems. It is stated often, for example, that the formation of satisfactory floc is retarded by low temperature and by inadequate agitation, yet how many plants observe and record the nature of the floc produced each day, so as to provide the material for correlated study of its variations with other characteristics of the water during an entire year?

The measurement of floc formation in its various aspects, however, should be preceded by a study of the raw waters with a view to determining a more accurate and satisfactory method of apportioning coagulant to raw water to obtain satisfactory coagulation. The usual method of turbidity reading with adjustments for rising, falling, constant, fine, medium, and coarse turbidities leaves much to be desired, particularly when frequently the actual procedure results in abandoning all methods other than adding chemical until the coagulation becomes satisfactory. These methods are necessarily wasteful, since for each water there exists a critical concentration of coagulant which is most effective and economical. Can we not devise a satisfactory index to the "coagulant demand" of a water by a simple test? When it is borne in mind that the flocculation of waters is dependent upon the nature and amount of fine particles present it would appear that the search for such a measure should be in the field of colloid chemistry.

Another phase of the coagulation problem which has taken on an importance in recent years is the effect of the varying hydrogen-ion concentration upon flocculation. There appears to be an optimum range of P_H within which the coagulation proceeds most satisfactorily. Water-works operators and investigators should begin to accumulate complete data regarding the P_H values of different waters in the country under all conditions. In the State of Maryland we have been making, for several months, determinations of hydrogen-ion concentration on all waters and have instituted these tests as a daily procedure in several large filtration plants.

The study of sedimentation problems in the light of recent developments in physical chemistry may require some modifications of our older concepts. The effect of electrolytes, of competing and protective colloids, of surface tension and osmotic pressure are of more than purely scientific interest. Recent work has demonstrated, for instance, that the Brownian movement is observed with practically every type of clay suspended in water, varying from the rapid motion of the finest particles to the more sluggish one of the larger particles or aggregates or when hampered by the presence of electrolytes.

Filtration—The internal forces within a sand filter bed are of greater magnitude than is generally realized. Experience in Maryland with a number of peculiar phenomena in filter beds has disclosed a startling variety of forces released in filter beds, which appear to be intimately connected with the character of sand and of applied water. The appearance of internal contraction in a sand bed of such strength that the

surface area of the bed may be reduced by more than 5 per cent of its original area is of importance in calling attention to the unsolved problems concealed within the bed.

Chlorination—Sanitarians have established definitely that waters may be made safe for potable purposes by chlorination. The water-works official, however, must go a step further. He must make the water potable as well as safe. If the water is unpalatable and objectionable because of tastes and odors, then the problem of chlorination may not be considered as solved. It is only a few years since the conception of the mechanism of chlorine treatment has undergone some modification from the simple hypothesis of direct oxidation. But in this comparatively short period, a series of questions have arisen which are still imperfectly answered.

In this field again we must have recourse to highly technical investigations to aid us in clarifying our concepts of chlorination processes and in controlling their operation. Even to-day it is difficult to answer definitely whether the action of chlorine is physical, physico-chemical, or chemical, whether its action is selective for different types of bacteria and, if so, what the causes for such selection are. The action of other disinfectants is elective and their toxicity is dependent upon their position in definite ionic series and upon the characteristics of the different bacteria, such as their response to Gram stain. The surface character of different classes of bacteria show a marked influence upon their behavior under different conditions.

Where we attempt to treat raw waters of complex organic and inorganic content, our present methods of control are entirely empirical and not infrequently unsuccessful. The causes of tastes with low doses and the absence of tastes, at times, with excessive doses of chlorine are still in the category of the unknown. It is not a solution of the difficulty to state that tastes and odors may be prevented by proper regulation of applied chemical, for the terms "proper regulation" are indeed broad in interpretation. Proper chlorination control, on the contrary, would seem to be possible of attainment only after a complete understanding of the details of the complex disinfection processes has been reached. May we not call upon this Association to take the lead in the initiation of these studies?

Seeing Ourselves as Others See Us

ONE reads about the construction of sewers in America, and one marvels. Are our methods completely out of date, or are the Americans in the habit of constructing works in a costly and dangerous manner? Experience of recent American practice does not justify the conclusion that the work is faulty, or that the methods whereby rapidity of construction is obtained are extravagant. There is very little doubt that in this country engineers are too apt to act on precedent, and to leave to the contractor and the contractor's foreman a great deal of work which could be done much better by the engineer. The contractor is very often a person whose knowledge and experience are much less than his commercial ability and assurance; it is more than probable that he relies almost entirely upon his foreman. In any case his business is not, as a rule, limited to one job. At the best his attention must be divided. Thus, the details upon which the speed or economy of the work depend are left to the judgment of the foreman. The average foreman cannot compare in intelligence or knowledge with the properly qualified engineer. We, as engineers, look at his work, and we think that we could see ways of speeding things up or of saving money; but, as a rule, we do not interfere with time-honored methods hallowed by precedent. Therefore the work takes much longer to execute, the timbering of trenches has to be of a character to stand for months, the cost of pumping becomes excessive, and many other troubles incidental to delay occur.

A study of American methods as illustrated by work recently carried out at Granite City, Ill., described in *Engineering News-Record* [March 4, 1920, p. 461], shows an enormous difference between English and American practice. The work at Granite City may be open to criticism, but it is nevertheless worthy of consideration, as it is typical of much other work. We read of a concrete sewer, 8 ft. in diameter, being constructed on a bad foundation consisting of quicksand in some places, at the rate of 35 ft. in 24 in., including excavation and refilling. The depth of the trench ranged from 15 ft. to 22 ft. How many of us have seen a trench 15 ft. deep containing a 12-in. sewer left open for months owing to our slow methods! Surely the difference is remarkable. We read of heavy pumping in the Illinois trench. Excavation and refilling were done by means of a grab bucket and moving crane. In good ground only the lower part of the trench was timbered. Planks, 2 in. by 12 in., driven by hand assisted by water jets were used. The joints below the water line were covered with batten strips 1 in. by 6 in. in size. An electrical pump kept the trench water low. The bottom of the trench was levelled by men with shovels, and the concrete base of the sewer was dumped without waiting for the trench to be entirely dry. Collapsible steel forms were fixed, and concrete was dumped from a traveling car fed from a mixer alongside. The work was done in 35-ft. lengths, and the forms were withdrawn after the concrete had been laid twelve hours. Whatever may be our view of such methods, it is certain that an enormous amount of pumping, timbering and troubles incidental to a lengthy process must have been avoided.

Whether our methods will ever be speeded up on American lines or not, it is certain that such speeding up can only be done by engineers. Undoubtedly a material improvement could be effected if engineers of suitable experience accepted the responsibilities usually taken up by foremen of inferior knowledge. If engineers did their legitimate work, it is obvious that they would take up much that is done by workmen who, for lack of knowledge, carry out their work by slow and timorous methods. We should not then be faced with the fact that, while many good engineers are out of a job, there is a demand for foremen, who are offered pay equal to that of an engineer. Why do we allow the ignorant so-called practical man to do our work, and leave us unemployed, while the work suffers?—*The Surveyor and Municipal and County Engineer, London.*

What Is Dry Rot?

The term "dry rot," the U. S. Forest Products Laboratory finds, is applied by many persons to any decay which is found in wood in a comparatively dry situation. Thus loosely used the term actually includes all decay in wood, since wood kept sufficiently wet can not decay.

In the more limited sense in which pathologists use the term, "dry rot" applies only to the work of a certain house fungus called *Merulius lachrymans*. This fungus gains its distinction from the fact that it is frequently found growing in timbers without any apparent moisture supply; in reality it does not grow without moisture and is as powerless as any other fungus to infect thoroughly dry wood. Given moist wood in which to germinate, it is able to make its way a surprisingly long distance in dry timbers, drawing the water it needs from the moist wood through a conduit system of slender, minutely-porous strands.

Wood in the typical advanced stage of dry rot is shrunken, yellow to brown in color, and filled with radial and longitudinal shrinkage cracks, roughly forming cubes. In many instances these cracks are filled with a white felty mass, the interwoven strands of the fungus.

The dry rot fungus is active in nearly every region of this country, in Canada, and in Europe. It is very destructive to factory and house timbers and to logs in storage. Coniferous or soft woods are more commonly infected by it than hardwoods.

Annual Meeting of American Society for Testing Materials

Expansion of Committee Work and Great Growth of Co-operation with Other Societies Mark the Year's Developments — President Capp Urges Cultivation of Research — Waiting Attitude Toward Federation

PROPOSALS for a radical change in the general working plans of the American Society for Testing Materials were made by the retiring president, J. A. Capp, in his presidential address at the society's annual meeting last week. Held in a new meeting place, Asbury Park, N. J., in place of the traditional one of Atlantic City, and following upon a year during which many important changes affected the society's life, the meeting was of distinctive character. That interest on the part of the membership is not decreasing was made evident by the attendance, which approached the record figure of last year, about 650 present. In one sense, however, the meeting resembled a committee convention rather than a society gathering, as more than fifty sessions of committees and subcommittees were held during the week, among them the meetings of a number of committees of other societies and intersociety committees.

Research and Specification Work

Dividing the whole field of the society's work into standardization and research—the latter being directed toward increasing our knowledge of the properties of materials and our ability to measure these properties by test—President Capp asserted that standardization by means of the drafting of specifications has been cultivated energetically and successfully, while research has been left to individual initiative. Partly as a result of this, we are today distinctly behind the requirements of technology and engineering with respect to knowledge of materials and ability to select the right material for a new service, as well as skill in applying tests to determination of quality to suit the required service. For these reasons he suggested organized development of the field of research on the part of the society. Ways and means of doing this were not proposed, but he suggested that if the society devoted as much energy to research as to standardization, the results in the two departments would be more commensurate.

As a measure of the extent to which committee work has progressed, the fact may be cited that at the Asbury Park meeting not far from 100 specifications were dealt with: 28 new specifications were proposed (and adopted) as tentative, 24 earlier tentative specifications were advanced to the rank of standard, and in addition changes were made in 13 tentative and 23 standard specifications of earlier dates. Contrasting with the volume of this work, its importance is probably less than that of the work accomplished in some prior years, as many of the investigations and revisions were concerned with minor subjects or with slight detail clauses.

Technical papers on materials, test methods, and machines or instruments for use in testing made up about one-half of the program of the meeting, as at previous meetings. Various new facts on the properties or the behavior of different materials were brought out, and a dozen or so of new testing instruments and machines was described. One or two papers on the purely scientific side of technology and a number of papers verging on the broader field of engineering manipulation of materials were included.

Three representatives of the society attended the June 3-4 conference at Washington, where the Federated American Engineering Societies was created. The report of these representatives was considered by the Executive Committee in the course of the meeting, and that committe's conclusions announced to the society by President Capp. The authorities were much impressed with the desirability of the federation, he stated, but the conference was so recent that there had not been time to prepare a formal statement for discussion at the meeting. A circular will shortly be issued to the members presenting the history and present status of the whole matter and including also a questionnaire on the various elements of the proposition, through which the Executive Committee will learn the sentiment of the membership as a guide to its attitude. "Our sympathies," said President Capp, "are with the movement." It is possible that a letter ballot on certain definite proposals will be sent out, in case it is thought desirable for the society to take final action this year.

Events of the Year

Independent society headquarters were established during the past year in Philadelphia, in the house of the Engineers Club; during the preceding 22 years of its history the society was directed from loaned offices in the University of Pennsylvania. Within the last twelve months also the society joined in the formation of the American Engineering Standards Committee, and in fact one of its former presidents, A. A. Stevenson, is chairman of that committee. Despite the increase of expense involved by these changes, with a contribution of $1,200 to the Standards Committee and $1,000 to Engineering Council, and in the face of greatly increased publication and management costs, the society showed a surplus of $6,200 for the year after deduction of a $2,000 sinking fund toward the triennial book of standards.

One sore question that has dogged the work of several committees of the society for a number of years was disposed of some months ago by action of the Executive Committee, announced at the meeting. It concerns the inclusion of clauses governing engineering design or construction in a specification for material. The question arose at various times in connection with drain tile, sewer pipe, lime, and gypsum. After consideration of the principles involved the Executive Committee made the declaration that specifications for engineering work should not in general be included in the society's material specifications. As a result of this action the gypsum committee abandoned plans to prepare descriptive specifications of methods of applying gypsum plaster and the like.

George S. Webster, of Philadelphia, was elected president for the coming year; G. K. Burgess, of the Bureau of Standards, Washington, vice-president; and L. G. Blackmer, of St. Louis, D. E. Douty, of New York, Prevost Hubbard, of Washington, and R. S. Whiting, of Chicago, as members of the Executive Committee. A. A. Stevenson retired from the Executive Committee, under constitutional limitation, after nine years service as

officer, including one term as president of the society, the longest service in the society's history. Resolutions of appreciation were passed in recognition of his devoted and efficient work.

Co-operative Work on Specifications

Various committees of the society have worked in co-operation with other societies in the past, but so much new co-operation was set on foot since the 1919 meeting as to give this phase of the specification work a distinctly new status. Most interesting of the items, besides the formation of the American Engineering Standards Committee, is the organization of the new Joint Committee on Standard Specifications for Concrete and Reinforced-Concrete, in co-operation with the American Society of Civil Engineers, American Railway Engineering Association, American Concrete Institute, and Portland Cement Association. The society is represented on this committee by R. L. Humphrey, A. T. Goldbeck, E. E. Hughes, L. S. Moisseiff, and H. H. Quimby, Mr. Humphrey being also chairman of the Joint Committee. This committee was in session during the meeting, almost continuously, endeavoring to outline its program for completion during the current year.

Important cooperation with railroad organizations was started, a new departure. A general scheme of co-operative procedure was formulated by the society and the Mechanical Section of the American Railroad Association, which is to guide joint standardization work in various special subjects. Under this plan a joint committee on Steel Castings for Railroads has already been organized. In work affecting the American Railway Engineering Association it was not possible to arrange for joint-committee work, but exchange of views and other informal co-operation between committees of the two organizations dealing with the same subject was successfully established. The most important items affected at present are steel rails and tie plates. Steps were taken to initiate joint work with the Society of Automotive Engineers in standardization of aircraft steels, but the future of this work is doubtful. Constant touch is maintained with the Boiler Code Committee of the American Society of Mechanical Engineers, in order to keep the requirements of the boiler code and the other codes being developed by that committee in harmony with the specifications of the American Society for Testing Materials.

Concrete culvert pipe is being dealt with by a joint committee of the society, the American Concrete Institute, American Association of State Highway Officials, American Railway Engineering Association, American Concrete Pipe Association, American Society of Civil Engineers, and U. S. Bureau of Public Roads. Standard pattern practice is under consideration by a newly organized committee of the American Foundrymen's Association, National Association of Pattern Makers, Steel Founders' Society of America, American Malleable Castings Society, Metal Division of American Institute of Mining and Metallurgical Engineers, and American Society for Testing Materials. The society also maintains representation on the American Bureau of Welding and the Conference for Standardization of Technical Symbols.

Research into the influence of sulphur and phosphorus on steel quality is doubtless the largest and costliest item of co-operative work begun during the past year. This research is in charge of a joint committee (organized six months ago) of the society, the Bureau of Standards, American Railroad Association, Society of Naval Architects and Marine Engineers, Association of American Steel Manufacturers, War Department, Navy Department, Steel Founders Society of America, and Society of Automotive Engineers. As has already been reported, a full program of the initial test series has been developed, and the steel for the tests has in large part been melted and rolled; tests are now being started.

Close contact is maintained by the society with the Engineering Division of the National Research Council, in which the society has a representative. A research committee of the Engineering Division on the subject of high-speed tool steels is in touch with one of the subcommittees of the society. Another research committee on road construction and highway economics maintains similar contact. It is expected that the society will be represented in the Engineering Division's proposed research work on heat treatment of steels. On the other hand, the Engineering Division has turned over all research in magnetic analysis of steel to a committee of the society.

American Engineering Standards Committee

Standardization of rolled structural steel shapes has been organized under the direction of the American Engineering Standards Committee within the last six months. The society is not directly represented in this work but keeps in touch with it through a committee.

In the development of the work of the American Engineering Standards Committee, seven organizations have acquired representation in addition to those which founded the committee. These additional ones are National Safety Council, National Fire Protection Association, National Board of Fire Underwriters, Associated Factory Mutual Fire Insurance Companies, Electrical Manufacturers Council, National Electric Light Association, and Society of Automotive Engineers.

Two standards of the American Society for Testing Materials have already been accepted as tentative American standards and five others have been proposed to the Standards Committee. None of these include steel specifications, but a number of specifications for steel, iron, and non-ferrous metals are shortly to be proposed for grading as American Standards.

With a view to harmonizing its work with an important development reached by the Bureau of Standards, the Executive Committee of the society adopted the series of standard testing sieves worked out by the bureau, and all of the society's technical committees are now working to use this standard series in their specifications where sieves are mentioned. The Executive Committee also considered adoption of the practice of expressing all measurements in the society's specifications in both English and metric units. This subject, however, is under reconsideration.

New Tentative Standard Specifications

That a wide range of technical activities was covered by the new standardization carried out in the committees during the past year is to be seen from the following list of specifications presented for the first time. All of them were accepted by the society as tentative standards.

Commercial bar steels.
Sheet high brass.
Aluminum for use in manufacture of iron and steel.
Gypsum plasters.
Turpentine.

Wooden boxes, nailed and lock-corner construction.
Adhesive insulating tape.
Workability of concrete for concrete pavements.
Commercial sizes of broken stone and broken slag for highway construction.
Commercial sizes of sand and gravel for highway construction.
Broken slag for waterbound base.
Shovel-run or crusher-run broken slag for waterbound base.
Natural or artificial sand-clay mixtures for highway surfacing.
Method for ultimate chemical analysis of chrome ores and chrome brick.
Method for making and storing specimens of concrete in the field.
Test for unit weight of aggregate for cement concrete.
Method for determination of voids in fine aggregate for cement concrete.
Test for specific gravity of road oils, road tars, asphalt cements and soft tar pitches.
Test for specific gravity of asphalts and tar pitches sufficiently hard to be handled in fragments.
Test for quantity of clay and silt in gravel for highway construction.
Test for quantity of clay in sand-clay, topsoil and semi-gravel for highway construction.
Test for quantity of clay and silt in sand for highway construction.
Methods for sampling of stone, slag, gravel, sand and stone block for use as highway materials, including some material survey methods.

Important Items of Committee Work

Only one new specification was prepared by the Steel Committee (A1) during the year, this applying to commercial bar steels. The well advanced condition of standardization work suggested by this fact appeared to be reflected in the results of most of the other specification committees. Revision of existing specifications was done on a very extensive scale, however. In most cases the changes made were of minor character or in individual detail clauses. This was true of the work of the Steel Committee, but here the revision of two detail items took a prominent position, in one case on account of the very broad importance of the subject, and in the other case because of a conflict that developed in the committee.

Retain Increased Sulphur Allowances

By far the most significant action of the Steel Committee related to one result of the war emergency conditions, namely, the relaxation of sulphur and phosphorus rejection limits by 0.01 per cent (for sulphur in all steels, for phosphorus only in acid steels) two years ago. It has been necessary under the condition of intensive steel production during the war to use less pure fuel and ore than in normal times, in consequence of which it became difficult or impossible to maintain the usual low limits on the two prime impurities in steel. Raising of the rejection limits by the society followed, but at the 1919 meeting the former (low) limits were restored in all classes of steels that were considered specially sensitive to the influence of sulphur or phosphorus. As for the remaining specifications (14 in number, including such important classes of material as steel for buildings and ships, boiler tubes, and steel rails), the restoration of the low limits was postponed until 1920. When the special research into the influence of sulphur and phosphorus was organized, six months ago, a further postponement of the restoration was expected in some quarters. However, the action to be taken remained uncertain until a day before the society's meeting, when the Steel Committee decided to recommend that reduction of the rejection limits in these fourteen specifications be deferred another year. The committee's stated reason was that the difficult industrial conditions which originally called for the increase still obtain. The quality of ore, scrap and particularly fuel is still so unsatisfactory as to make it impracticable, it is said, to work to the former low limits in all classes of steel. Moreover, a change for the better in this condition does not appear to be in sight. The society approved the sulphur and phosphorus recommendation by accepting the committee's report in its entirety.

Overweight of Wide Plates—New industrial conditions made it necessary to revise the existing specification table of overweight allowances on very wide steel plates (132 in. and over in width). This table was intended to apply essentially to widths up to about 144 in. Several mills have recently installed plate rolls of much larger capacity and the allowances of the table no longer correspond to actual overweights. It was proposed in the committee, therefore, that the table be limited to widths from 132 in. to 144 in., and that pending determination of actual overweights individual agreement be relied upon as to wider plates. The proposal was later withdrawn.

Magnetic Analysis of Steel—Experiments aiming to determine the applicability of magnetic analysis to the detection of flaws and non-uniformity in finished steel parts were reported by the committee on this subject (A8). Results of the tests will not be given until next year although twenty-seven railway rails have already been examined. A total of 102 standard rails will be tested, including direct-rolled rails and others rolled from reheated blooms. Other work has been started on forged vane-wheels of steam turbines, on steel pinions for automobiles, on welded joints, on manganese steel, and on the subject of granular structure of steels.

Copper-Steel and Corrosion

New data on the corrosion of different iron and steel sheets were reported by the committee on Corrosion of Iron and Steel (A5). Sets of 16-gage and 22-gage sheets are exposed at Fort Sheridan, Ill., Pittsburgh, and Annapolis, since the early part of 1917. In the two former locations, many sheets have rusted sufficiently to be reported as "failed," and the present showing is strongly favorable to copper-bearing metal.

At Pittsburgh, where the most severe exposure is obtained, the result at the May, 1920, inspection was as follows: Out off 146 sheets of copper-bearing steel and iron (including puddled and ingot iron, open-hearth and bessemer steel, all with copper content above 0.15 per cent, ranging from 0.18 per cent to 0.62 per cent), 42 have failed, or 28 per cent. Out of 84 non-copper-bearing sheets (copper content below 0.15 per cent, ranging from 0.01 per cent to 0.14 per cent), 81 have failed, or 97 per cent. This is after 41 months' exposure.

Tests of exposure of the same materials in salt, acid mine and normal (tap) water are about to be started as a check on the atmospheric-exposure results. Exposure tests of galvanized sheets may also be undertaken.

Nomenclature of Bronze and Brass

Of the large amount of work done by the committee on non-ferrous metals, practically all was in detail revision except for a new specification defining aluminum for use in the manufacture of iron and steel. A new, radical, terminology for brasses and bronzes was proposed by the committee. Leaning on the recommendation of the British Institute of Metals, the committee proposes to designate each alloy by its constituents (for example, lead-zinc-copper, to describe a brass with lead content of 1 per cent), with an added color description

(yellow brass, red brass, yellow-red brass); and for bronzes (tin-copper alloys containing over 50 per cent copper) with the principal modifying element as prefix. It also proposed to designate all metals of the German silver type by the work "nickelene"; and copper-nickel alloys by the term "cupro-nickel" with proper prefix or prefixes (as iron-manganese-cupro-nickel).

Paint and Oil

The committees on paints and oils offered little that was new. Committee D-1, on Preservative Coatings for Structural Materials, besides doing a considerable amount of detail work on paint materials is attacking a new problem with a recently organized subcommittee on Specifications for the Fundamental Requirements of Paint for Specific Purposes. The committee has also followed the work of the Government interdepartmental committee on Paint Specification Standardization, and is shaping some of its own work accordingly. Committee D-2 on Lubricants, hereafter to be called Petroleum Products and Lubricants, presented the scientific results of investigations by subcommittees on sulphur determination and emulsification, the latter including a new test for emulsification.

Douglas Fir Specifications

Definite advance was made by the Timber committee (C-7) through a complete change in its existing specification for Douglas fir timber. Previously this specification referred only to bridge and trestle timbers, and while based on a density rule something similar to the modern grading rule for Southern pine, it proved in practice to be defective. The new specification covers all structural uses of Douglas fir, and classifies the material into dense and not dense (corresponding to the dense and sound yellow pine). Dense Dougles fir shall show on one end or the other an average of six rings per inch and at least one-third summerwood measured on a 3-in. radial line; but coarse-grained material will be acceptable if the amount of summerwood is at least one-half. There are detail rules for applying these measurements, and clauses defining the various permissible defects and the locations in cases of different use where specified defects may or shall not be present. No. 1 and No. 2 structural grades are defined in terms of density and defects. A table of working stresses is appended.

Specifications for wooden boxes, nailed and lock-corner construction, were presented by Committee D-10, on Shipping Containers. These are of new type. They classify woods in four groups, from soft to hard, state thicknesses for the different groups, thickness of cleats, and size and spacing of nails.

A specification of method for testing textiles was proposed by Committee D-13 on Textile Materials and was accepted by the society. This is notable for specifying six testing machines of different capacities for the test of fabrics of different strengths. The several machines, for fabrics of maximum strength ranging from 25 to 650 lb. per inch of width, are limited to capacities of 50 to 800 lb.

Committee D4 on Road Materials was among the most active in the presentation of specification and tests. Four tentative standards were offered for adoption as standard, and five new tentative tests, one tentative method of sampling and six tentative specifications were proposed. In spite of a considerable opposition from the floor to the proposals affecting concrete all of the recommendations by the committee were adopted.

The new tentative tests cover a variety of road materials ranging from specific gravity determinations for oils, tars, asphalts and pitches to quantity of clay in various earthy road material. The new tentative specifications cover commercial sizes of broken stone and broken slag, sand and gravel, specifications for broken slag for waterbound base and for shovel run slag for the same purpose and finally for natural or artificial sand-clay mixtures for highways surfacing. All of the foregoing were adopted with little or no discussion but two proposed specifications on concrete grading and consistency were opposed.

The first of these was preprinted as Proposed Tentative Specifications for Proportions for Concrete for Highway Construction and presented, in mandatory specification form, the various proportions producing a 3,000-lb. concrete as determined by Professor Abrams at Lewis Institute and as published in *Engineering News-Record*, May 13, 1920, p. 964. Before presentation, however, the committee withdrew the tables in their specification form and asked permission to print as an appendix to the report. This was opposed by Richard L. Humphrey, chairman of committee C-2, who contended that the subject covered was specifically concrete, though in its application of interest in road construction, and that therefore publicity should not be given to the matter without conference with committees C-2 and C-9 who are more definitely interested in it. The same argument was made in reference to a proposed tentative specification for Workability (in the preprints, "Consistency") of Concrete for Concrete Pavements (in the preprints, "for Highway Construction"). This is in effect a specification for the "slump" test, and was opposed not only on account of jurisdiction of the committee but also on account of the invalidity of the test. The committee, however, had foreseen such opposition and had obtained a ruling from the Executive Committee to the effect that in this particular case, judgment must be rendered from the floor. By a vote of approximately 40 to 10 the committee was sustained.

Cement and Concrete

Of great importance in the history of the society and of the concrete industry is the announcement of Committee C-1 on Cement that a single American standard specification for cement is in sight. This has been the goal of many years of endeavor but complete achievement has been delayed because of the proposal of the United States Government Departmental Committee to specify, to take effect next January, a fineness with a permissible 20 per cent residue on a 200-mesh screen, as against the Society standard of 22 per cent with a 1 per cent tolerance. In its report this year Committee C-1 announced that after a conference with the government committee it recommended that the 1 per cent tolerance clause be removed from its specification, the intimation being, though it is not directly stated, that the government will withdraw its 20 per cent clause and a universal cement standard will be adopted in which the required fineness on 200-mesh screen is no less than 78 per cent.

Committee C-9 on Concrete and Concrete Aggregates presented three appendices to its report, observations on the effect of organic impurities on concrete, noted on p. 1244 of last week's issue, on methods, of making

compression tests of concrete, and on weight, voids and consistency. The second of the two noted carries nearer the specification stage the adoption of compression tests of concrete. It discusses in some detail such controversial points as quantity of mixing water, consistency or mobility, and proportioning methods. The committee announced that a co-operative series of tests in different laboratories for the study of these controversial matters has been outlined. The committee submitted three tentative tests.

Committees C-4, Clay and Cement Sewer Pipe; C-3, Brick; C-7, Lime and C-8, Refractories, reported little other than the routine specifications noted in the earlier table, either to be advanced to standards or presented as tentative. It is noteworthy that C-4 announced that by letter ballot it had agreed that the specifications for clay sewer pipe and for cement-concrete sewer pipe be presented to the society as separate forms, thus ending a long dispute. C-11, on Drain Tile, has revised its Standard Specifications for Drain Tile, although that standard had been submitted by the society only a few months ago to the American Engineering Standards Committee. The revision consists in taking out from the freezing tests of tile the provisions for previously boiling the specimen. It has been found that this practice causes a considerable decrease in the strength of concretes, even those of some age, and has some slight adverse effect on clay tile.

Committee C-11, on Gypsum, has been very active, as the submitted revisions in tentative specifications attest. In the specifications for gypsum plasters the committee has made the revisions required by the ruling of the executive committee that methods of construction practice do not come under the authority of the society. The same ruling caused Committee C-7 on Lime to disband its subcommittee which was dealing with plastering.

New Committee Work Planned

Steps have been taken to enter into a number of new lines of standardization work during the coming year. Petroleum Products are to be considered by the existing committee on Lubricants, whose scope has been correspondingly enlarged. The broad subject of metallography has been assigned to the former committee on Magnification Scales for Micrographs. Three new committees have been organized to study screen wire cloth, pyrometry, and heavy chemicals. Provision has been made to formulate and compile the technical nomenclature of the various subjects with which the society deals, and to frame definitions of the principal terms. A new start has been made in standardizing methods of testing, by a reorganization of the standing committee on this subject and by arranging for definite procedure of co-operation between this and the various committees on special materials.

Requests for the organization of a committee on standard specifications and tests for sand had been received, but the society decided that this subject could better be dealt with by means of conference of the several committees concerned with sand (such as those on lime, concrete, gypsum and road materials.

Technical Papers on Materials

While contributions on properties of materials were not of prominent importance at the present meeting, a fair amount of new data was presented. A note on relations between composition and structure of bronze, by William Campbell, was of exceptional scientific grade.

Data on other materials brought out included: Figures and plotted curves on the strength and ductility of molybdenum steel, with and without other alloying metals; figures on the variation of strength of malleable iron with size of piece and character of surface; fatigue data on aluminum alloys; proof-test figures on heavy power-forged ships' chains from the Boston Navy Yard; elaborate data on strength of plywood; studies of the relation between seamless and plied tubes in steam hose; examination of the so-called asphalt content in road oils and an investigation of the characteristics of steam-distilled petroleum residues.

Observations on Behavior of Materials

Discussing the internally-cracked condition of rails which has been the center of interest in the study of transverse fissures during the past two years, J. E. Howard gave the results of recent investigations made in connection with a bad train wreck, and explained the internal cracks as being the result of shrinkage after hot-sawing. Active discussion developed, in which, however, the steelmakers' representatives took no part. Stresses induced by cold rolling of metals were studied by H. M. Howe and E. C. Groesbeck by rolling two superimposed strips and measuring the resulting curvature. The report of these results was traversed by R. W. Woodward, W. R. Webster and W. C. Templin, the first-named demonstrating that two thin strips and one thick one behave differently in cold rolling.

Concrete behavior was the subject of four papers which will bear future abstracting. These included a study of stress-deformation and modulus of elasticity by G. M. Williams (U. S. Bureau of Standards), a report on the effect of hydrated lime on the strength of concrete by D. A. Abrams (Lewis Institute), a further discussion of the benefits of rodding concrete by F. E. Giesecke (University of Texas) and report on a newly discovered relation between the surface-area and the bulking of sand by Messrs. Young and Walcott of the Hydro-Electric Power Commission of Ontario. The first two received a great deal of discussion, largely in opposition to the conclusions of the authors.

Testing Instruments and Methods

More than usual time this year was given to the description and discussion of new types of testing machines. These include a ductility machine which weighs the pressure required to produce cupping in sheet metal; a high-speed alternating torsion tester, which utilizes the inertia principle; an automatic elastic limit recorder of the punch type; an instrument for measuring the hiding power of paints; a colorimeter for white pigments; a development of the plastometer to measure plasticity; an automatic cement tension tester which substitutes a liquid under pressure for the usual shot pressure recording; and an apparatus for extremely delicate flexure tests.

Several new test methods were also described, among them a method of determining the weight of zinc coating on a galvanized finished (shaped) article; a porosity test for electrical porcelain, using fuchsine; and an impact-wear test for road concrete. Studies of the accuracy of the Deval abrasion test for rock were reported.

Lining Irrigation Canals with Concrete Without Forms

Permanent Concrete Mortar Lining Economically and Quickly Placed on Canals in Southern California

By Francis Cuttle
President, Riverside Water Co., Riverside, Cal.

CONCRETE lining for irrigation canals to prevent loss by seepage, erosion of the bank, and growth of vegetation is a measure which on account of the heavy expense is generally impossible when the concrete has to be placed in forms. On the lines of the Riverside Water Co., at Riverside, Cal., however, for many years, a plaster concrete mortar lining has been placed with economy and with succeeding low maintenance. The practice of placing the concrete has been so developed that at the present time it is carried on

OLD UNLINED IRRIGATION CANAL

very rapidly as a routine part of the maintenance of the system.

It is obvious that a concrete lining 4 or 6 in. thick of good mortar cast between forms will prevent seepage, erosion of bank, and will eliminate the growth of vegetation; but this is so expensive as to be often prohibitive, particularly in localities where irrigation systems are just beginning and where there have not as yet been any returns from the lands. Twenty-six years ago this condition led the Riverside Water Co. to line a section of one of its canals five miles in length with a cement-mortar plaster ¾-in. thick. This canal is 12 ft. wide on the bottom and 4 ft. deep. It has been subjected to the severe test of having little water in it during the long, dry summers by reason of the fact that it is at the tail end of the system, and being taxed to its utmost carrying capacity during the rainy season; yet this canal today is in good working condition, and has required only trifling expense for repairs during the twenty-six years of its existence.

CANAL BEING PLOWED UNDER PREPARATORY TO PLACING LINING

More recently the company has been lining its canals with a cement-mortar coating 2 in. thick plastered directly to the prepared bank of the canal without the use of forms. Eight miles of such a canal lining were built in 1914 on the line of an old earthen canal of the company that had been in use for forty years. This canal has been in use for nearly six years and has given perfect satisfaction.

It is the present practice of the company to apply this 2-in. lining to most of its canal revisions. A concrete consisting of one part cement, three of sand, and five of stone passing a 1¼-in. screen is used.

A special method of preparing the bank is now in use. First the banks of the old canal are plowed in with a tractor plow and the loose dirt puddled with water. The banks of the new canal are then brought to grade and alignment, the canal being narrowed from 12 ft. on the bottom to about 30 in. on the bottom and the depth increased from 30 in. to about 4 ft. The slope of the sides is about ⅜ ft. to each foot vertical. After the plowed and puddled canal has been excavated roughly to the shape desired iron rods are driven from the top of the bank to the bottom of the slope desired for the finished earthen bank. These rods are driven about 3 ft. apart and are used as the guides on which

PLACING THE CONCRETE MORTAR LINING

CUTTING SLOPES WITH VERTICAL KNIFE

a large heavy knife is screeded to slice the earth into a smooth bank of the desired slope and alignment. This knife is somewhat over 3 ft. in length and is pushed down the slide slope from the top to cut the earth as required.

The sand and crushed rock are disposed in piles about 100 ft. apart along the canal and a concrete mixer mounted on wheels is moved from pile to pile. The material is wheeled from the mixer to the point where work is being done, and shoveled from wheelbarrows directly on the canal bank. Water for mixing the concrete and spraying the banks both before and after the concrete or plastered lining is applied is furnished by laying a pipe along the line of the canal, water being pumped by gasoline engines.

The concrete is dumped over the side of the bank as a fairly stiff mix. A stick 2 in. thick is placed on the prepared bank 3 ft. away from the completed or rather just laid green concrete. A straight edge is then laid from this stick to the surface of the green mortar at the bottom of the canal and is in the hands of two men. Concrete is then shoveled onto this straight edge, which is brought up to the top of the canal filling a section 3 ft. length with the green concrete. The stick is then moved farther along the earth bank and the process repeated. This leaves the concrete in a rough form to be finished with a wooden float.

If the mortar is mixed to a proper consistency, the banks of the canal wet enough but not too wet, and applied in the manner above outlined the mortar will stick to a bank not exceeding 8¾ in. to 1 ft. slope; if it is very wet it will slide down, and in the hands of inexperienced men there may be difficulty in this respect, although with a proper mixture applied in the above manner little difficulty in placing the lining has been experienced.

Very rapid progress has been made in linings of this sort. The old plaster lining was put in, according to the records, at about 1,000 lin.ft. per day. The new 2-in. thick lining can be built at the rate of 100 ft. per hour with a gang of men about as shown in one of the accompanying views.

Common Sense and Engineering

By J. E. Aldred

Mr. Aldred, who has been the moving spirit in a number of the greatest power developments in the United States and Canada, has established at Johns Hopkins University a series of lectures on engineering subjects. The current series he opened himself with an "Introductory Address." The following paragraphs from that address give some rather frank views of engineers and engineering by one who represents capital and managing direction rather than the engineering details of design, construction or maintenance.

I am to say something about the common sense in engineering. When we say "common sense," we mean the application of those fundamental elements of judgment which have, through usage, come under the homely term "common sense." It is more difficult to define than to illustrate. As applied to engineering, it may have no relation to engineering as such, but it may be of great importance as related to the application of engineering to a problem. It is an element which is of importance in the training of students of engineering because, if kept constantly before them, it will, in the process of time, become instinctive in the practice of their profession. It is difficult to overestimate its importance, because it is something which may be passed on through an organization, and it may have a strong influence on the personnel of that organization.

It has been my thought that I might best present to you what is in my mind if I attempted to take you with me through some of the personal experiences I have had in connection with engineering matters, beginning about twenty years ago, when I took up the first large project which brought me in close contact with engineers and engineering problems. This took the form of a development carried out by the Shawinigan Water and Power Co. in Canada. When I found that I was to take up this enterprise, I thought it well to see what work of this character was being carried out at Niagara Falls and elsewhere. When I went to Niagara Falls and looked over the two large plants there—one having been built by the Niagara Power Co. and the other by a company under the name of the Niagara Falls Hydraulic Power and Manufacturing Co.—I was at once impressed by the difference between these two enterprises.

A Comparison of Two Plants

The plant of the Niagara Power Co. had been carried out by the engineers and designers with the effort to make this a show plant; the beautiful powerhouse was designed by no less celebrated architects than McKim, Mead & White. The grounds about the station looked almost like a park, and in the center of the plot, facing the power station, was a beautiful bronze flagstaff. The development indicated that an expensive upkeep would be necessary. The water was brought in from the river in a canal of comparatively small capacity, conveyed to the water-wheels which stood at the bottom of deep pits which had been cut through the solid rock. The water, discharging from these wheels at something like 150 ft. below the surface of the earth, was carried under the city of Niagara Falls in a tunnel which served as a tailrace, and by means of which the water was discharged into the Niagara River below the Falls. Everything about this enterprise indicated a lavish expenditure and a disregard of economy.

The plant of the Niagara Falls Hydraulic Power and Manufacturing Co. showed, in every respect, the opposite inclination. The water was carried in a canal on the surface of the earth to the edge of a cliff, where it was taken from a collecting basin by means of penstocks over the side of the cliff and down to the bank of the river, where powerhouses were built. Here were installed the water-wheels and generators, and the water, after passing through the wheels, simply spilled into the river at the lower level.

The impression made upon me as the result of examining these plants was that the engineer who had carried out the latter development had shown great economy and common sense in the general way in which he had met the requirements. I inquired as to who was responsible for the plant, and met Wallace Johnson, who had carried out the plans. The result of my visit was that when we were ready to go on with our work at Shawinigan Falls I called Mr. Johnson from Niagara Falls to take up the work in Canada; and that decision I never regretted. In all of the work carried out by Mr. Johnson there was constantly in evidence the desire to simplify problems and to apply sound reasoning and sense to the carrying out of every part of the work.

Now, to show how important this is—what a far-reaching influence a man may have on his associates. With Mr. Johnson there came to Canada from Niagara Falls two young men who quickly attracted my attention by reason of the fact that they, too, showed in their work an appreciation of the desirability of simplifying problems and applying to those problems calm and sane reasoning. It is enough to say that one of those men is now the head of the Engineering Department of the Pennsylvania Water and Power Co. and the other is the general manager of the Shawinigan Water and Power Co. in Canada.

Mind you, I do not for a moment mean to convey the impression that these qualities which we designate as "common sense" and "reason" will stand alone. They must necessarily be accompanied by technical training and the brain and ability, without which no man may rise to a dominating position in his profession. But the value of association of those men with that first man who was picked out among engineers as a man who more nearly answered the description of a safe and sane man, of sound judgment and common sense, has been of inestimable value to the men I have mentioned.

$1,000,000 Was Saved

The next large development in Canada with which I was associated was the development of Cedars Rapids, in the St. Lawrence River, and this furnishes a good example of how common sense and reason applies to a large undertaking. The Cedars Rapids development consisted of turning one section of the river bank into a huge canal which, skirting the rapids at this point in the river, gives at the lower end of the canal, under a head of about 30 ft., a large volume of water. When we came to the construction of this project we found it difficult to get contractors to make a reasonable bid for the work by reason of the fact that a good deal of the ground they would require to operate on was under water. After calling in some of the principal concerns in the country we decided that it would be advisable to carry out this work ourselves. We laid out the plant and uncovered the area, exposing the bottom of the river, and after we had put the thing in shape so that everything was visible to the naked eye, we brought in a contracting firm in whom we had confidence to do the work.

It is enough to tell you that this method of carrying out this work resulted in a saving of over a million dollars, as against the best price we had from any contracting concern in the country. After we had worked on the Cedars Rapids for a year and a half, we saw signs of distress on the part of the contractors. They were working on the basis of so much a yard for earth, rock and concrete. They were good men and competent, and we went to them and asked them how they were getting on. And they finally confessed that it looked as if they would have two years' work for nothing. This was not a desirable situation. We had a year's work ahead of us to finish this plant and to put it in operation to meet the requirements of the city of Montreal. I said: "We will put an auditor on your books, and if your statement is correct we will make a new arrangement with you." We very quickly ascertained that they had told us the truth, so I worked out a proposition whereby they would be assured a profit of $150,000. We then said: "Now, go ahead with the work; keep the prices that you have been working under and see what you can do in the end. If you make any saving over and above the $150,000 that we are giving you as a profit we will divide it with you."

They worked up to such a degree of speed and efficiency—and they were employing between two and three thousand men—that during the next year it was perfectly wonderful to see the work go on. The net result was they not only saved the $150,000 that we agreed to give them as a profit, but they saved $75,000 additional, which we divided with them. In other words, the common sense policy applied to this undertaking cost us not one cent, but it resulted in a saving to us and the contractors' making $187,500.

I well remember when I first heard of the work which was to be carried on in the development of power on the Susquehanna River. A friend of mine told me of a visit he had made to the work and described the manner in which it was being carried on. He was familiar with the economical system we employed in our work in Canada, and he was setting up this Susquehanna River work as a sample of the opposite kind of management. After he had described the undertaking and the character of its plans for the carrying out of the work, I said: "Well, we may have an opportunity of taking it over some day." I little realized at the time the seriousness of that statement, but three years later I was appointed receiver for the company. I brought down and put in charge of the completion of this work—the plant was about 50 per cent completed—one of the young men I previously referred to as having come to Canada with Mr. Johnson, and he carried out this huge undertaking—in sole charge of the engineering work—with the net result that the completed plant was at least 25 per cent better than it would have been in accordance with the original plans, and at a cost of something over a million dollars less than the amount which we had provided for him to do the work.

How Foolish Engineers Can Be

To illustrate how foolish engineers can be, I will tell you of one detail in connection with this plant on the Susquehanna River. We found, according to the original plans, that provision was made that the transformer house should stand on a bridge and that the cooling coils for the transformers should be submerged in the tail-race (this was a water-saving device), under the arches of this bridge. Well, as you know, these cooling coils have hundreds of joints, any one of which is liable to leak, and the only way to get at these cooling coils to make a repair was by putting on a diver's suit and going down under the bridge. The absurdity of such a scheme must be evident to anyone, yet this was a scheme devised by one of the well-known engineers in this country.

Now, a word as to the penalty for not applying reason and sense to engineering undertakings. In considering this, please keep in mind that a substantial percentage of the great engineering works undertaken are initial failures. I suppose you hardly realize that, but I know it to be true from a survey made of the principal engineering undertakings in this country and outside, and if it were necessary—but I think it would be inadvisable—I could give you a list of thousands of huge engineering undertakings in this country that have been substantial failures.

Personally I have seen hundreds of reports on water-power projects, but I have never yet seen an unfavorable report. So far as I am personally concerned, there is no such thing. To consider the seriousness of this, I will give you a specific instance that I know of about a company (which shall be nameless) which carried out a large water-power development on this continent on the strength of a report by one of the three or four best-known engineering concerns in America. That enterprise involved an initial expenditure of over seven million dollars. The report set forth that the company could develop an initial 100,000-hp. capacity, and eventually could develop as much as 400,000-hp. capacity. The company has been in operation for ten years now and it has never in any one year developed 20,000-hp capacity. What about it? Here is a report of a reputable (supposedly), well-known, eminent engineering concern, on the strength of which report people made an investment

of millions of dollars. Lost! And any man with sound common sense and any knowledge of the business could have said right at the start that it would be lost.

What does it mean? It means that a lot of lads sitting in a drafting room down in New York designed, subject to a report which they had from some of their superiors, I suppose, a plan to generate electricity by means of water-power under conditions with which they were unfamiliar. They had only surface knowledge, but they wanted to do a job. Engineers always want to do a job of work. They never turn down a job; but what is the net result? The loss of millions of dollars in the course of a work that would do an indefinite amount of harm to other similar enterprises that may be suggested for years to come.

I urge the necessity of bringing to bear upon the student of engineering the influences that will tend to make him more practical and constantly have in mind that an engineering project must check up, not only from the standpoint of the technical and the desirable, but from the standpoint of the reasonable and the desirable, and that the student must cultivate this habit of considering his work from the standpoint of "common sense."

Locating an Underground Water Supply by Water Worn Gravel Clues

By F. S. Tainter

Consulting Engineer, 60 Wall Street, New York City

DEPOSITS of a peculiar gravel found in a deep test trench was the clue successfully followed by the writer in locating an ample source of water supply for the Government Proving Ground at Aberdeen, Md., in 1917, after it had become evident that neither surface or shallow underground water of sufficient quality and quantity were available. This gravel was composed of conglomerate quartz combined with hard slate of varying colors, all much water worn.

Similar gravel was found at a depth of 80 ft. at a well being sunk at another point. Inquiries disclosed the fact that the same gravel had been encountered at a well previously sunk on the reservation. A range was then established, a profile showing surface and known sub-surface conditions was drawn and another well ordered sunk. All existing maps were studied and the gravel already mentioned was compared with samples from various points beneath the bed of the Susquehanna River. The writer also recollected that while building a dam across the New York fork of the Susquehanna River at Colliers, N. Y., 22 miles distant, he had encountered a similar gravel.

Reasoning from the data thus accumulated, a hypothetical line some two miles long was staked out and nine wells sunk along it. At an average depth of 140 ft., in beds of coarse sand and the Susquehanna gravel, these wells yielded some 300 gal. per minute each, but two other test wells, sunk only 125 ft. to the right and to the left of the line, produced less than 40 gal. The water was potable, and required no softening for boiler-feed use.

A careful revisional study of the entire development, supplemented by color tests upon the wells themselves, confirmed the writer in believing that the locations were along the channel of an old Susquehanna delta. At a point some 4½ miles upstream from Havre de Grâce is a rock barrier, on which lies a sand and gravel bottom capable of filtering through to any existing subterranean channels a practically inexhaustible supply of water, which, led gradually to lower levels between two heavy strata of clay, makes its way to the sea under pressure through ancient water courses.

Concrete Base Repaired With Precast Slabs

Patches in Good Condition After Five Years' Use—Method Considered Practicable in Original Construction

By Charles B. Dugan

Engineer, National Steel Fabric Co., Chicago

AN EXPERIENCE in precasting concrete slabs for repairing pavement base, although it is old, is of interest in view of the plan now being considered by the Wyoming highway department for constructing a concrete road of precast slabs. With this experience as evidence, it is believed that precast slab construction is entitled to consideration where local conditions make especially difficult the ordinary methods of molding the pavement in place, or where the last possible interruption of traffic is demanded.

CAST SLABS LAID AND JOINTS FILLED

Due to improper curing and, more especially to the faulty grading of aggregates, numerous failures occurred in widely scattered spots over some 45 mi. of concrete pavement laid under the direction of the California Highway Commission, during the years 1913 and 1914 and on a trunk route, where the original traffic was more than tripled by the attraction of the improved highway. This particular stretch of pavement was laid without expansion joints and the failures occurred generally in the middle of the pavement and immediately adjacent to transverse contraction cracks. Mechanical tests for abrasion, and observation of the extent of ravel at these weaknesses, very closely defined the ultimate dimensions of the failure and after a careful analysis of the extent and cost of replacements, the author conceived the idea of precasting concrete inlays at a central maintenance yard, where the mixing and curing could be effected more thoroughly and with much greater economy, due to the reduced overhead cost and the concentration of labor into a single, efficient gang.

At first the slabs were cast in an irregular trapezoidal shape to fit best the needs of an individual replacement. This plan was quickly abandoned in favor of a uniform size inlay, 18 x 36 in., and 25 per cent greater in thickness than the original pavement. The larger, irregular shaped slabs had the disadvantage of being awkward to handle and of requiring special forms. They also had to be marked with station numbers and loaded in numerical order to insure delivery to their particular locations on the work.

POURING AND SPREADING ASPHALTIC OIL

The stock size of inlay permitted of a standard form, which was developed with a flat bottom and with hinged sides, kept in position by ordinary hasps. The lumber used was all surfaced and tightly joined, and was rubbed down with crude oil on the inner faces of the form previous to being put in use. Excellent results were obtained in a clean-cut, close-grained product and in a long life for the forms. Loops of No. 4 soft iron wire were cast into the slabs toward each end and allowed to project about 4 in. The inlays were dyked and kept under water for two weeks, and, after drying out for an additional ten days, were lifted by means of a 2-in. pipe slipped through the wire loops, and loaded into a 5-ton truck. Abrasion during transit was avoided by using 1 x 4-in. strips for separation.

These slabs were delivered in estimated numbers alongside of the concrete to be replaced. The opening in the concrete was cut out to eliminate all chalky material and was then trimmed back to a vertical face to accept the necessary number of inlays. The subgrade was reduced to permit of placing the inlays flush to grade, and, if spongy, it was excavated and backfilled with graded rock compacted to a maximum degree by heavy tampers. A 1-in. sand cushion completed the foundation. Painting the sides of each block just before it was finally seated insured the best possible bond and a thorough penetration when the mastic filler was poured into the joints upon completion of the repair. The wire loops served as a means of raising and lowering the blocks to eliminate any unevenness in the sand cushion and to bring the surface to a straight-edge grade. They were cut off flush when their purpose had been served.

The accompanying illustrations show a single installation of four inlays with the mastic filler poured. They

COVERING ASPHALTIC OIL WITH SCREENINGS

also indicate the method of replacing the ⅜-in. asphaltic oil cushion with which this particular section of pavement was covered.

This method of repair was put in operation in the fall of 1914 and during the season of 1915, and recent inquiries about the condition of the work indicate its success.

Free Engineering Advice

Speaking on "Some Problems of the Practising Engineer," before the Oregon Chapter of the American Association of Engineers, John W. Cunningham, of Barr & Cunningham, engineers, of Portland, made the following comment on the giving of "free" engineering advice:

Engineers have from time to time, registered a complaint against the giving of "free" engineering advice by governmental departments and notably by departments of the colleges and universities. Actuated by a commendable but misdirected idea of public service, these departments have gradually extended their functions until they cut in appreciably on the opportunities for the engineer in private practice. The United States Department of Agriculture and the associated state extension departments have been particular offenders in this respect. Originally they were intended to help the farmer in his chicken raising, fertilization, control of pests, and similar problems. Now they prepare complete engineering reports on drainage, irrigation and power development, and teach the farmer to lay the grades for his ditches, select and install his pumps and electric plants and design his bridges, and buildings, everything free for the asking.

The writer sees no objection to college and university professors undertaking outside engineering work in their spare time. They should, however, charge for it in proportion to their experience and the responsibility assumed. Such work is both legitimate and desirable to broaden the practical experience of engineering teachers and is only detrimental to practicing engineers when services are given without charge or fee or for a disproportionately low fee.

Free engineering advice by manufacturers and material men should be opposed most strenuously by professional engineers. The field of the practising mechanical and electrical engineers is especially affected by the activities of the machinery manufacturers and their agents. The pump salesman tells the intending purchaser, "You don't need an engineer; just fill out this blank and we will tell you what machine to select and how to install it." The back pages of catalogs have become veritable text-books on engineering. The structural engineer must meet the competition of the free engineering advice by steel manufacturers and sellers of reinforcing metal.

The sad part of it all is that this "free" engineering advice is never in reality free. Where by public departments, it benefits a few at the expense of the general taxpayer. Where it comes from manufacturers or their agents, it enters inevitably into the price paid for the commodity. Free services are usually casual and free advice is poor counsel, and really most costly. The camouflage should be exposed, and those bodies which are supposed to represent engineers should stamp such activities as unprofessional.

Unfair Competition

A form of competition quite difficult for the practising engineer to meet is that of the man entirely competent in his line and regularly employed on a salary, who takes occasional outside jobs for evening or extra work. The right to undertake such work cannot be disputed, but the man who uses this right should not by a reduction of legitimate fees, injure the practice of that other engineer, who has office rent, stenographic services, and other overhead charges to consider before he can count his actual profits.—*John W. Cunningham in a paper before the Oregon Chapter, A. A. E.*

Method of Estimating Sewer Construction Costs

Diagrams Based on Average Gang Performance—Costs Tabulated for Quick Reference—Typical Gangs and Average Machine Outputs

By George C. D. Lenth
Assistant Chief Engineer, Sewer Division, Chicago

During the past year, when prices and wages have varied from week to week, it has been necessary continually to revise estimates for sewer construction. To expedite this task various short cut methods have been successfully employed. Their use is particularly advantageous in making estimates for work which involves the use of excavating machines. Fundamental to these methods is a thorough knowledge of the average performance of gangs in accomplishing given tasks in a unit of time, usually a day. Such performance records, based on data collected over a long period, are presented. From them diagrams have been constructed and cost tables prepared which have a wide utility to engineers and contractors.

The shortage of labor makes it necessary to employ machinery wherever it is practicable. In many instances machinery must be used if the work is to be completed, even if the cost is as great as, or is greater than, hand work. The estimator, therefore, requires definite knowledge of the crew necessary for each operation and a reasonable knowledge of the performance of equipment.

Under the classification of endless-belt machines are included such trench excavators as the P. & H., the Austin, the Parsons, the Buckeye and the Bucyrus. Machine performance and construction crews average about as follows:

Excavator Crew—For steam-operated trench excavators the following crew is necessary: One foreman, one hoisting engineer, one fireman, one laborer supplying coal and water, two laborers loading the machine, one bracer, two laborers aiding the bracer, one bottom man grading ditch, and one watchman; making a crew of twelve. At the present time (May, 1920) the cost of operating a machine of this type in Chicago and vicinity is $120 per 8-hr. day, including the above crew, fuel, depreciation, repairs and interest on the investment. When the rate of progress of the machine is known or determined by experience, the unit cost of

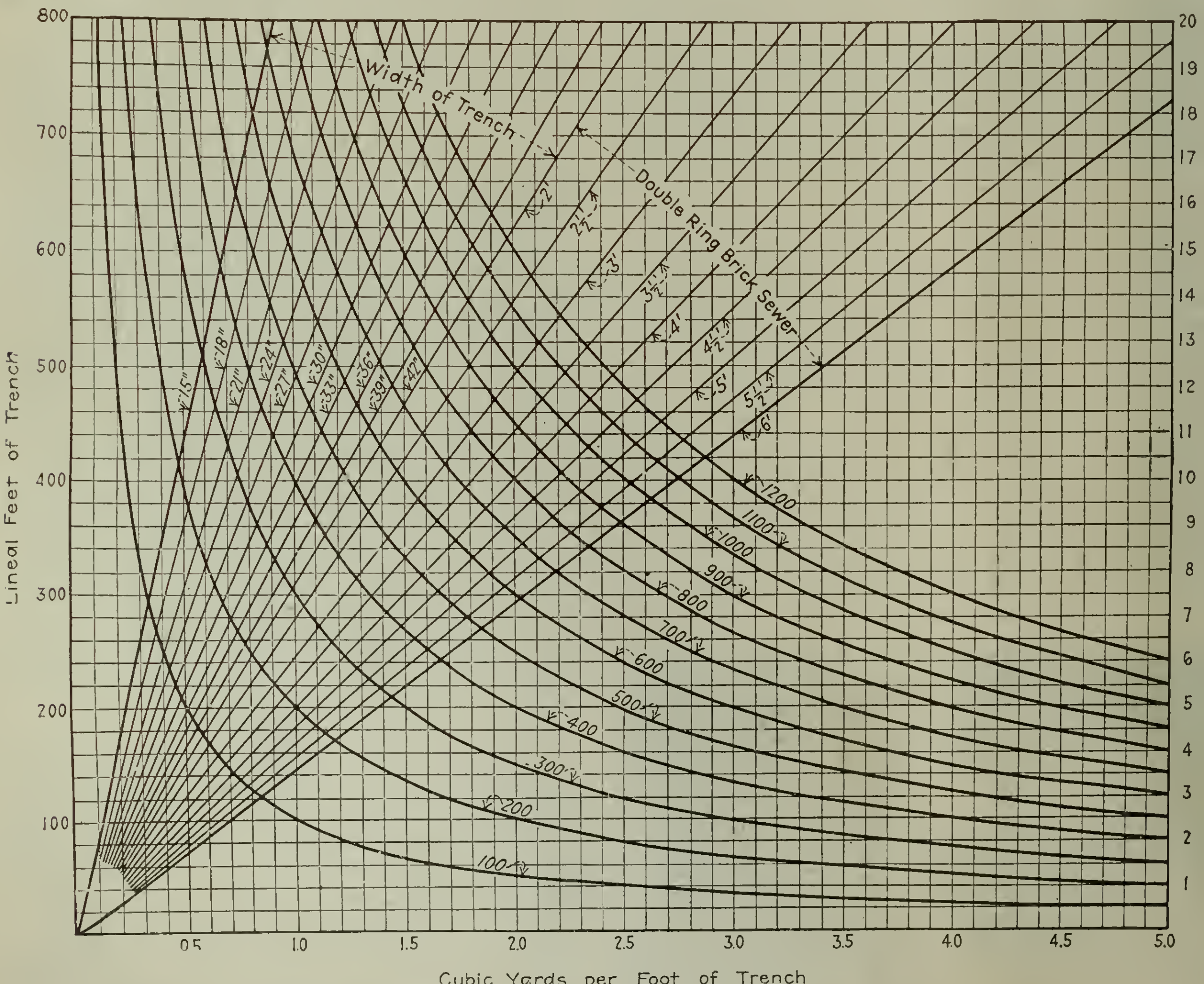


DIAGRAM 1—FOR ESTIMATING PROGRESS OF SEWER EXCAVATION WITH TRENCH EXCAVATORS

excavation and bracing, exclusive of timber, is readily obtained. In this connection the estimator should bear in mind that it is the daily average performance over a period of weeks or even months that must be used in order to be safe. Manufacturers often overstate, or give maximum rates of the output, of their equipment, rather than the average rates.

In the glacial clays of northern Illinois and southern Wisconsin the average rate of excavation per hour, under good condition, is as follows: Depth of excavation less than 8 ft., from 50 to 60 cu.yd.; depth of excavation less than 12 ft., from 40 to 50 cu.yd.; depth of excavation less than 16 ft., from 25 to 35 cu.yd.

Pipelaying Crew—The force ordinarily necessary to lay tile pipe, following an excavating machine, is as follows: One mason, one tender, one laborer lowering pipe, one cement mixer and carrier and four laborers covering sewer pipe and removing sheeting and braces. The cost of pipe laying, exclusive of materials, is $68 per 8-hr. day. The unit cost of pipe laying can be readily determined when the rate of progress of the excavating machine is fixed.

Manhole Crew—The force ordinarily needed to build the manholes, catchbasins, etc., is as follows: One mason, one tender to mason, two laborers and one cement mixer and carrier. The cost of bricklaying on manholes and catchbasins is $44 per 8-hr. day for 4,000 bricks laid, or $11 per thousand of brick.

Backfilling Crew—The force used in backfilling the sewer trench is generally one hoisting engineer and two laborers. The cost of backfilling is $30 per 8-hr. day, including the above crew, fuel, depreciation, repairs and interest on the investment. If it be assumed that a No. 10 Parsons or a small Austin backfiller, on a 300-cu.yd. basis, is used, the unit cost per yard is 10c.

Mason Crew—If the sewer is to be constructed of brick of an internal diameter varying from 2½ ft. to 4½ ft., the force needed is as follows: Two masons, one tender to masons, one cement mixer and carrier, two brick tossers, one brick wheeler and one form setter. The cost of bricklaying is 80 per 8-hr. day, and the cost of laying a thousand brick will vary from $24 on a 2½-ft. double-ring brick sewer to $19 on a 4½-ft., double-ring brick sewer.

When sewers or conduits are to be constructed in trenches whose outside dimension exceeds 78 in., machines of the shovel type, such as steam shovels, dragline excavators and keystone excavators are employed for the excavation. The shovel spans the trench excavated, and is carried on suitable timbers properly braced. It is moved on rollers with the aid of the hoisting engine on the shovel and a cable and dead-man ahead. The rate of progress varies from 60 to 100 cu.yd. per hour, with an average performance of 70 cu.yd. in good soil.

The force necessary on steam shovels is as follows: One foreman, one engineer, one cranesman, one fireman, four bracers, four tenders and bracers, two bottom men trimming ditch, one laborer for supplying coal, water, etc., and one watchman. The cost of operating a steam shovel in Chicago and vicinity is $200 per 8-hr. day, due allowance being made for fuel, depreciation, repairs and interest on the investment.

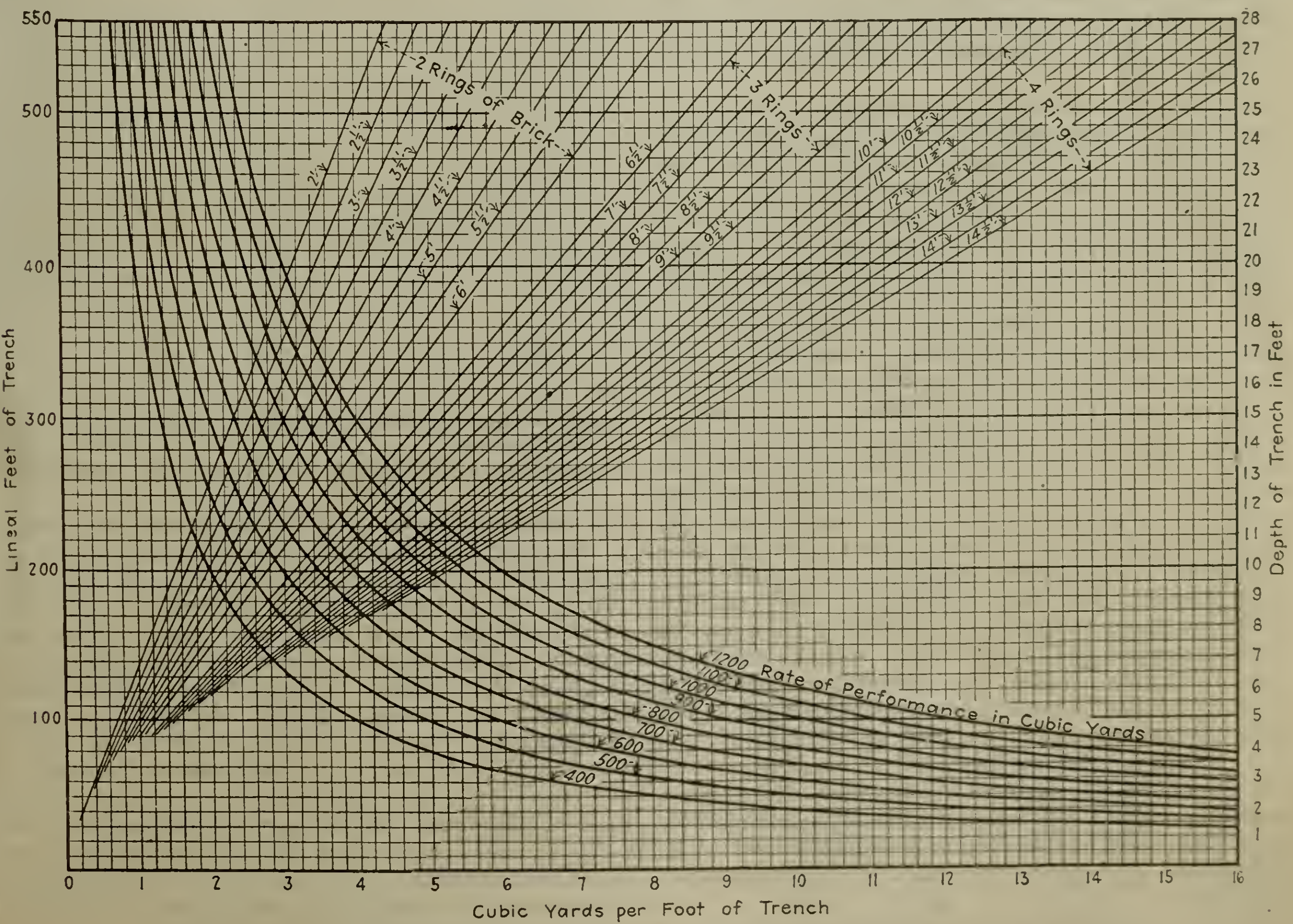


DIAGRAM 2—FOR ESTIMATING PROGRESS OF SEWER EXCAVATION WITH STEAM SHOVELS

In the above units the rate of wages of sewer bricklayers is $1.50 per hour, and the average rate of wages for sewer laborers is $1 per hour.

Unit costs having been established, Diagrams 1 and 2 illustrate the methods of establishing the progress per day. This progress is controlled by the speed of the excavating machine; after this has been determined the organization of the construction forces can be planned.

On Diagram 1 for machines of the endless belt type, the depth of cut is plotted along the right margin; the diagonal lines marked 15 in. to 42 in. are the widths of trench dug by machines of this type, and the diagonal lines marked 2 ft. to 6 ft. are the widths of trench necessary for double-ring brick sewers of the respective internal diameters; the curves marked 100 to 1,200 indicate the rate of yardage per day; the cubic yards per foot of trench are plotted along the lower margin and the lineal feet of trench excavated are plotted along the left margin.

Use of Diagrams

To illustrate the use of Diagram 1, assume a 24-in. tile pipe sewer with a 12-ft. cut. The width of trench to be dug in this case will be 36 in. Along the right margin of the diagram is indicated the cut or depth of excavation. Following the 12-ft. line horizontally to where it intercepts the diagonal line marked 36 in., and projecting this point of intersection vertically, the excavation is found to be 1.35 cu.yd. per foot of trench. Excavating machines of this type will average 300 cu.yd. per day in a 12-ft. cut. From where the vertical line 1.35 cu.yd. per foot intercepts the curve marked 300, project the point of intersection horizontally to the left and the rate of progress found is 230 ft. of trench per 8-hr. day.

Diagram 2 is constructed on the same principle as Diagram 1. The group of diagonal lines marked 10 ft. to 14½ ft. (internal diameter) are the widths of trench necessary for circular brick sewers having four rings of brick laid edgewise, making the total width of the trench at the springing line approximately 2½ ft. greater than the internal diameter. Similarly in the group indicated 6½ ft. to 9½ ft., the width at the springing line is the internal diameter of the sewer plus three rings of brick laid edgewise, which is approximately 2 ft., and in the group indicated 2 ft. to 6 ft., the width at the springing line, is the internal diameter of the sewer plus two rings of brick laid edgewise, which is approximately 1.5 ft. In constructing this chart, allowance has been made for the sloping of the sides of the trench due to excavating with a machine of the steam shovel type. In excavating with a machine of the endless belt type the walls or sides of the trench are practically vertical.

To illustrate the use of Diagram 2, assume an 8-ft. brick sewer with a 20-ft. cut. Along the right margin of the diagram is indicated the cut. Following the 20-ft. line horizontally to where it intercepts the diagonal line marked 8 ft. and projecting this point of intersection vertically the excavation is found to be 7.6 cu.yd. per foot of trench. Excavating machines of this type will average 800 cu.yd. per day. From where the vertical line 7.6 cu.yd. per foot intercepts the curve marked 800, project the point of intersection horizontally to the left, and the rate of progress found is 105 ft. of trench per 8-hr. day.

With the above unit costs and the foregoing explanation of the use of Diagrams 1 and 2, the contractor is in a position to use the cost computation form shown. This form is valuable because it enumerates most of the items affecting the cost of work. A list of this kind often prevents the omission of important items.

The first twelve items constitute the basic information needed for the making of an estimate, the money items of which are numbered from 12 to 36. Items 1, 2 and 12 are the known data; items 3 and 11 are obtained from Diagrams 1 and 2; item 4 is the actual sewer displacement of the finished construction; item 5 is the difference between item 4 and item 3, which is the amount of the backfilling; item 6 is obtained by computation or from a table of quantities; items 7 and 8 are self-explanatory; item 9 is the feet of hand excavation required to be done, such as the hand excavation at the start of the job, adjacent to sewers intercepted, etc.; item 10 is to indicate the number of times the machinery must be taken down and the cost of this entered in one of the blank spaces as 32.

Diagrams 1 and 2 have other uses. The writer has used them quite successfully as a superintendent in charge of construction work on sewer and water systems. Daily reports were received of the average cut

(1) Diameter (internal horizontal)		
(2) Depth of cut in feet		
(3) Total yardage		
(4) Surplus yardage		
(5) Net yardage		
(6) Masonry per foot		
(7) Cost per unit—material		
(8) Cost per unit—placing		
(9) Feet of hand excavation		
(10) Subways, elevated roads, etc		
(11) Rate of progress		
(12) Length		
(13) Excavation—hand		
(14) Excavation—machine		
(15) Excavation—surplus		
(16) Backfilling		
(17) Removal of pavements		
(18) Sheeting and bracing		
(19) Pumping		
(20) Materials		
(21) Cost of placing		
(22) Forms—square feet		
(23) Steel—pounds		
(24) Reconnection of house drains		
(25) Reconnection of sewers		
(26) Reconnection of catchbasins		
(27) Reconnection of service pipes		
(28) Water mains		
(29) Gas mains		
(30) Conduits		
(31) Car tracks		
(32)		
(33)		
(34) Insurance		
(35) Overhead, profit, etc		
(36) Total		

Use for estimate.

COST COMPUTATION FORM FOR SEWER CONSTRUCTION

and the performance of each type of excavating machine, and a ready method was necessary to ascertain whether or not the particular machine in question was performing at a loss or a profit. A base curve was used on the diagram, below which curve the machine was operating at a loss and above which the machine was operating at a profit. The report was received that machine No. 1 excavated 300 ft. of trench 12 ft. cut, 42-in. width of trench. From the diagram the excavation is 1.55 cu.yd. per foot and the rate of the machine 460 cu.yd. per day. The cost per cubic yard on the basis of $120 is 26c. In Chicago, where there are from eight to twelve excavating machines operating on as many jobs, with the average cut and other data known, by means of the chart the writer has thus kept records of cost and performance for each machine.

Electrolytic Sewage Treatment

A Half Century of Invention and Promotion

By Robert Hall Craig,
Sanitary Engineer for Water Supply, Construction Division of the Army, Washington, D. C.

FIFTY years ago C. F. Kirkham, in British patent 2,653 (dated 1870) proposed a filtration process for sewage treatment but suggested: "That on its way to the filters the liquid should pass through a receptacle in which are a number of zinc and copper plates by which arrangement a continuous current of electricity is made to pass through the sewage water and will materially aid in freeing it from its manurial properties." From that time until this, as the following review shows, inventors have busied themselves with attempts to perfect an electrolytic process of sewage treatment, generally by direct action on the sewage but in several cases by the production of hypochlorites from a solution of common salt, the hypochlorites to be added immediately to the sewage being treated.

In 1873, F. H. Atkins (British Patent 556) proposed to "apply galvanic action, magnetic action, or electrical action to filtering apparatus, reservoirs or tanks for the purpose of precipitating organic matters or impurities held in suspension or solution in the water or other liquids." He arranged plates in the tanks and passed electric current through the liquid by using the plates as electrodes.

In 1874, E. H. C. Monckton (British Patent 265) proposed to use "electrified channels for purifying sewage or to drive ozonized water [ozonized it would seem by electrical action] into sewage." He likewise proposed to employ windmills to generate electricity which may be used for treating sewage.

Reviewing the subject in 1888, J. W. Slater, in his book on "Sewage Treatment, Purification and Sterilization" stated that "The action of the electric currents on polluted waters remains to be studied. Laboratory experiments hold out hopes but on a large scale they may prove costly." In a later chapter he states that "another agent recommended is electricity, generally in combination with other processes or agencies." From experiments on a small scale, the writer [Slater] is disposed to conclude that imperfect effluents from any kind of process might thus be brought to a high degree of purity. On the question of working costs it is difficult to decide but probably where there exists a fall of water, or other inexpensive means of turning a dynamo-electric machine, the process might be practicable."

In 1889, William Webster of England conducted experiments with his patented process in which he passed an electric current through the sewage, using iron or aluminum electrodes. He called attention to the oxidizing and precipitating effect of electrolysis and told of the probability of the production of hypochlorites.

Later Hermite of France developed the idea of the formation of hypochlorites from the electrolysis of salt solutions. At Ipswich, England, the Hermite process was used, where the liquid hypochlorite was run into the main sewer. This was abandoned in 1905 after about ten years operation because the results obtained were not commensurate with the cost.

In 1893, at Brewster, N. Y., the Woolf process of producing hypochlorites from a solution of common salt was applied on a small scale to sewage. Soon afterward a much larger Woolf plant was built at Danbury, Conn., but in 1895 the latter place was enjoined from discharging the effluent from this treatment plant into the Still River and filtration was adopted in its place. Practically the same process was used in Bombay in 1897, but abandoned after four months' trial, it being found that the same amount of free chlorine could be obtained from "chloride of lime," at one-half the cost. (Folwell's "Sewerage.")

Fuller, in his "Sewage Disposal" (1912), after mentioning the Webster, Hermite and Woolf processes, says "electrolytic treatment for the formation of hypochlorites is not sufficiently certain to recommend its regular use."

The Harris process of employing electricity was tested on the Passaic River water in 1893. The system was again tested by Fuller, in 1896, at Louisville, Ky., on the Ohio River water for the purpose of "coagulating and purifying the muddy Ohio River water." The conclusion reached at that time was that the process accomplished little along the lines of oxidation but that it did have merit as a means of coagulating the water preliminary to subsidence and filtration.

This Harris-magneto process was installed at Santa Monica, Cal., and was later modified to conform to patents taken out Aug. 2, 1910, by L. G. Lautzenhiser and C. P. Chandler, which patents were an improvement on the Webster process. Because of the rapid decomposition of the upper edge of the iron plates copper strips were placed on these edges and provisions made for reversing the electric current so that wear on plates would be even. It is this company's plants in Oklahoma which were described by J. A. Evans, Engineer State Department of Health of Oklahoma, in *Engineering News-Record*, Jan. 15, 1920, as being practically all shut down.

The writer did some experimental work for the Electro-Sanitation Co. of East Palestine, Ohio, in the winter of 1914-15 at New Brighton, Pa. The process used was that of the Lautzenhiser patents. Experiments were conducted on normal sanitary sewage after it had been allowed to flow through a two-story settling tank which gave a retention period of 1½ hours. The first set of experiments showed a treatment cost for electricity alone at the rate of 3c. per kw.-hr. of $6.58 and the second set of $4.16 per 1,000,000 gal. These costs do not include labor or deterioration of plates, interest on investment, etc., but merely cost of current.

The general conclusions drawn from the results of these tests and from those of Prof. Turley, J. E. Walker and others are as follows:

Advantages—(a) Average reduction total bacteria on nutrient agar at 37.5 deg. C., 82.2 per cent. (b) Average reduction of B. Coli, 92.2 per cent. (c) Produces ferric hydroxide which aids in coagulation, sedimentation and clarification of the treated sewage. (d) Liberates nascent oxygen which destroys bacteria and effects partial oxidation of the organic matter. (e) Requires low sewage head to operate, not more than a foot. (f) Resultant stability is fairly high. (g) Odors are not noticeable.

Limitations—(a) Must be preceded by unit, either fine screens, plain sedimentation or an Imhaff tank, which will remove the suspended matter in order to permit the electric machine to satisfactorily operate. If solid suspended matters go through the machine they will

receive only an external treatment. (b) Septic sewage cannot be run into the machine. (c) Production of ferric hydrate results in deterioration of iron plates, necessitating renewal of electrodes. (d) Requires careful and experienced operation with constant expert chemical and bacterial control. (e) Oxidation is not sufficient under regular operation.

The Landreth process, in which lime is used in conjunction with the electrolytic action, is described as having the following fundamentals: "(1) The production of nascent oxygen and hydrogen by the electrolysis of sewage previously rendered caustic, preferably with calcium hydroxide; the caustic inducing electrode passivity by the formation of an oxide film, and also acting as a precipitant. (2) Removal of the electrode accretions while producing nascent oxygen and hydrogen by electrolysis with electrodes rendered passive in the previous process followed by the addition of a caustic precipitation such as calcium hydroxide. (3) Alternate application of the above processes as occasion demands, to produce nascent oxygen and hydrogen and maintain the electrodes in a passive condition."

An experimental Landreth plant was operated at Elmhurst, L. I., in 1914. A test plant was installed at Decatur, Ill., to treat starch waste and gas plant and packing house wastes. An experimental plant was installed at Easton, Pa., in 1918. Phillipsburg, N. J., and Allentown, Pa., are installing plants of this type and should conclusively show the results of this combination of electrolysis with lime treatment.

The Bull process, in which an electrolytic cell with graphite electrodes is used to produce perchloride of iron by electrolysis of a salt solution and by passing through iron borings the chlorine and hydrochloric acid formed has not been developed commercially. Caustic soda is a byproduct.

It does not appear that the electrolytic processes will supplant the treatment of sewage by the natural biological processes, such as in septic tanks and filters.

Government Standardization in Building Field

If standard specifications could be prepared and agreed upon in a much larger number of cases than has yet been done, it would greatly facilitate the work of architects and builders. And if building methods and the requirements of city building codes could be thoroughly studied and revised this also would aid in reducing building costs. It seems probable that hundreds of millions of dollars could be saved within a few years if a comprehensive and intelligent study were made of all phases of building including fire prevention and the plumbing, heating, lighting, and hardware equipment of buildings. It would also reduce the cost of repairs and maintenance of these buildings; partly because deterioration would be slower and failure would be less frequent, and partly because repairs would be easier and cheaper to make. The government would do only a portion of this work of research and standardization, as many engineering societies, industrial organizations and manufacturers would co-operate. But the government should take the lead, and do an important part of the research work, and nothing which the government could do would be more useful and constructive or would be more appreciated by the building industries and the public.—From an address by E. B. Rosa, chief physicist, Bureau of Standards, on "The Economic Importance of the Scientific Work of the Government."

Experience with Precast Revetment Block on a Dam

Grouting Relaid Blocks with Long Joints Up and Down Slopes Effects Repairs Which Withstand Heaviest Storms

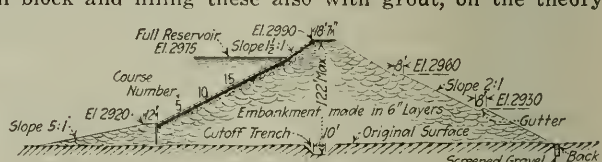
WIND velocities of 72 miles per hour accompanying the heaviest storms have been successfully withstood by the revetment of grouted precast concrete blocks on the slopes of the Belle Fourche dam of the U. S. Reclamation Service. The repairs which had to be made before a stable protection against wave action was obtained and which amounted to making the slopes an unbroken monolith by the grouting of the joints, are described in the May *Reclamation Record* by B. E. Hayden, project manager, Belle Fourche Project.

The revetment on the face of the dam as originally constructed consisted of concrete blocks 6½ ft. x 5 ft. and 8 in. deep, laid on the 2 to 1 slope, and blocks of the same size but 6 in. deep laid on the 1½ to 1 slope. At the bottom of the slope the revetment is supported by a footing of wooden piles and a concrete wall. A parapet wall 2 ft. high runs along the top of the revetment. The blocks were cast at the Snoma gravel pit 6½ miles away on the river bank and were transported to the dam on a narrow-gage railway built for that purpose. The foundation for the revetment consists of a 2-ft. layer of gravel, the top foot of which is screened and the lower foot pit run carrying an excess of sand. From about El. 2,977 to the top of the dam the bed is only 1 ft. thick and consists of screened gravel. Blocks were laid with close-fitting joints although not pointed. Horizontal joints were continuous; vertical joints were broken.

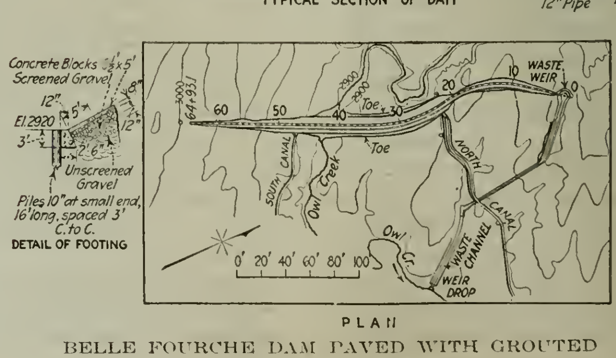
On April 14, 1912, a characteristic seasonal storm occurred, lasting for several hours, with what was estimated to be a 60-mi. wind from the northwest, driving squarely against the face of the dam. When the storm had subsided so that an examination could be made it was found that 230 blocks were dislodged and breaches made in the pavement at various points between stations 29 and 42. The water surface at the time of the storm stood at El. 2,959, or 16 ft. below capacity.

Briefly, the method of repair followed was to refill the breaches with gravel, relay the disturbed blocks 6 to 8 in. below grade, and finish with a continuous layer of concrete to grade. The concrete was reinforced and anchored to the blocks below.

It was decided that all blocks in the "danger zone," (thirteen to twenty-fifth course—there are 29 courses in all) should be secured by filling all horizontal joints with grout and by drilling 1½-in. holes at the lower corners of each block and filling these also with grout, on the theory



TYPICAL SECTION OF DAM



PLAN

BELLE FOURCHE DAM PAVED WITH GROUTED PRECAST SLABS

that the mortar would work down into the underlying gravel and form a lug below the block. Subsequent examination proved that the work as outlined was never accomplished, as in most instances the grout did not penetrate the full thickness of the blocks either at the joints or in the keys at the corners. Very few cases were found where a lug was formed at the bottom of the key below the blocks.

Minor disturbances occurred subsequent to the 1912 storm, but no serious trouble was experienced until May 10, 1916, when a windstorm of considerable violence, lasting for more than 24 hours resulted in the displacement of 366 blocks in the revetment between stations 12 and 44, and in slight disturbances at a number of other points. The maximum wind velocity noted for a short period during this storm was 60 miles per hour, resulting in waves approximating 5 ft. from trough to crest, or about the same as in 1912. Spray from the waves rushing up the slope was carried in sufficient quantities by the wind to thoroughly drench a pedestrian walking along the top of the dam. The direction of the wind was northwest, or normal to the axis of the dam.

Water Back of Paving.—A peculiar condition noticed in both the 1912 and 1916 storms was the spurting of water from the joints at and just above the water line upon recession of the waves. The maximum length of jet noted was approximately 18 in. normal to the surface of the pavement. This would seem to indicate that during the period of recession of the waves a considerable superelevation of water existed behind the blocks at the water line. The height of this superelevation and the forces resulting therefrom evidently overcame the weight and frictional resistance of the blocks and gradually lifted them from their bed.

After studying the effects of the storm and considering various plans suggested to make the revetment permanently safe against damage from wave action, and in view of available equipment and experiments previously conducted, the following plan of repair was adopted:

1. To chisel or V out all joints between the thirteenth and the eighteenth courses to a depth of about 5 in. and to refill with a good grade of cement mortar.
2. To relay all blocks from the eighteenth course to the top of the dam, placing the blocks with long dimensions up and down the slope breaking horizontal joints and leaving the vertical joints continuous; blocks to be placed on undisturbed gravel where possible and great care to be exercised in keeping the surface of the gravel bed uniform.
3. To fill all breachs with unscreened gravel well rammed and puddled.
4. To lay all blocks with open joints 1 to 2 in. wide and to fill the joints with a good grade of cement mortar.

The work of relaying the upper course of blocks was commenced Sept. 2, 1916, under the direction of R. V. Sass, superintendent of construction.

On Sept. 11 the second shift was put on and a little later the third. All three shifts were used until the work was nearly completed. The blocks were handled by a 50-ft. boom, revolving derrick. The blocks were removed in such a way as to form a V-shaped opening in the revetment. The derrick moved along the top of the dam picking up blocks in front and relaying them behind.

The work was carried on in eight-hour shifts with nine men comprising a crew as follows: One shift boss, one crane or derrick man, one swing man and six laborers. Two laborers on the slope in front lifted the blocks and fastened the dogs, and four at the rear smoothed the surface of the gravel and slid the blocks into place. Pieces of wood 1½ x 1½ x 4 in. were used to separate the blocks until they were grouted in.

V-ing the joints was begun on Sept. 19 at station 53 and was carried back to station 4 except between stations 14 and 21, where a projection of high land protects the pavement. Back of station 4 the pavement is not affected by wave action, as it is protected by bending of the shore line. The blocks between stations 4 and 12 were not relaid, but all joints in this section were V-ed to the top of the dam.

The compressor and dinkey used in connection with the chiseling out of the joints were passed around the derrick by means of a temporary trestle. Wagons loaded with gravel for the cement work were swung around the derrick by means of the boom. The chiseling was done with hand air drills. Four drills were used at first, but later five were operated almost continuously with three shifts of eight-hours each. The steel used had a wedge-shaped point slightly bent. Joints were opened to a depth of 5 in. The air was furnished by a compressor having a capacity of 153 cu.ft. per minute, mounted on a flat car and transported on a 3-ft. gage track previously laid along the top of the dam. Power was furnished by an old 18-ton dinkey locomotive—a left-over from construction days. By this arrangement it was possible to move the compressor without delaying the work.

Grout was made with 1 part cement to 3 parts sand, passing a ½-in. mesh screen. For the larger joints a coarser gravel was used in order to get more strength of concrete. The mixture was made quite sloppy and dumped directly onto the pavement at the upper end of the vertical joints. It was then worked down the slope and into the openings. No difficulty was experienced in getting the mortar well into the joints and the gravel bed below. All blocks were thoroughly wetted and all V-ed joints carefully cleaned before grouting was done. Two shifts of eight hours each were used on this work most of the time. Three shifts were used for a short time only. Each shift comprised about 15 men. Light was supplied by eight acetylene lamps. L. A. McConnell was in charge of this feature of the work.

The maximum number of linear feet V-ed per shift of eight hours was 498, and the average per shift was 372. The total number of linear feet of joint V-ed was 49,913. The maximum number of blocks relaid per shift of eight hours was 130, and the average number per shift was 57. The total number of blocks relaid was 6,466.

With comparatively few exceptions the paving blocks were of good quality and were not injured by rehandling. Over a small area, however, well toward the south end of the dam, a rather large percentage of blocks broke while being tipped up for grappling. In a small percentage of instances the grouting and keying previously done offered some resistance to the removal of blocks.

In one place a pocket with an area equal to four or five blocks was found where the gravel had settled away from the pavement at least 1 ft., and the blocks were held up by being slightly arched and tightly wedged together. Slight settlement was noticed in a number of other places, but of so little extent that it probably had little effect on the pavement. In general the bedding of the blocks was excellent, and whatever settlement had taken place in the dam had been followed by a corresponding adjustment of the gravel and paving.

When the work was completed the whole face of the dam took on the appearance of one continuous monolithic slab of concrete. The work was so well done that after a year's time with temperatures from 30 to 110 deg. Fahr. there was nothing more than hairline cracks anywhere to be seen in the pavement, and at the close of the third season (1919) there was still not the slightest suggestion of failure or defect, notwithstanding the fact that during these three years the reservoir has been filled to the spillway crest and the heaviest storm to visit this section of the State since the construction of the dam had been experienced.

New Water-Supply for Phoenix, Arizona

Phoenix, Ariz., has awarded contracts for a 36- and 38-in. gravity redwood pipe line 32 miles long, to bring Verde River water to the city from the mountains to the north. The supply available is reported to be sufficient for a city of 100,000, three times the present population. Phoenix now gets its water supply from deep wells and pumping stations and this source is unsatisfactory because minerals and sulphates in the water shorten the life of plumbing fixtures and give a disagreeable taste. Preliminary work for the new supply is now under way but construction of the conduit will not commence until September, and it will be approximately a year before the line will be completed.

Lake Harbor Planned at Milwaukee

Scheme Adopted by City Contemplates Piers, Terminals and Warehouses on Jones Island and Lake Shore

PLANS for a complete revision of the port facilities of Milwaukee, Wis., which will be executed at the rate of about $500,000 per year, have been adopted by the Harbor Commission and, as provided by law, submitted to the Common Council for approval. The proposed scheme involves an elaborate development of an outer harbor, which has not hitherto existed at Milwaukee, and the addition of terminal facilities on the outer shore of the inner harbor at Kinnickinnic Bay. Preliminary preparations for the work involve the reclamation of land on Jones Island, much filling behind a new bulkhead north of the harbor entrance, and construction of additional breakwater to protect the outer harbor.

At the present time no wharves or terminals exist on the lake front of Milwaukee, but all shipping is taken care of in the rivers emptying into the lake there. Entrance to these rivers is protected by parallel jetties and by a lake breakwater northward of the entrance. The southerly river has natural protection in Jones Island, so called, which is in reality a narrow, irregular peninsula juting out parallel to the shore and at present occupied only by fishing shacks and, at its north end next the harbor entrance, by the new sewage disposal works under construction.

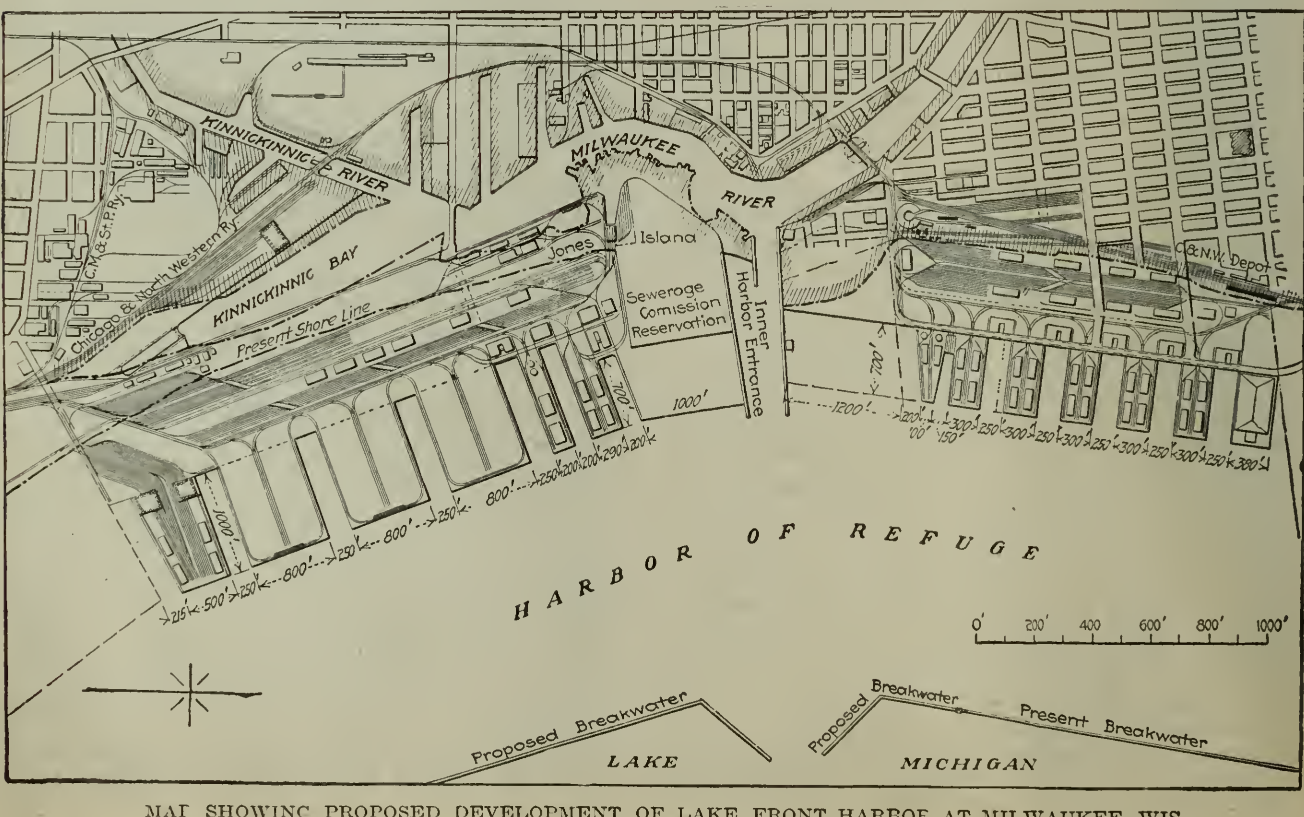
The outlines of the new development are indicated on the accompanying map and comprise three separate sections, one along the inner side of Jones Island, one along the outer or lake side of Jones Island, and one along the lake shore north of the harbor entrance.

Along the inner side of Jones Island there will be a quay extending from a proposed car-ferry slip south of the Sewerage Commission's reservation to an extension of the north side of Greenfield Ave., a distance of about 1,500 ft. Just south of the sewage disposal plant will be the two-car ferry slip 100 ft. wide at its inner end and 150 ft. wide at the outer end. Toward the northerly edge of the quay for a distance of about 300 ft. are located coal pockets for fueling ships and near the south edge of the car ferry slip tanks for fuel oil. South of the car ferry slip and east of the coal pockets is an area of about 600 x 400 ft. for the storage of coal. South of this storage area is one quay unit 600 ft. front and 300 ft. wide devoted, according to the general plan, to miscellaneous cargo.

Between the Greenfield Ave. bridge, which it is proposed will be a bascule bridge with 200-ft. span affording easy communication between the manufacturing district to the west of the river and all parts of the terminal on Jones Island, and the present juncture of Jones Island with the shore is an area devoted to coal storage and, at the extreme southerly end, to a dry dock with appurtenances.

The outer harbor south of the entrance is made up of wide piers extended out from a much enlarged ground area of Jones Island. At the south end is a grain elevator pier, 1,000 ft. in length with a slip on one side 250 ft. wide and on the other 215 ft. Provision here is made for two grain elevators of 1,500,000 bu. each. Next, to the north, would be three large coal piers, each 1,000 ft. long and 800 ft. wide for the handling and storage of coal, each with rear land having a holding capacity of over 400,000 tons. North of these would be two other piers 1,000 ft. in length and 200 and 290 ft. wide respectively. These are to be used for miscellaneous cargo.

North of the harbor entrance there are designed six piers and six slips, besides a recreation pier. Five of these piers are 300 ft. and 700 ft. long; one, 100 ft. wide at the outer end, and 300 ft. wide at the shore end;



MAP SHOWING PROPOSED DEVELOPMENT OF LAKE FRONT HARBOR AT MILWAUKEE WIS.

and the recreation pier, 380 ft. wide and 700 ft. long. The slips vary from 200 to 250 ft. in width. These piers all extend out from the bulkhead line which is at the rubble mound that has just been completed by the city.

As indicated on the drawing, all of the new terminals are fully equipped with railway tracks. The Jones Island development in addition to being tied up by tracks to the car ferry slips is connected at its southern end with main-line tracks running over to the existing railways on the mainland. On the north side of the harbor entrance there are two tracks on each side of each freight pier with crossovers every 100 ft. At the center of each pier will be three tracks with track connections between all the tracks of the pier. There is a railway connection here to the south through Polk St. and with the Chicago & Northwestern Ry. at the north, near Wisconsin St. Viaducts also are indicated over the tracks for roadways to connect with the numerous terminals of the northern development and there is a marginal way paralleling the whole length of the water front.

In general the terminals north of the harbor entrance are for miscellaneous cargo and package freight, although open spaces are provided for coarse or bulk freight on every pier. On each of the five full piers are four sheds separated from each other, each being 200 ft. long and 70 ft. wide with a clear height of 30 ft. beneath the roof trusses. At the head of each 200-ft. slip is a concrete warehouse of six stories so designed that the number of stories can be increased if desired. These warehouses are located 50 ft. to the rear of the front of the quay so that by means of traveling gantry cranes loads can be transferred directly between the warehouses and barges lying alongside of the quay at the inner end of the slip. To the rear of the storage tracks are other additional warehouses in which cargoes can be held either for or from merchants in the adjoining district. Approaches are provided to all these warehouses by roads for trucks and drays as well as by rail.

While on detailed designs are submitted at present, it is intended to provide freight-handling machinery of the most advantageous type in all parts of the port development. Permanent construction mainly of concrete is recommended for these piers and warehouses.

The present work on the harbor consists only in the completion of the rubble mound at the harbor entrance, the filling behind which is also going on, and the construction of a revetment along the inner side of Jones Island. It is intended, however, to proceed with the work at the rate of about $500,000 per year, the money for which is raised by a bond issue. All construction is carried on under the direction of the Milwaukee Harbor Commission, of which W. T. Bruce is chairman. The proposed plan for the development of the harbor was perpared by H. McL. Harding, consulting engineer, New York City, who was retained for that purpose by the Harbor Commission.

Aqueduct Proposed for Argentine City

The City of Mendoza, Argentine, has requested an increase in the municipal water supply. A plan to use the waters of the Rio Blanco, and at the same time to construct an electric power station at the falls of this river has been approved by the governor of the Province and is now before the Minister of Public Works of the nation. The project will mean the construction of an extensive terminal and aqueduct system, estimated to cost $5,590,000.—*Commerce Reports.*

Concrete Road Uninjured By Weight of Ice Jam

Ten-Foot Fill Under 6-8-In. Slab Laid in 1919 Alone Suffers From Heavy Cakes That Bury Pennsylvania Highway

TWELVE miles north of Harrisburg, Pa., the Susquehanna River breaks through a mountain range known locally as the Blue Mountains. The bluffs on either side are quite high and very steep, their shoulders projecting out into the river valley, forming the Juniata Narrows of the Susquehanna. Due to the restricted width the river flows with great swiftness at this point, washing very close to the base of the rock cliffs. Two miles above the Juniata Narrows the Juniata River joins the Susquehanna from the west at a point known as Clark's Ferry. In times of flood the eastern bank from the river junction to the narrows is subject to

FIG. 1. TOP. THE LARGE ICE BLOCK IS IN THE EXACT CENTER OF ROAD. FIG. 2. BOTTOM. THE SAME SPOT WITH THE ICE CLEARED AWAY

severe scouring action, due to the large volume of water from the Juniata forcing the current close to the eastern shore. In the early spring, when the ice breaks up, large cakes are often thrown high and dry on the eastern bank above the narrows.

When the old Pennsylvania Canal was built along the shore of the Susquehanna, the engineers were forced to run its line very close to the foot of the projecting cliffs of the Juniata Narrows. Then the Pennsylvania

FIG. 3. TOP. LOOKING NORTH ALONG ROAD CENTER LINE BEFORE REMOVING ICE. FIG. 4. BOTTOM. SAME ROAD AFTER REMOVING ICE

Railroad built its double track line up the river. At the Narrows the railroad was forced to cut into the rock slopes on one side, and on the other to encroach on the old canal prism with the fill for the right of way.

The State's highway engineers in building a road north from Harrisburg were confronted with the alternative of either going inland over the mountains, which involved heavy grades and longer distances, or following the river and finding a way of getting through the Juniata Narrows. As the road is an important one —being a part of the William Penn Highway and the Susquehanna Trail—engineers followed the latter course, using the towpath of the old canal as the basis of the new road. Considerable heavy filling was necessary to extend the towpath into a modern highway and most of the borrow was taken from the canal bed, being practically the only material available except at prohibitive cost. The fill was built up to from 8 to 10 ft., the upper 2 ft. being cinders. To protect it against being scoured by the river a masonry and concrete wall, rising 20 ft. above mean low water, and with a pipe railing along its entire length, was built between the narrows and a point opposite the mouth of the Juniata River.

The fill was made during 1918 and upon it in 1919 the state highway department laid a concrete pavement of a 1:2:3 mix, 18 ft. wide, 6 in. thick at the sides and 8 in. at the center, and reinforced with wire mesh weighing 25 lb. per 100 sq.ft., such a design being the Pennsylvania standard.

The severe winter just passed covered the watershed of the Susquehanna and its tributaries with a heavy blanket of snow and held the Susquehanna ice-bound for 80-odd days. A warm rain and a rising temperature over the western part of the watershed brought the Juniata down in flood. The ice at the junction was breaking but had not begun to move. The great mass of ice and water from the Juniata added to the congestion at the narrows and mountains of ice were piled high at this point. As it did not break, ice above the narrows piled higher, reaching the eastern shore, and making for what was considered one of the worst seasons in the history of the river.

The water and ice backed up over the river banks causing considerable damage in the town of Duncannon on the western shore, and covering the road with 5 ft. of ice and water on the east. This condition prevailed March 7. The Juniata subsided below the level of the road March 10. The following day, however, the Susquehanna broke—which made matters worse as the ice in the narrows still held. The gorge cleared March 14 and as the water subsided a deposit of ice cakes ranging in size from 2 ft. square to 20 x 30 ft., and $2\frac{1}{2}$ ft. thick was left on the road.

This deposit was three or more feet in depth and covered a section above the narrows about 1,600 ft. long, and below the narrows 1,000 ft. Following the breaking up of the ice the water fell rapidly, causing considerable damage to the fill below where the ice had jammed. The fill was thoroughly saturated during the period of the flood and for some time thereafter and the road was subjected to not only the weight and action of the heavy ice cakes but was undercut in places as much as three ft. How the fill suffered is shown in an accompanying photograph. Knowing the character of the foundation many engineers doubted that they would find the slab entirely uninjured when the ice was cleared away.

By March 20 the force of men that the state put upon the road had practically cleared it of ice and

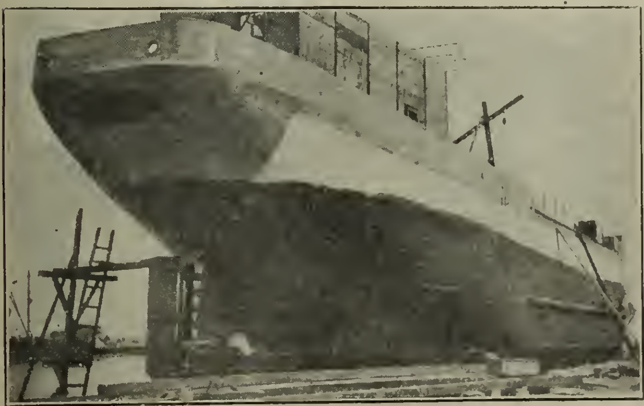
FIG. 5. THREE-FOOT UNDERCUT FAILS TO INJURE CONCRETE SLAB

debris. Smaller cakes of ice were either thrown or pushed off the road, or butted off with motor trucks. The largest cakes were removed by fastening chains to them and hauled to points where they could be dumped into the canal.

An inspection of the road made April 1 failed to show any damage to the pavement as the result of its unusual experiences. The fill, however, had been damaged somewhat and the pipe rail was entirely destroyed in places, the posts being driven into the ground by the weight of the ice. The concrete wall protecting the river side of the fill was undamaged. A series of photographs was taken when the ice covered the road and after the road had been cleared and several of them are reproduced herewith. They were taken in sets to show the same spots, during the ice jam and afterward.

Experimental Concrete River Steamer Is Built in Argentina

CONCRETE for ship construction has been used experimentally for one small river steamer in Argentina, according to information from the United States Department of Commerce. The accompanying view shows the vessel on the ways. It has a length of 131 ft., beam of 23 ft., and the depth of the hold is 16 ft. Its displacement is 600 tons and carrying capacity 450 tons and is driven by two 50-hp. oil engines, which give



600-TON CONCRETE RIVER STEAMER ON WAYS IN ARGENTINA

a speed of 7 miles per hour. This power plant will later be replaced by two 100-hp. engines. It was built for river service, and is now making regular trips between Buenos Aires and Montevideo. The vessel was designed and built as an experiment by Hume Bros., a company of Anglo-Argentine civil engineers. In spite of a great need for river boats the company has had to prove the value of the concrete ship by actual operation. The ship was used for three months to carry sand and stone from Sauce, Uruguay, to the Argentine port of La Plata, on which work it brought in a net profit of over $5,000, U. S. currency. The cost of construction was somewhat higher than for a wooden ship of equal size on account of the experimental nature of the work, but the builders state that the price can be reduced considerably below that of wooden ships. Lumber is scarce and expensive in Argentina, and it is hoped that the river service companies will look to the concrete ship as a solution of the demand for tonnage.

Industrial Decentralization as a Cause for Regional Planning

By Thomas Adams
Town Planning Advisor, Canadian Commission of Conservation. Ottawa, Ont.

IT HAS come to be recognized that the planning of cities and towns involves consideration of wider areas than are comprised within the arbitrary boundaries of municipalities. This is partly due to the need of making the boundaries of city plans adaptable to conditions of natural topography, which too seldom influence the selection of the administrative boundaries of cities, but it is also due to the modern tendency of manufacturers to locate their plants outside the city boundaries and thereby create wide belts of industrial development all around the city areas. The need of planning of these new regional developments is creating a serious problem for all growing cities.

In nearly all countries that have city planning legislation, including several states in the Union, the need for planning suburban regions surrounding cities and towns is recognized by the power given those municipalities to approve the planning of subdivisions within three to five miles radius outside their boundaries.

These considerations are chiefly responsible for the movement that has come to be known as regional planning. Many of the forces that formerly encouraged concentration now encourage the dispersal of industry. As factory buildings become old, and less adaptable to new processes of manufacture; as room for expansion in crowded cities becomes more restricted; as transportation and highways improve, the balance of advantages in favor of dispersal grows in volume. Transportation facilities, for the majority of industries not needing water communication, are better outside than inside cities.

There have been only two serious obstacles to the movement toward dispersal, namely, the limited area for obtaining a supply of power and the absence of housing accommodation in country areas. The first of these obstacles has been removed in many districts by the development of the system of distribution of hydro-electric power over wide areas. The difficulty of obtaining housing accommodation in rural areas still operates to prevent the removal of works away from existing centers of poplation, but it is not sufficient to stem the tide of industrial migration from the cities.

Reasons for Removal of Industries

An investigation being made in Montreal and Toronto for the Canadian Commission of Conservation by Capt. G. H. Ferguson, M.E.I.C., shows how strong the centrifugal movement of industry is in these cities. The chief reasons found to influence manufacturers in moving away from the central areas of the chief cities in Canada, are, in the order of their importance: (a) To obtain room for expansion of works where land can be purchased at moderate prices. (b) Improved railway facilities. (c) Lower assessment with lower taxes. (d) Better conditions for the persons employed in the industry. (e) Better quality of labor. (f) To obtain better premises and lower insurance rates. (g) To centralize a more or less scattered plant at one headquarters. (h) To be adjacent to works engaged in allied industries. (i) To be adjacent to source of raw materials. (j) Lower rates for power service. (k) Improved facilities

for delivery of product to residential portion of city. (l) Freedom from dust and dirt of a location in the central portion of the city. (m) Freedom from arbitrary city by-laws.

In America established industries are leaving the cities and migrating to semi-rural districts.

The large cities that are losing their industries and revenues should consider how to convert the movement to their advantage and prevent serious losses of revenue by reduction of assessable values and how to prepare regional plans so as to prevent the recurrence of evils that have caused the dispersal of industries from the city areas. This movement is taking place under conditions that will inevitably repeat the same evils unless the new areas are properly planned.

The Disease of the Modern City

There is a growing body of opinion in favor of the disintegration of existing large cities. This opinion appears to be based on the assumption that the size of cities is in itself an evil—whereas the real evil is not the extent but the character of the growth. The modern city is not suffering from any excessive natural growth, but from a sort of elephantiasis, caused by congestion and speculation obstructing the vessels of the civic body that are necessary for natural growth. The disease can be prevented by proper city planning, but if once allowed to become severe it may be necessary to amputate the parts most affected and replace them with new parts. Such is the solution suggested for the slum areas at a cost that is almost prohibitive to the average city.

The want of proper control of land development causes not only undue density of buildings in parts of our cities and undue scattering of buildings in other parts, thereby increasing taxation and driving industry away, but it also increases the difficulties of carrying on business with despatch and efficiency, and the straining of public utilities beyond their capacity.

The scattering of residences and factories over our suburban areas—which, with proper planning, should be a most beneficial movement—causes loss and injury to the community by reason of the haphazard development and the consequent waste of public utilities. As unplanned cities grow, the costs of administration increase rather than decrease. Transportation, while becoming more centralized, becomes more rather than less costly. All the advantages of better sanitary conditions are lost for lack of air space around the

The growing cost of food is not entirely due to war conditions. It has been partly caused by the artificial cleavage set up between the city and the country. The present tendency toward decentralization, if properly organized, could help to remove the causes of this cleavage. Hundreds of thousands of acres are lying idle around American cities waiting for buildings that will not come for generations and producing no food at the door of the consumers. While the widening of the area of urban development is a good thing in itself, it is losing most of its advantages because of this wasteful speculation and want of planning.

Most of our cities and towns are facing financial problems created by the above conditions that will tax the wit of man to solve in the near future.

The difficulty of curing the disease in the existing city has given rise to proposals made in England for creating new towns on new sites. A garden city is a self-contained town developed on an agricultural site by securing a concerted movement of manufacture from crowded centers; having the greater portion of its area permanently reserved for agricultural purposes so as to combine town and country conditions; so organized as to give to the inhabitants the benefit of the increase in land values due to the conversion of the site from agricultural to industrial purposes.

The ready acceptance of the belief that manufacturing cities are a natural growth and not an artificial creation has made it difficult for some people to realize the practicability of the creation of new towns. Natural law has much to do with the concentration of industries in particular localities, but in the main, cities and towns are artificial creations. Dr. Arthur Shadwell, an English publicist, expresses the view (*Industrial Efficiency*, p. 47) that "industrial districts become so by reason of natural advantages" and that this is not fully realized by promotors of "garden cities." This is only a half-truth. Industries are constantly changing their locations, in spite of the lack of organization and means to facilitate the making of changes. Dr. Shadwell admits it, in contradiction of his own view that "those who cry 'back to the land' and advocate the removal of industries to the country do not seem to be aware that it is perpetually going on. Factories are constantly being put down in country places." This industrial movement is proceeding rapidly in spite of the natural tendency for industries to remain rooted in the wrong location, long after it is proved to be economically unsound to remain in them owing to the cost of removal and the difficulty of transporting skilled labor from one place to another.

Sites selected for new towns must possess two of the primary essentials of manufacturing industry that depend on location, namely, proximity to raw materials and marketing facilities or transportation. The third essential, cheap power, may also depend partly on location but largely on the absence of the hampering conditions and vested interests of old established communities, and on the value of planning the producing plant and system of distribution in relation to a well-planned and concentrated factory area. In this respect the building of a new town affords an opportunity for substantial economies and improved facilities. The fourth essential, skilled labor, can be attracted anywhere if good housing conditions are provided, and in this connection the "garden city" has the advantage over the typical higgledy-piggledy town that has grown up in the past.

There are plenty of sites with great natural advantages in America and Britain for building new towns and the regional survey is the first step necessary to ascertain the best situations for such towns.

Whether our solution of the problem of city growth and industrial expansion be by controlling and planning metropolitan areas within and adjacent to existing cities, or by planning and developing new cities, it must be based on regional units of area and not limited to individual cities or parts of cities.

It is certain that in the future science will be applied to town development as it has been applied in the past to the development of the mechanical processes of industry. When that time comes we shall have both new towns and new suburbs of existing cities organized and planned, in the interests of health and convenience. For both purposes the regional survey and the regional plan of area adaptable for industrial development are essential preliminaries.

Earth, Clay and Sand Roads—Their Improvement and Maintenance

Extracts from a Paper Read by A. R. Hirst Before the Seventh Annual Canadian Good Roads Congress, Winnipeg, June 1-3

SOUND advice for that large body of engineers whose chief concern is the proper improvement and maintenance of rural highways was embodied in the paper read before the seventh annual good roads congress held under the joint auspices of the Canadian Good Roads Association and the Manitoba Good Roads Association, by A. R. Hirst, chief engineer of the Wisconsin State Highway Commission. The chief points emphasized by Mr. Hirst are reproduced herewith:

(1) Earth roads will, for all time, comprise the largest fraction of our road mileage; therefore their intelligent construction and maintenance are of paramount importance.

(2) They should be given a proper cross-section adjusted to the soil of which they are made and to the drainage conditions prevailing, as rapidly as funds can be made available for the work. Gang maintenance grading methods should be used where funds are not available for the final grading.

(3) They should be well drained by providing them with proper ditches, waterway structures of adequate size and blind stone or tile drainage where necessary.

(4) The most careful attention should be given to the real road terrors—those sections upon which traffic is constantly being stuck. Such sections constitute an astonishingly small percentage of the total mileage of earth road, and cause an astoundingly large percentage of the traffic troubles on earth roads.

(5) The grading and draining of earth roads is of little value unless it is immediately supplemented by an intensive system of patrol maintenance.

(6) The surfaces of many earth roads should be modified by application of the proper material if they are to be maintainable properly and are to give efficient service.

(7) These modifiers are: For sand roads, clay or clay gravel; for clay roads, sand or sandy gravel.

(8) Given proper drainage and the proper modification of the top surface, earth roads will give satisfaction during the summer traffic season on roads carrying almost an indefinite amount of traffic.

(9) They will, however, if on clay, fail to give service on very heavily traveled roads and practically on all other roads during the spring break-up and during prolonged wet seasons when their surface cannot be given effective smoothing.

(10) The maintenance of earth roads should take the form of patrol maintenance, a man and team or a man and motor truck being given a specific section of road for the condition of which section he is made entirely responsible.

(11) The best tools for the maintenance of earth road surfaces are: (a) The light two-horse blade grader, and (b) the Minnesota or the Wisconsin planer. Split logs and other forms of drag should be seldom because they go down into every transverse depression and upon every transverse ridge and accentuate these defects instead of removing them.

(12) Very moderate crown should be used on the traveled way of all earth roads. They should be maintained flat until the road has to be made ready to go into winter quarters when the crown should be increased.

(13) Most of the modifications for earth road surfaces to make them more maintainable and more passable are slow processes. Additions of material are best made a little at a time and then worked, mixed, and smoothed, additional material being used as necessary until a maintainable surface is finally secured.

(14) It is obvious that in practically any unit of government, given the alternative of spending all of the highway funds available in regrading and draining earth roads and in the modification and maintenance of their surfaces, or of expending all of the funds available in the construction of a few miles of surface roads, the people of the unit of government will receive much more benefit if the money is expended in the regrading, draining, modifying and maintaining.

(15) This does not mean that I believe that construction should be neglected. It must be pushed as fast as it can be financed, but the speed of construction can well be retarded, if necessary, to provide for the proper maintenance of all important roads.

Cement Testing Steamer Heated By Electricity

Home-Made Apparatus Suitable for Small Laboratory Made with Special Constant Water Level Device

By Howard H. George

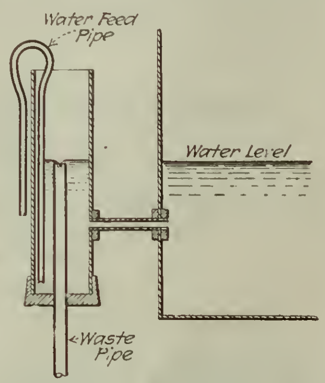
Assistant Engineer, Public Service Ry. Co., Newark, N. J.

AS PART of the equipment of a small cement laboratory in connection with the construction of the Public Service Terminal, at Newark, N. J., the writer had occasion to design and build a small heater to be used in the steam tests of the cement. The location of this laboratory was at a point where no gas supply was available and where the use of a gasoline heating unit was prohibited because of the fire risks. The source of heat was therefore restricted to electricity, direct current from the 550-volt trolley circuit being the only current near enough to be readily connected with the laboratory.

The boiler was the 12 x 12 x 24-in. standard copper vessel with tray and lid, containing two steam vents for insertion of thermometers. A special constant water-level device was designed which shows very plainly in the accompanying view. It consisted of a small brass cylinder, open at the top. A nipple con-

COPPER STEAMING APPARATUS WITH ELECTRIC HEATING COILS AND CONSTANT WATER-LEVEL DEVICE

nected this with the water chamber. Running through the bottom was a small copper waste pipe, the top of which was set at such a level that the overflow began when the water in the boiler had reached the desired level. The water-supply line was another small copper tube curved to enter the cylinder at the top and discharge in the bottom. During the operation of the apparatus a very small flow of water was sufficient to maintain a constant level in the boiler. The operation of this device is shown more clearly in the accompanying diagram.



SECTION THROUGH CONSTANT WATER-LEVEL DEVICE

The heating unit consisted of five coils in series, each wound on an $\frac{11}{16}$ in. mandrel, 20 in. in length. They were copper wired with sheet mica insulation and had eleven turns per inch. A $\frac{3}{16}$-in. rod runs through the center of each coil with hard rubber caps at each end. The five coils, designed for 110 volts each, are connected in series on a 550-volt d.c. line and consume 8.2 amp. It proved very satisfactory and efficient.

The following data are of interest in connection with the length of time required to bring the water to the boiling point by this method:

Volume of box, 12 x 12 x 24 in.	3,456 cu.in.
Volume of coils and water, 12 x 12 x $5\frac{13}{16}$ in.	1,674 cu.in.
Volume of air and steam	1,782 cu.in.
Volume of water	1,603.44 cu.in.
Area of heating surface	231.94 sq.in.
Volume of coils	70.56 cu in.
Temperature of water at starting point	53° Fahr.
Temperature of room at starting point	63° Fahr.
Temperature of room when water reached boiling point	67° Fahr.
Time required to raise water to boiling point	30 minutes

Making Wood Fire Resistant with Paint

Fire retardent paints are the most practical means so far discovered by the U. S. Forest Products Laboratory by which small amounts of wood can economically be made fire resistant. The only other known methods of decreasing the inflammability of wood are to keep it wet, or to inject into it certain chemicals under pressure. These methods, though more effective than painting, are usually either impracticable or too expensive to be considered. Ordinarily calcimine or whitewash has proved in tests to be as fire resistant as any paint covering tried. It is cheap and convenient to use. Although it will not prevent the burning of wood exposed continuously to a high heat, a good coat of calcimine on wood will decrease the danger of a blaze spreading from burning cigarettes, sparks, matches, and similar small sources of fire. Calcimine is, of course, more effective for inside than for outside use.

For exterior use numerous patented fire retardent paints are available. An effective outdoor paint which has been developed at the Forest Products Laboratory consists of linseed oil, zinc borate, and chrome green. This paint has maintained its fire resisting properties through more than three years of exposure to the weather.

Engineers—From the Business Man's Point of View

Extracts from Address by Homer L. Ferguson, Past-President of the U. S. Chamber of Commerce, Before the Organizing Conference of Engineering Societies, Washington, D. C., June 3-4.

As I understand it, the main purpose of your meeting is to co-ordinate in some way the engineering societies and the engineering thought of the country, as embodied in those societies, and to perform public service. So, as far as the cooperation of the individual engineer in business matters and in his organizations is concerned, I can assure you it can be done, because I have been doing it in a number of ways for the last six or seven years, and there is nothing connected with the game to be frightened at. In fact, engineers have a distinct advantage over business men in that they may easily and readily qualify as business men in practically any capacity, and practically no business man, as such, can qualify as an engineer. And so, to cooperate individually as engineers, all that is necessary is to assert your rights and your duties as business men. And that can be done in any community. Business men, in my experience, welcome it. They are glad to have your advice, and there are practically no problems concerning local business administration in which the engineer is not needed and not welcome.

Engineer Needs Self-Confidence

The only disadvantage the engineer labors under, or the only two disadvantages, so far as partaking in public assemblies is concerned, are, in my judgment, first, a reserved modesty which the practice of engineering rather enforces on a man; and, second, an ability to write a lot better than he talks. If I could change the engineering courses in the colleges of the United States, I would put in the curriculum the means to teach engineers to think on their feet. All of us know engineers of the highest attainment who, when asked to participate in a problem involving large amounts of new business, frequently act as though they have a "gold brick" to sell. They have been so modest that they have been unable to express themselves forcibly to business men, who want quick action, who want to be assurred by a more or less dominant note in a man who is negotiating with him.

I started out as an engineer, and, if you will pardon a personal reference, was in a business where the engineering was difficult enough, I believe, but where it depended absolutely for its continuance on public policy—on politics, in other words. And along with a great many engineers in my particular calling, that of ship building—we have had to come to Washington year after year for 25 years with our hats in our hands, asking that our business be considered as a national business; as vital to the best interests of the country. We were not listened to. We were considered as lobbyists, and not a line and not a word was written into the law affecting the sea that was desired by any ship owner or ship builder for 15 years.

You civil engineers went down and built a big canal, and then our lawmakers passed a law that American citizens could not own a ship going on that canal if, at the same time, they owned stock in a transcontinental railroad. And so, along with others, I made up my mind that if it was not possible to convince business men and my own associates that in the case of my particular business, which is a world-wide business, that we had a real case, that we deserved the backing of business men, there was not any need of going to Washington and talking to any one in political life. So I switched off engineering, pure and simple, and went into the publicity business on a large scale, and have been practising it more or less since. You won't have anything much in any business, nowadays, unless the voice of the profession to which you belong is heard.

Take for instance the recent railroad case. I know of a gentleman in Congress who voted in favor of the prohibition of strikes on railroads—I mean, the kind of a strike where everybody agreed to quit and not let anybody else

work. Every labor organization in his State went after him and from them he received thousands of telegrams, but he received only one letter, a very modest letter, from a business man, commending him for his stand. Notwithstanding that, there were at least 200,000 business men who thoroughly approved of his stand, but no one said so. There is such a thing as having brains and experience, but they do not do much good if you keep them to yourself. And that is particularly so here. The danger, as I see it, of any national organization is that it shall be used as a means of partisan politics, or promoting the interests of any particular party or of any particular man. As soon as it takes on that phase it loses its strength as an organization representing the sentiments of any class of citizens or of engineers. As soon as we get into the expert testimony class we lose something of our character as broad-gaged engineers.

Government an Engineering Job

The Government work is so vast and covers so many fields that it seems almost impossible for any group of men to grasp it all; and yet, in my judgment, there is engineering in it from start to finish. The things that are in the public mind today, like the budget system, the good roads movement, the rehabilitation of the railroads, water power conservation, the fuel question, the question of great central power plants for the conservation of fuel and for the purpose of utilizing railroads to the best advantage, are all in their essence engineering questions, and it thus remains for the engineers to take part in these questions. The difficulty with public service, gentlemen, is that you cannot put your finger on the thing that you did, unless, of course, you are a politician, and claim everything.

Work is accomplished by joint action. It is just like the movement of great bodies. Individual glory does not come to any man. The work can only be done through a sense of service and at a considerable sacrifice and effort. But, nevertheless, it needs be done. It needs to be done in a thousand different ways. And engineers, as citizens and as business men, who do not take part in public affairs are entitled to no more sympathy than the man who criticizes, for instance, the action of his Government, local, state or national, and yet does not exercise his right to vote and participate in political affairs. The advantage that engineering influence in the country would have over any other sort of organization, unless it were perhaps the medical man, would come, in my judgment, from their training. If we are taught anything at all it is to recognize the truth when we see it, and to know that red figures cannot be turned into black figures by argument. We do not seek to twist every fact we see into something which conforms to ideas which were inherited, let us say, when we were 21 years old, when we first voted. We seek the truth and speak the truth, and we stand for the one big idea on which the safety of the Republic rests, and that is proper information and education. We stand for the truth. We want the truth to be known, and we should insist that in large matters involving the expenditure of huge sums that it should be known as nearly as it may be known before the work is undertaken.

The Public Interest Neglected

Now, we have engineering societies which never affiliate with each other much. We get together and congratulate each other once in a while and discuss matters of interest. We seldom discuss things of public interest. We seldom discuss matters in relation to public affairs; and, in the meantime, we have in this country a great group of educated men who come pretty close to running the Government. Of course, the judiciary must be made up of the lawyers, and most of the administrative forces of Government are generally from the legal profession, and a very large majority of the legislative forces of Government are generally from the legal profession. Why? Their education is not more fundamental and no more general than that of engineers. It is because they have been trained to public service. It is because they have been trained to public speaking. Now, in the olden times I daresay the work of lawyers and the work of teachers and the work of preachers was the most important work that could be performed by any man in a public capacity. But who can say now, in these days of modern industry, that the profession of the engineer is not the most vital of the public professions? I believe it; and, as far as business men are concerned I have never hesitated to tell them that the engineer is the vital connecting link, and he is entitled to a voice. He can easily have a voice by simply getting up and being heard.

Much comment is seen in any paper you pick up of Labor running the world and of Capital running the world. Very little is said of the element of management and of brains. Gentlemen, brains run the world. Without them the vast resources of a power like Russia are inert and worthless; and without them, the millions of men in China, wonderful workers, are worthless. The connecting link between the two comprises those engaged in the engineering profession, and they are the people who have made it possible for the poor to have more than any or our fathers and grandfathers had, and for them to live in a state of comfort and decency wherever they have a mind to work.

Field for Constructive Work

I have not any suggestions, gentlemen, to make as to how the work here in Washington could best be done. I do know that there are public agencies with which this organization can become affiliated. I know there is a great deal of work to be done where specialists and experts are needed in connection with proposed legislation and present legislation, and that real constructive work can be done by men who are willing to give of their time and services to do this work. In the Chamber of Commerce of the United States, during the past five years, we have had to seek all over the United States to find men who are able and willing to give of their time in the preparation of reports on which business men throughout the country to the extent of 1,200 or 1,500 base their judgment as in favor of or against a particular thing. It has been very difficult to get men to do this work, and I am particularly delighted to know that these great societies have taken up this work of public service, because it is the most necessary and the most fundamental work in this country today. Eternal vigilance is the price of liberty, and those of us who love our country and who are willing to serve it anywhere must realize that only by serving it can we possibly make it a country worth while; that we have a real duty to perform as Americans; that we must not expect and will not get any pay for it at all, and frequently there will be a great deal of criticism. But I believe it is vital that our people should know the truth, should be advised of the truth in time, and put men in positions, not to represent themselves, not to represent special interests, but to represent the sound engineering opinion of the United States.

Meters Pay and Make Everyone Pay

The Commission has continued its policy of placing meters as rapidly as possible. On Dec. 31 the service was 92.2 per cent metered—there being only 64.9 taps on the flat rate—and we hope during the coming year to have all of these services metered. Too much importance cannot be given to the matter of metering the water to customers. In the first place, in a municipally owned plant, in which all of the citizens are interested, it makes everyone pay for the water used by them, and therefore, throws no burden on any one. In the next place, it is gradually making for better plumbing and more attention being given to the water supply by each one of our customers. Metering has meant the saving of a water famin in our city. It has converted an unprofitable run-down plant into a profitable, gradually improved efficient one, with no hardship on any one who uses, but does not waste the water. It would be utterly impossible for the Commission, with the present perfectly adequate water supply to the needs and uses of the town metered, to supply enough water to the city were it not for the meters.—From 1919 Annual Report of Commissioners of Public Works, Charleston, S. C.; J. E. Gibson, Manager and Engineer.

Design of an Octagonal Reservoir at Enid, Oklahoma

Depth and Shape for a Capacity of 2,000,000 Gallons Investigated for Economy Under Present High-Price Conditions

By I. S. Siegrist
Assistant Engineer with Black & Veatch, Consulting Engineers, Kansas City, Mo.

AMONG the improvements to the water-works system of Enid, Okla., now under construction, is a 2,000,000-gal. covered low service octagonal concrete storage reservoir, built half in excavation. The reservoir will store water from a new system of wells. Careful investigations were made of the economical depth of reservoir, shape and design of sections under present high-price conditions.

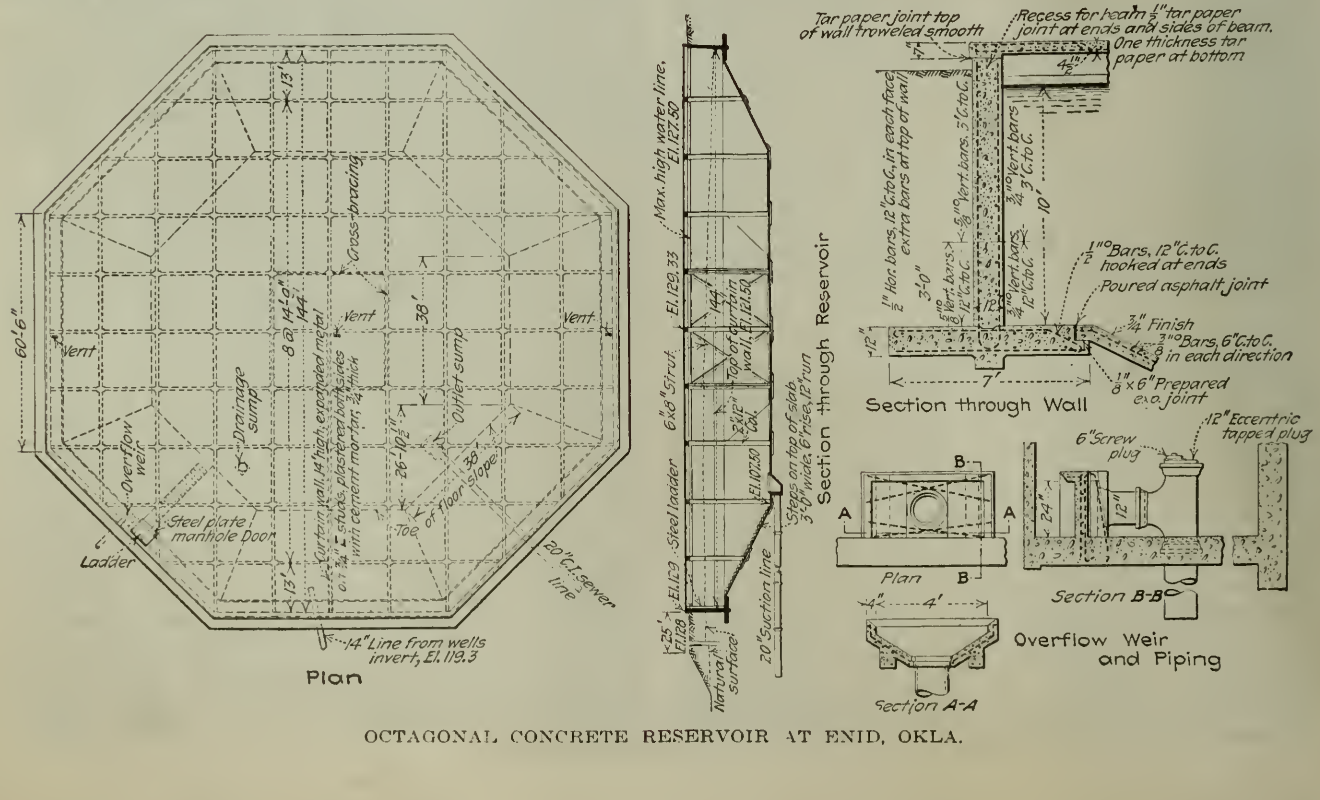
Analysis showed that a reservoir with a sloping bank surmounted by a low wall was more economical than one with a wall the full depth of the reservoir. It was then necessary to determine the proper depth and the best shape for the reservoir. The sloping bank is entirely in cut. The wall is designed to support the backfill with the reservoir empty and to carry the water pressure without placing any reliance on the backfill. On account of the somewhat large area, the expansion in the roof slab will be considerable, and the wall was therefore designed as a cantilever, with an asphalt joint at the roof. The resistance of the backfill was taken as an additional element of safety, and also to provide against certain possible contingencies not considered in the design, such as uplift under the footing and thrust from the expansion of the roof. The base is designed so that the resultant falls near the edge of the middle third.

An extended investigation was made as to the economical depth. It was not necessary to consider the drainage, so that cost alone was the determining factor. On account of the easier analysis, a reservoir of circular shape was assumed, and estimates of cost were made for reservoirs of depths of from 12 ft. to 26 ft. It was found that the cost decreased with the increase in depth until a depth of 24 ft. was reached. The decrease was slight for depths below 20 ft. and that figure was therefore used in the design.

In a comparison between a square and a circular reservoir, it was found that the latter would have 64 ft. less length of wall and would cost approximately $1,000 less than the square reservoir, taking into account the extra cost of forms and columns. Even with this estimated difference in cost, some hesitancy was felt regarding the circular shape, on account of the possible difficulty in building forms and securing a true circle. The octagonal shape then suggested itself as a means of avoiding the more difficult form work required by a circular shape, and upon analysis it was found that the quantities were only slightly greater, and the cost probably slightly less, than for the circular reservoir. The octagonal shape was therefore adopted.

The roof columns and beams were of usual design, the live load being taken as 50 lb. per square foot. On account of the light loading and the height, the columns were designed with a radio of length to diameter of 20.5. The compressive stress over the whole section was 173 lb. per square inch and the stress due to moment caused by unequal loading was 120 lb., giving a total maximum stress of 293 lb. per square inch. The allowable stress by the Los Angeles reduction formula on the columns as designed was 390 lb. per square inch.

The cross bracing at the center of the reservoir was designed to carry the thrust due to an unequal movement of the roof slab under expansion, which could be calculated only approximately. It was assumed that the weight of the slab and live load for half a panel over the projected diameter of the reservoir rests on each of two opposite walls, and that one side sticks and the other slides easily, so that the difference in the coefficients of expansion is 0.5. This is an extreme assumption, and struts designed to resist this stress should carry any load that may come on them.



OCTAGONAL CONCRETE RESERVOIR AT ENID, OKLA.

The bottom slab was reinforced so as to have 0.3 per cent of steel in each direction. The footings under the columns were designed to spread the load from the columns. After the design had been completed the floor was checked as a flat slab by the Chicago code and the stresses were found to be conservative.

The reservoir was designed by Black & Veatch, consulting engineers, Kansas City, Mo. The contract has been awarded to the Smith-Graham Construction Co., of Augusta, Kan.

The Value and Application of a Traffic Census

Extracts From Paper Read Before Seventh Canadian Good Roads Congress By W. A. McLean, Deputy Minister of Highways, Ontario

ROADS should be built for the traffic they are to carry. This is an axiom of road building which cannot be too strongly emphasized; but which by many road authorities has been met in a hazy, experimental manner, and without proper consideration of probable traffic; and the quality of wearing surface, its width, and the strength of foundation adapted to anticipated traffic. As a result, we find single-track gravel roads where double-track roads or a concrete pavement should have been built; and, conversely, asphaltic pavements are rolling and disrupting in idleness where a good gravel roadway would better serve every purpose.

It follows, then, that adequate information as to traffic is desirable as a rational basis for designing the road or pavement which is to serve any given location; and as a basis for determining whether an expenditure of $1,000, $10,000 or $50,000 for any given work, would be justifiable.

The value of a traffic census has limitations which are at once evident. Thus, the amount of traffic which will pass over many roads after construction, may bear little relation to the traffic over the unimproved road. In such cases, it is the potential traffic of a district which should be considered, rather than existing traffic; but definite data, obtained from actual count, is of use in determining the probable traffic which the improved road will be called upon to carry. Thus on the Toronto-Hamilton highway, traffic amounted to from 300 to 700 vehicles per 12 hr. at various points; but with the completion of the concrete pavement, these figures leaped to 2,500.

Potential Traffic Estimate Essential

The potential traffic of a district, preceding the construction of a road, is a matter for careful estimate; just as probable traffic for an electric or steam railway may be based on the population and industries served. A somewhat interesting series of charts was published in the report of the Ontario Highway Department for 1915, a net result of which was to show that not less than 80 per cent of the traffic of the province is carried by 20 per cent of the highways; that 80 per cent of the roads are but lightly traveled, and are such as can be adequately built with a single track of gravel or broken stone. Also that few roads serving a purely rural population would be required to carry a maximum of traffic much in excess of an average of 200 vehicles a day.

Traffic in excess of that amount, except adjacent to the largest cities, may usually be attributed to interurban influences.

Knowing the potential traffic of a district, the highway engineer turns to data of the carrying capacity of various types of road and pavement—a matter in which there is room for much diversity of result. For example, limestone gravel has less wearing capacity than a gravel from trap or granite. The foundation and subsoil have a decided bearing on the case. Roughly, and with scope for such modification, the wearing capacity expressed in vehicles per day, of various materials as used in Ontario, may be broadly gauged from the following schedule:

	Single-horse	Two-horse	Light Trucks or Pass Cars	Motor Trucks	Total
Single-track gravel	40	15	20		75
Double-track gravel	50	50	100	5	200
Water-bound macadam (single track)	50	30	40		120
Water-bound macadam (double-track)	90	50	100	10	250
Double-track gravel, oiled or tarred	175	75	400	10	660
Double-track macadam, oiled or tarred	200	150	600	10	1,000
Macadam penetration bituminous	200	300	1,000	50	1,550
Macadam foundation, bituminous concrete	200	400	2,300	100	3,000
Bituminous concrete on cement concrete foundation	200	400	4,200	200	5,000
Cement concrete	200	200	4,400	200	5,000

Among the purposes which a traffic census may serve are the following:

1. To determine the traffic importance of one road as compared with another in the same system, and thus to differentiate between different roads as to community value. This data may be useful in laying out a system, especially with a view to granting government subsidies.

2. To determine the traffic value of the same road before and after improvement. Such information is useful in determining the economic value of highway improvement.

3. To determine the increase of traffic on the same road during a period of say five years, by two different censuses. Such data is useful in anticipating future increase in highway travel.

4. To determine character of traffic, whether farm, local between centers of population, or tourist, and thus to arrive at a fair distribution of cost.

5. To determine respective percentages of horse-drawn, passenger car, and motor truck traffic, and by comparing previous censuses to estimate future changes with a view to adjusting type of construction.

6. To determine total gross tonnage passing over a fixed point for a period of 12 daylight hours, in conjunction with the speed at which this tonnage travels, useful data in determining: (a) Amount of wear, including impact and displacement resistance sustained by a certain type of roadway, comparing this with maintenance charge per year; (b) whether such roadway is economically fitted to bear this gross tonnage.

7. To determine the importance of various phases of traffic, and therefrom determine the loadings and speeds which should be permitted; viz., for purposes of traffic regulation.

Modern Traffic Demands

In a review of the road situation in the British Isles and a forecast of what future demands will be made upon the highway designer, Sir Henry Maybury, Director of Roads in the British Ministry of Transport, recently told members of the Institute of Transport at its first meeting that modern traffic demanded, in addition to durable, dustless non-slipping and noiseless surfaces, the following:

1. For its great trunk roads a width between fences of 100 to 120 ft. with possibly a central ballasted tram track screened by trees.
2. Carriageways of minimum camber—say 1 to 30.
3. Improved sight lines at road intersections.
4. Road corners curved to a wide radius.
5. More permanent road surfaces needing less frequent renewals.
6. Rapid access to the great airdromes which will be located at the outskirts of all popular centers and for which town planning schemes will doubtless make provision.
7. Adequate footways to insure the safety of pedestrians, who are now in danger on pathless roads between steep banks.
8. Fewer grade crossings and swing bridges, especially in dock areas.
9. Stronger bridges.
10. By-pass roads to enable the fast traffic to avoid congested areas.
11. Well smoothed-out gradients and the suppression of hogbacks over culverts.

Working of Laws Regulating the Practice of Engineering

Extract from Paper by T. L. Condron, chairman of Engineering Council's Committee on Licensing of Engineers, presented June 21 to Western Society of Engineers

IN ORDER that there may be a clearer understanding of some of the annoyances and difficulties resulting to engineers from registration or license laws, comment will be made on some of the requirements. The clauses providing for issuance of certificates to all engineers practicing in the state when the law goes into effect, may be disregarded here.

In nine states certificates will be issued only to those passing an examination: Colorado, Florida, Idaho, Illinois, Iowa, Michigan, Oregon, Virginia and Wyoming. In most of these states, an engineer holding a license to practice in another state where a similar law is in effect may be excused from an examination. Consequently, regardless of the qualifications that an engineer may have or of his experience or reputation, he must submit to an examination, the character and scope of which is uncertain, before he will be permitted to practice his profession in these states. For instance, in the State of Illinois, a non-resident must have passed an examination in some other state having equal requirements to be exempt from examination under the Illinois law. Consequently, men, eminent in the profession and with many years of successful practice, are required to take an examination in the same manner as those just entering the profession. Efforts are now being made to have this ruling with regard to the Illinois law changed.

Engineers do not find their field of practice limited to a single locality as is generally true for physicians and frequently true for lawyers, but an engineer's practice usually extends over several states. Engineers of reputation are frequently summoned, on very short notice, to advise and pass upon propositions outside of the state in which they reside. It is therefore against public policy to bar experienced engineers from interstate practice because they may not have qualified in each and every state by taking examinations and obtaining licenses in advance of any professional engagement in such states.

To obviate this difficulty, the proposed uniform law of Engineering Council stipulates that a non-resident engineer may legally offer by letter, announcement or otherwise, to practice in the state without first obtaining a certificate. A non-resident engineer may also legally practice not to exceed 15 days in any calendar year without being registered, provided he is legally qualified for such professional service in his own state or country. This clause is intended to cover cases of professional consultation on emergency work.

An equally important provision is made to cover the case of a non-resident or newly-arrived engineer called upon to practice professionally in a state in which he is not registered. He is to be legally permitted to practice after he has filed an application for registration, for such reasonable length of time as the board requires in which to consider and grant or deny his application.

No such provisions as these just outlined appear in most of the registration or license laws now in force in several states, and engineers are certain to find that these laws, if enforced, will cause them embarrassment and annoyance as their practice extends beyond the state in which they are residents.

Engineering Council has not formally approved the uniform law recommended by its committee, principally, I believe, because Council is awaiting the decision of the American Institute of Architects as to whether it will approve or oppose the inclusion of architects and engineers under one registration law. Moreover, the Institute of Mining and Metallurgical Engineers has formally expressed itself as not in favor of the registration or licensing of engineers. It seems to make very little difference whether individual engineers are in favor of such legislation or not, because of the fact that eleven states already have enacted such laws, *and it is now important that the engineering profession unite in demanding uniformity of legislation and the elimination of unnecessarily burdensome requirements.*

Experience With Riveting Snaps in Scotch Shipyards

VAGARIES of performance of construction tools have no geographical limitations. In the January and February issues of its *Transactions* the Institution of Engineers and Shipbuilders in Scotland is found discussing the same problem of breakage of pneumatic hammer riveting snaps that is familiar to the American erector, fabricator and shipbuilder. It is apparent that design, material (and its heat treatment) and handling all have a part in determining the span of life for a snap, subjected as it is to rapid alternations of compression, tension and bending.

Two variations from standard design (which is much the same as the American standard) that had an influence in reducing breakages were (1) a snap head with hole drilled down the center of the shank to a point well inside the head, and (2) the collarless snap, in which the fillet it either greatly increased in radius or eliminated. In Scotland just as in America it is at the fillet that failures almost invariably start. High-grade crucible carbon steel, heat-treated to give a hardened face and end but with the temper drawn from the middle of the shank to afford maximum toughness, is preferred by most of the Scottish shipbuilding men, it seems. Several methods of manipulation in heat treatment were discussed.

The importance of the handling that the tool received was proven by a test in which one lot of snaps was divided between a yard of the Clyde and one on the Tyne. "The former were broken at once, while the latter all worked well. Two snaps from the lot sent to the Clyde were transferred to the Tyne and worked well, while two transferred from the Tyne to the Clyde were at once broken." The most obvious differences in handling were in the "angling" of the hammer and in the amount of play allowed the snap out of the barrel of the hammer. The greater the angle from the axis of the rivet at which the hammer is "rolled" around an imaginary cone in heading up, and the greater the distance the snap is allowed to rebound at each blow, the more severe the strains set up, and the shorter the life of the snap. Cold rivets and insufficient air pressure were factors in increasing breakage, in the opinion of one of the discussors of G. D. Hollis' original paper, who added that the better riveter a man was, the less he rolled his hammer.

Zoning Proposed for San Francisco

A tentative zoning ordinance for San Francisco has been prepared by the City Planning Commission after a year of field work and map preparation under the direction of R. S. Woodward, of the city engineering department. Six zones are proposed. The first would be for single-family dwellings. In the second zone all classes of residences would be permitted, besides various other buildings not considered detrimental to a residence section. The third zone would be commercial, but the same sort of residences as are allowed in zones 1 and 2 would be permitted. Zones 4 and 5 are light and heavy industrial districts, and zone 6 is the slaughter house and generally unrestricted section.

Notes from Foreign Fields

BRIDGE ERECTION IN HONDURAS

By W. T. Penney
GENERAL CONTRACTOR, GUATEMALA, CENTRAL AMERICA

TORRENTIAL floods are perhaps the chief danger to the bridge erector in most South American countries. Since the operation is typical of the conditions and also affords a record of fairly rapid work, the recent erection of a railway bridge in Honduras will be described.

In 1914 the writer entered into a contract with the government of Honduras to erect the bridge at Pimiento, the terminal of what is known as the Puerto Cortez railroad, some 50 miles in length, extending from Puerto Cortez to Pimiento. The bridge consisted of two spans, respectively 450 and 90 ft., and their necessary foundations. It was erected in quick time, taking into consideration the isolated country and the labor employed, which consisted of four American bridge men and some American negroes, together with natives of Guatemala and Honduras.

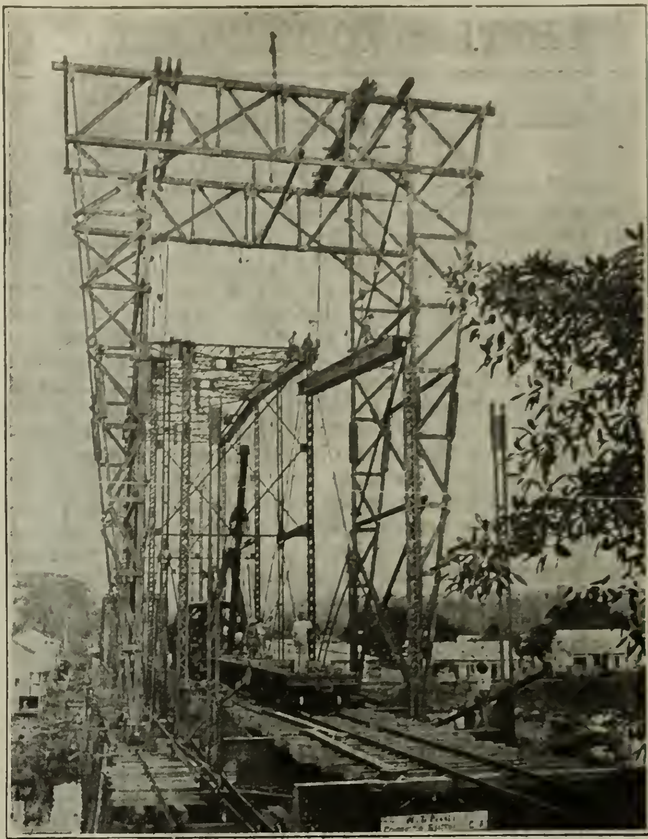
The Uluea, over which the bridge is located, is one of the largest rivers in Honduras. The water is low and safe for falsework five months of the year, but the balance of the year the stream is a raging torrent, carrying, among other things, immense trees. It behooved me to get my falsework in before the flood period. In making this assertion I know whereof I speak. Some few years ago I erected a number of bridges for the United Fruit Co., in Bocas del Toro, Panama. The camp was some distance from the bridge site. The particular span was 300 ft. long, was erected, pinned, bolted and partly riveted, but not anchored. The falsework was removed. There was a very high rise in the river during the night and when the crew returned in the morning the span had disappeared—left for parts unknown. The drift had completely carried it away.

To return to Honduras: Fortunately both abutments were on high ground, thus permitting us to get them in, and all other preparations made for a quick start when river conditions permitted. The bridge steel, the traveler and the timber for falsework were on the ground and checked out accurately.

The equipment was first class, consisting of two hoisting engines, a steam hammer No. 2, an orange peel dredge and a compressor fully equipped, together with all other necessary tools. The railroad company, luckily, had some good steel flat cars, one of which was promptly appropriated for a derrick car. When this was completed it picked up the 12-ton end posts and the 10-ton top chords. All the work was done with this car with the exception of placing the end posts, raising the top chords and a few of the intermediate posts, which was done with the traveler.

The floor system was placed as the falsework proceeded, thus making one operation and saving timber. The boom of the derrick car was made long enough to drive bents 30 ft. apart. No leads were used. The one river foundation consisted of two sheet pile cylinders, excavated with the orange peel dredge, and concreted with a bottom dump bucket to save unwatering.

The span, luckily, had link and pin bottom chords.



TRAVELER USED ON BRIDGE ERECTION IN HONDURAS

This type of structure saves riveting in a country where riveters are scarce and the climate intensely hot and also permits one to remove falsework as soon as the erection is completed. It is always safer to rivet up rigid bottom chord, especially in a long and heavy span, before removing all the blocking.

As the erection proceeded the span was well bolted and drifted and a few of the important points were riveted, so that when the last connection was made the blocks were split out and the traveler was run back to a safe place, the timber salvaged and the piles chopped off. The river rose a week after removing the falsework.

The spans were fabricated by the Edgemore plant of the American Bridge Co., and the work was well done. Every clearance was perfect, and there were no interfering or badly arranged countersunk rivets to contend with. The iron was properly assembled for transportation; the chord bars bolted in bundles of four and each pin separately and strongly boxed. Rivets, bolts and small pieces came through intact, not a box broken. Let it be noted here that in shipping bridges to foreign countries it is essential to have pilots and driving caps for all pins, "slathers" of bull pins, fitting-up bolts and washers, and to see that they go on the first shipment.

Automatic Cement Briquet Testing Machine

A new automatic cement testing machine, known as the Olsen-Boyd automatic cement tester, is described by T. Y. Olsen in a paper presented before the recent meeting of the American Society for Testing Materials. This machine substitutes for the usual shot flow a cylinder filled with liquid which operates to move a needle on a dial during the automatic application of the load. When fracture occurs the needle stops and the breaking load is read directly from the dial.

LETTERS TO THE EDITOR

Definition of Engineering Needed as Basis for License Laws

Sir—The agitation which has been in progress for many years past concerning the necessity for some form of license law, and which has crystalized into legal enactments in some states, has provoked much discussion as to what engineering really is. In those laws which are now in force definitions differing from one another in many ways are set forth. It is evident that any law which prescribes rules and regulations for the practice of a given profession, and which does not clearly define what that profession is, will lead to much confusion.

We are led to believe, however, that in the case of engineering this definition should be negative rather than positive, for it is much easier to say what engineering is not than to express in set phrases exactly what it is, and, furthermore, when a definition of engineering is enacted into law, that at once puts a limit, at least legally speaking, upon the practice of that profession. If the definition must be positive, and perhaps legal form would require that, let it be in general terms which, while they set forth clearly the sphere of engineering, are yet elastic enough to include all forms of engineering activity.

The following definition has appealed to the writer as coming nearest fulfilling the foregoing requirements: "Engineering is the Science and the Art of Design." It is a science because it constitutes a body of systematized knowledge and it is an art because in its practice it is the application of the principles of science. The sphere of engineering is that of design, planning that which is to be done in accordance with the principles of science and setting forth that plan in a set of drawings and specifications. When that is accomplished the work of engineering is done. What follows or preceeds falls without its sphere.

Perhaps the commonest error in regard to engineering is to confuse it with surveying. "Surveying is the Science and the Art of Measurement." A comparison of this definition with that above given for engineering will disclose that, while closely related in practice, they have nothing at all in common in principles. We do not, of course, mean that surveying is in any sense an easy or a limited sphere, but it shares nothing with engineering, save perhaps the element of precision. The engineer may survey and in most cases he has to use the results of surveying, but in making a survey he is not doing engineering work, and in order to be an engineer it is really not necessary that he know anything about surveying. A lawyer may be a stenographer and he uses the results of stenography, but we should not therefore confuse stenography with law. Yet that is just what happens in the popular mind in the case of engineering and surveying. To be an engineer, to the layman, means nothing more than the ability to do a little land surveying. As absurd as all this is, it is deep rooted in the popular mind and will have to be reckoned with in any attempt to secure the enactment of an engineering license law. The writer speaks from his own personal experience on this point.

Another common error, particularly in the South, is mistaking the engine-driver for the engineer. This may seem like hair-splitting, but it will be found to be vital in framing any form of engineering license law. Its neglect will lead to inevitable confusion and defeat of the real purpose of such a law.

A third common error is mistaking the contractor for the engineer. It is here that the greatest obstacle is encountered in framing a license law for engineers, for great care must be exercised not to confuse the two and to exclude completely from the operation of the law the work of construction. A contractor builds what the engineer designs. The relationship is very like that existing between the druggist and the doctor. The druggist fills the prescription which the doctor writes.

Engineering work ceases when the plans and specifications are wrought out. So very clear is this distinction that a distinguished writer upon railroad engineering, A. M. Wellington, defines an engineer as one who does not build. Scientifically speaking, this is really not a definition at all, but, as Mr. Wellington evidently intended, it brings out very strikingly the distinction we are presenting here, and one which is of very large importance in the framing of any form of license law.

WALTER H. DRANE,
Chief Engineer,
Smith County (Tenn.) Highway Commission.
Lebanon, Tenn.

Señor Ibañez and His Reference to Engineers

Sir—I think Emile Low is unduly exorcised over what he seems to think is the disesteem in which the engineer is held in Mexico, as revealed to him by the articles of Señor Blasco Ibañez. Apparently he takes exception to the preface of the title "engineer" to the name of the person in the case cited, Sr. Bonillas, ex-Ambassador to the United States.

It is customary in all the so-called Latin countries, France, Italy, Spain, etc., and countries where the Latin languages are used, to preface the name of an engineer with the title of his profession, just as they do that of a lawyer and as we do a Doctor of Medicine. A lawyer, for instance, is generally referred to as "Licenciado" or often as "Doctor."

Mr. Low may, I think, rest assured that not only are engineers fully appreciated in Mexico but there, as in almost all countries outside the United States, they are accorded the distinction given to all learned men, if they be such, due to their professional attainments and their supposed or expected superiority over men of ordinary education and learning.

By the bye, the articles referred to, of Sr. V. Blasco Ibañez, are among the best, if not the very best of their kind, as they not only vividly but most accurately describe the conditions in Mexico and are extremely well worth reading.

F. LAVIS,
New York City. American International Corporation.

Wanted: To Define Engineer's Duties on Cost-Plus Work

Sir—I wish to submit to you a question which I hope you will answer through the columns of your magazine. This problem has been the subject of considerable discussion recently, and I believe that other readers may be interested enough to express their opinions. Briefly, the problem concerns the respective duties of the owner, engineer and contractor on the various classes of contracts now in use. To make my meaning clearer I will give a few typical examples:

First, in nearly all cases there are three parties to the contract, i.e., owner, engineer and contractor. The term "engineer" is intended to include the "resident engineer," and it is with his duties that I am chiefly concerned. The most obvious duties of the resident engineer are those of furnishing the lines and levels required for the construction work, and acting as an inspector, passing judgment upon the quality of material and workmanship embodied in the structure. These matters are usually covered at great length in the specifications. But now comes the more difficult problem of defining just where the responsibility of the resident engineer ends, and that of his superior engineer begins, and also the extent to which the engineers can go in dictating to the contractor as to how he shall manage his organization and generally conduct the job.

It is at this point that the form of contract begins to have an influence. In the lump-sum contract wherein the contractor agrees to furnish all material and labor to complete the work for a fixed sum, he stands to make or lose money entirely upon his ability to do the work economically and keep the cost within his bid. The owner has nothing to lose if the job actually cost twice the amount of the contract. Also the engineer merely is required to see that the contractor fulfills the specifications. In this case, is it not true that it is none of his business how the contractor organizes his forces and conducts the work, provided that the final result is according to the plans?

Upon entering the present period of uncertainty regarding prices of labor and materials, the percentage contract was devised for the purpose of protecting the contractor against losses due to rising prices and, also, to protect the owner against the wide margin of profit included in the item for contingencies that a contractor was sure to add to a lump-sum bid in order to protect himself. It is here that the duties of the engineers begin to be enlarged. Is it not true that the resident engineer is now expected to protect the owner against all inefficient methods of working, and insist upon having first-class equipment in the contractor's outfit, and that he employ only such methods of construction as will produce the lowest possible unit costs? Assuming this to be true, where can the line be drawn defining the powers of the engineers, as against those of the contractor? In this case, should the resident engineer have full responsibility for the management of the job, or should he merely act as an inspector as in a lump-sum contract? How can he, knowingly, stand by and see the contractor waste the owner's money in inefficient methods, when he is morally bound to protect the interests of his client? On the other hand, what authority can the superintendent of a job have over this organization if he knows that any, of all, of his orders may be countermanded by the resident engineer?

I would like to have an opinion from the editor or a discussion by the readers with the object of defining the duties of the inspector, resident engineer, and engineer-in-chief with regard to contracts of the percentage or cost-plus-a-lump-sum-profit type in which both sides of the question are fairly set forth.

Milton, New Hampshire. H. M. BRYANT.

The Importation of Chinese Labor

Sir—Serious consideration should be given the question of importing Chinese labor to relieve the shortage, which, by the Government's own statistics, is placed at from 3,000,000 to 4,000,000. To be able to coax a few million Americans into becoming laborers would be ideal, but what success would we have in peace time when during the war the laborers' patriotic zeal led them to graduate into the mechanic class and threaten industry with one strike after another? Undoubtedly we could find enough Americans of pioneer stock who are physically able to do that kind of work, even if we had to go back to the clam-digging Smiths of Long Island, but if we take them away from their job who is going to dig clams. Unfortunately there is no law compelling a man to work at some productive occupation. If there were, we could probably raise an army of 10,000,000 laborers from among the parasites who are living on other people's brains and brawn.

The suggestion of bringing in Chinese labor should have been taken up seriously several years ago. To overcome the prejudice of the public against the yellow race will require years of educational activity. The average citizen puts Chinese and Japanese in the same class; and how many Americans are there who can find China on the map? Does the average American know that a Chinese is a good laborer, and that the Japanese and not the Chinese are the real offenders on the western coast?

Education of the press should also be taken up, for if the press continues to feed us with misinformation there will be no education of the public.

Election of legislators who cannot be controlled or threatened by organized labor is also necessary. The labor unions will undoubtedly put up a strong fight against any legislation tending to modify the Exclusion Act.

The American Society of Civil Engineers should help a movement such as Mr. Ericson has started. and if he succeeds in awakening that society from its lethargy he is entitled to a place in the hall of fame.

Rockville Center, N. Y. WALTER G. FEDERLEIN.

Sir—Mr. Ericson, in *Engineering News-Record*, May 6, p. 927, brings out the point that the present shortage of labor and the resulting exorbitant prices threaten to postpone large engineering projects now under consideration to the detriment of our profession, a danger which a modification of our legislation in regard to Asiatic immigration would obviate.

This is undoubtedly true, and I fully agree with Mr. Ericson that American engineers should use their influence in this direction. But there is, beside the advantage this country would gain by utilizing Chinese labor, a very important feature of this problem to be considered on which so far little stress has been laid.

China in its present backward condition, without adequate means of transportation, with a lack of sanitary works, power development, etc., and, on the other hand, with undeveloped resources of a magnitude unsurpassed by any other nation, offers an unparalleled field to the American engineer. It is therefore, aside from any consideration of fairness and justice, to our interest to cultivate friendly feelings with the Chinese Republic. China owes a debt of gratitude to the United States for having generously canceled the indemnity for the Peking expedition, and just now we are, in concert with the other great powers, on the point of giving her financial aid, so the Chinese people would undoubtedly welcome the American engineer and appreciate his work if it were not for the feeling of bitter humiliation intelligent Chinese must feel when they see that we look down on their nation and shut the door on their fellows. How far such feelings would influence the employment of American engineers in China or reduce their usefulness, how far they would favor the employment of English or Japanese engineers in preference to Americans, we cannot tell, but, no doubt, the antipathy and prejudice thus produced would make itself seriously felt.

A more liberal policy in regard to Chinese immigration will be of great benefit to us, not only in our own country, but also on the other side of the Pacific; the work of modernizing the Chinese Republic by the assistance of the American engineer will then begin under the brightest prospect. We welcomed the work of a hundred thousand Chinese laborers behind the trenches in France, why not welcome their help here? Let's open the door—the wider the better.

St. Louis, Mo. CARL GAYLER, C. E.

Engineers in Massachusetts Civil Service

Sir—Under slavery, the negro's desires, hopes and ambitions were rarely ever considered when the swapping and selling of negroes began. If the negro desired to change his job, for one on another plantation, it was his privilege to "desire" a transfer as much as he pleased, this privilege being allowed simply because there was no way to control his thoughts. But an actual change, or transfer, could not be accomplished except by agreement between the plantation owners.

The Massachusetts Civil Service Commission still adheres to the obnoxious rule and practice of not permitting the transfer of an employee from one department to another except by agreement between the employing officials. Consequently the opportunity for advancement of civil engineers under civil service is controlled entirely by employing officials and the Civil Service Commission. Without "kow-towing" to his employer, an employee has absolutely no opportunity, consideration or redress in the matter of transference from one position to another.

A short time ago, an employee was not only denied the right to accept another position, but was also abruptly discharged from the position he held for daring to attempt to better his position. Apparently the opinion still holds that the right to accept another public service position is anybody's business except that of the employee.

Under the laws of Massachusetts, physicians, optometrists and lawyers are required to pass the State examinations only once in order to practice their professions, but in the same State civil engineers must pass State examinations every two years if they wish to be listed as engineers qualified for public service. At least that procedure is required by law although it is violated. Under this condition the lack of applicants for professional examinations is understandable and the dearth of competent eligibles is a natural result.

THOMAS N. ASHTON,
Civil Engineer.

Fall River, Mass.

Hints for the Contractor

Cable Erection and Tower Details for Chuting Plant

To prevent eccentric tower loading by the chute suspension cables, in the case of the building plant layout shown by Fig. 1, special tower top details and special methods of stretching and fastening the cables were adopted. Two cables were employed to provide independent suspension for the chute systems on the right and on the left of the center tower. Each cable was $1\frac{3}{8}$ in. in diameter and had a span between deadmen of about 715 ft. As indicated by the lettering of the cables, the line which carried chutes on each side of the center tower was drawn taut on the opposite side. This prevented any intermittent strain on the center tower from "take up" in the cable when concrete was flowing in the chutes.

To avoid eccentric loading of the tail towers, the tower top framing shown by Fig. 2 was employed. The load on the center tower being symmetrical no special framing was required. With the taut and slack line arrangement, however, and because of the size and length of the cables, the problem of stringing and fastening the cables required special solution. First, the two cables were strung over the three towers down to the anchors. Next, they were clamped together at the center tower with eight $1\frac{3}{8}$-in. cable clamps and then fastened to the center tower with two large U-bolts. Then the tight cables on either side of the center tower were pulled as nearly taut as possible with two triple blocks having a pull of about 12 tons; the taut and slack cables were then clamped together at, and U-bolted to, the top of each tail tower. Finally, the two cables at both ends were pulled as nearly taut as possible from the tail towers to the anchorages.

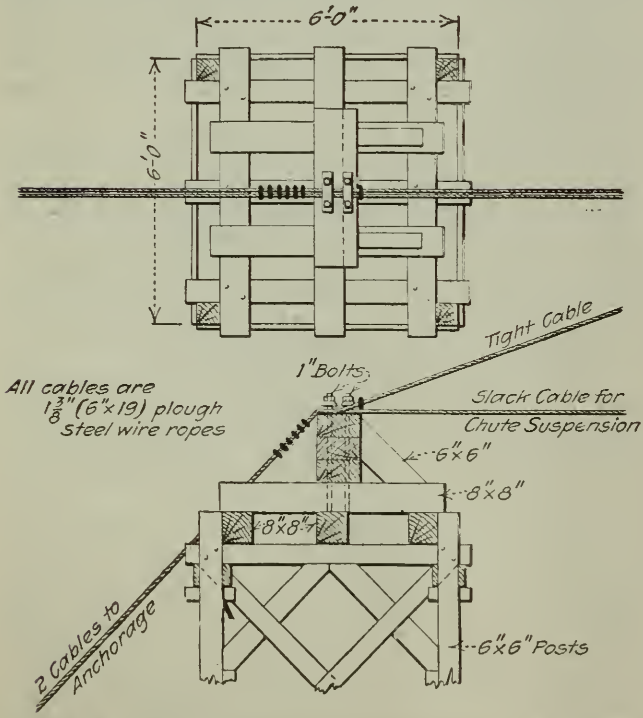
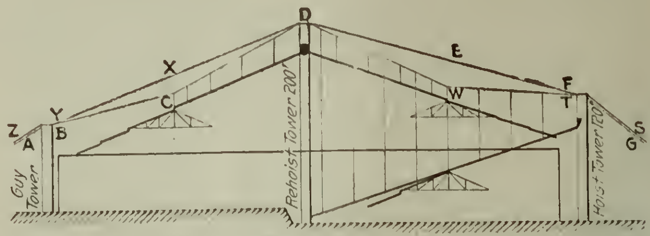


DIAGRAM OF SUSPENSION CABLES AND CHUTE SYSTEMS



TAIL TOWER HEAD FRAME

Some sag remained in the taut cables, following the procedure described. To remove this sag, counterweight chutes were suspended complete from the slack cables on both sides of the center tower. Then the cable clamps at the top of the center tower were gradually loosened and simultaneously the chutes were hoisted. When all the weight of the chutes was taken by the slack cables and the sag was pulled out of the taut cables the loosened clamps were refastened.

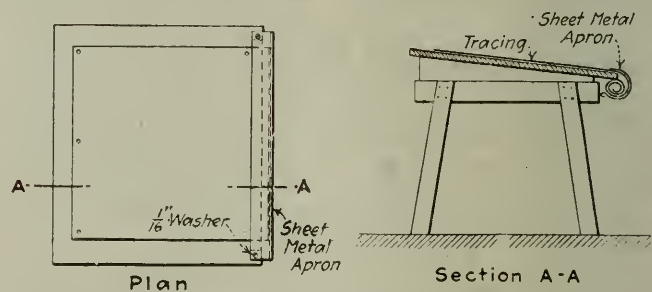
The M. J. Hoffman Construction Co., Indianapolis, Ind., were the contractors for the building, constructed for the Haynes Automobile Co., upon which the above described system was used.

Drafting Board Apron To Prevent Rubbing of Tracing

By Ralph G. Focht

Structural Engineer, Washington, D. C.

Referring to sketch on p. 929 of your issue May 6, showing a half-round piece attached to the edge of a drawing board to protect drawing from creasing: Such a device affords only partial protection to the tracing. The tracing will be rubbed by the clothing of the draftsman while he works over the drawing and if the tracing is long, as with maps full size drawings and like, it will extend to the floor. A bent piece of sheet metal or apron as shown herewith overcomes these objec-



tions at a small cost. This apron may best be made of sheet brass although a section of hanging gutter as used in house construction may be substituted. The section should be quite heavy to prevent bending when the draftsman bears against the board. Attention is also called to the fact that the apron prevents pencils and pens from rolling off an inclined board.

Another handy appurtenance to a drawing board is a piece of oil cloth mounted on an ordinary window shade roller, and attached to the top of the drawing board so that the drawing may be covered up at night, thus preventing dampness and warping of the drawing.

NEWS OF THE WEEK

New York, July 1, 1920

Compensation Committee Reports to Engineering Council

In its progress report to Engineering Council, presented at the meeting of June 17, by Chairman Arthur S. Tuttle, the Committee on Classification and Compensation of Engineers makes the following statements regarding the report of the Congressional Joint Commission on the Reclassification of Salaries.

"The classification of engineers proposed by the Congressional Joint Commission on Reclassification of Salaries shows that the work of this Commission has been guided largely by the work of your committee, and a comparison of its recommendations with those of your Committee will be shortly released for publication. It is the belief of the Committee, that, to say the least, the Federal Commission's classification, where it differs from that of your Committee, has no advantage. The compensations for the various positions proposed in the Federal report are disappointing as they do not provide anything like the increases which are believed by your Committee to be essential to the end that the engineering profession may attract and retain men of proper calibre to assume successfully the responsibilities placed upon it.

"From the analysis it would appear that in the lower grades of Federal service in 16 bureaus the compensations proposed by the Congressional Commission would be from 2 to 19 per cent less than those which have heretofore prevailed, while in the higher grades the increases range from 8 to 17 per cent. The proposed salaries other than those for the grade 'Junior Assistant Engineer' range from 20 to 30 per cent less than those suggested by your Committee."

Discussing work to be undertaken, the report states: "It is proposed to undertake a vigorous campaign for the purpose of securing recognition of the classification of various positions as recommended by the Committee last year and as adopted by Council on December 18, 1919, and at the same time to secure a general expression of opinion on the part of engineers and heads of services as to the compensation schedule tentatively suggested by the Committee."

In addition to addressing communications to the secretary of each of 123 engineering societies in the United States and Canada, arrangements are being made to secure co-operation on the part of the lay as well as the engineering heads of all services employing engineers and of all Civil Service Commissions.

Engineering Council Endorses Federated Societies

At its regular meeting June 17, after hearing a report on the Organizing Conference of engineering societies held in Washington, D. C., June 3 and 4, Engineering Council took the following actions:

Voted: that Engineering Council heartily endorse the plan of organization of the Federated American Engineering Societies and the American Engineering Council, adopted by the Organizing Conference of technical societies in Washington, June 3 and 4, and authorize its Executive Committee to proffer and perform on the part of Council such assistance as may be practicable in completing the work of the Organizing Conference and of the Joint Conference Committee of the Founder Societies in establishing the American Engineering Council.

Voted: that Engineering Council authorize its Executive Committee to deal with any question of co-operation with the Joint Conference Committee of the Founder Societies, relating to the permanent organization of the Federated American Engineering Societies, which may come up during the summer.

Voted: that the Secretary be instructed to invite to future meetings of Engineering Council delegates of the societies participating in the Organizing Conference in Washington, June 3 and 4, and editors of technical journals who may be interested.

No Cement for Street Repairs in Washington

Inability to secure shipments of cement has stopped all repairs on streets in the District of Columbia. A large amount of work, which is half finished, must stand in that shape for an indefinite period, it is predicted.

Delaware to Build Asphalt Instead of Concrete Highways

After having placed under contract approximately half of its concrete road construction program the Delaware State Highway Department, unble to secure cement shipments, has decided to complete its 80-mi. hard-surface highway program by the construction of roads with a bituminous foundation and asphalt wearing surface. This decision was reached at a conference held between the department's chairman and chief engineer on June 21.

The original program consisted of approximately 80 mi. of concrete highway, either of a concrete wearing surface or a concrete foundation with bituminous or asphaltic wearing surface, but the demand for completed roads and the condition of cement shipments has made it necessary to cancel that program. Inasmuch as no difficulty has been experienced in securing asphalt and stone, it was therefore agreed that the program should not be held up. Plans are now being completed and proposals will be called for about the middle of August for the construction of the 40 mi. of asphaltic road.

Architects Join Engineers in State Federation

New Minnesota Body the Result of Action of 200 Members of Local Engineering Organizations

Co-operation between architects and engineers in Minnesota is assured by the action taken at a joint meeting of members of the two professions, held in Duluth, June 19. The meeting was attended by about 200 engineers and architects, representing the five local engineering organizations of the state and the state chapters of all the national engineering and architectural societies.

Max Toltz, president of Toltz, King & Day, Inc., consulting engineers and architects, St. Paul, and past vice-president of the American Society of Mechanical Engineers, was chairman of the meeting. Frederic H. Bass, professor of sanitary engineering, University of Minnesota, and director of the American Association of Engineers, acted as secretary. W. C. Armstrong, chief engineer of the St. Paul Union Depot Company, chairman of the committee on organization, presented its report in the form of a resolution, which was adopted without substantial change after about three hours of spirited debate. The essential features of the resolution follow:

1. That a state federation of engineers and architects be organized in Minnesota whose membership may embrace all engineers and architects of the state.
2. That the organization be formed by the federation into one body of the Minnesota Surveyors' and Engineers' Society, the Engineers' Club of Minneapolis, the Engineers' Society of St. Paul, the Duluth Engineers' Club, Minnesota Chapter of American Institute of Architects, the Engineers' Club of Northern Minnesota, and such other independent and autonomous clubs, or societies of engineers or achitects, now existing, or hereafter formed, such as autonomous sections of national engineering societies, which may be found eligible.
3. That each federated club or society shall maintain its identity and shall not be restrained, by reason of such federation, from carrying on such technical, welfare and social work locally as it may choose.
4. That the existing Joint Engineering Board shall constitute the first board of directors of the state federation and shall so serve until the new board of directors created under the constitution and by-laws to be adopted shall be formed. Thereafter the board of directors of the state federation shall assume all the functions of the present joint board, and such additional powers as may be conferred upon it by the constituent societies.
5. That a general meeting or convention of the state federation be held at least once a year for technical, welfare and social work.
6. That the state federation be divided into sections representing architecture and the various branches of engineering, such as civil, mechanical, electrical, mining, etc., for promoting technical discussions in these respective branches at the annual convention.
7. That the state federation assume the publication of "The Bulletin," maintain an office and employ a secretary-editor, with such clerical forces as may be necessary.

(*Continued on p. 44*)

Committees Named for National Research Council

Plans have been completed for active work on the part of the division of engineering of the National Research Council. The personnel of the various committees comprising this division has just been announced. The chairmanship of the engineering division is held by Dr. Comfort A. Adams, Lawrence professor of engineering at Harvard University. He now is on leave giving his entire time to this work.

The division has been organized with the co-operation of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Society for Testing Materials, the Society of Automotive Engineers, the American Society of Illuminating Engineers and the Western Society of Engineers. In addition, the division works in close affiliation with the Engineering Foundation. The personnel of the division is composed of officially appointed representatives of these societies, together with twelve members at large. The work of the division proceeds under the direction of twenty committees on different special subjects. The work is confined as much as possible to problems of immediate importance to industry. The committees and their personnel, which will deal with subjects of interest to civil engineers, are as follows:

Committee on Economic Theory of Highway Improvement — T. R. Agg (chairman), professor of highway engineering, Iowa State College, Ames, Iowa; C. A. Baughman, R. B. H. Begg, L. E. Conrad, H. S. Fairbank, D. C. Fenner, R. B. Gage, H. J. Hughes, Mark L. Ireland, A. N. Johnson, H. J. Kuelling, H. J. MacIntire and R. W. Schoreder.

Committee on Structural Design of Roads — A. M. Goldbeck (chairman), engineer of tests, Bureau of Public Roads, Washington, D. C.

Committee on Tests and Properties of Road Materials — H. S. Mattimore (chairman), engineer of tests, Pennsylvania State Highway Department, Harrisburg, Pa.; R. W. Crum, H. J. Hughes, F. C. Lang, Morton Owen Withv.

St. Lawrence Waterway To Be Boomed at Detroit

The Great Lakes-St. Lawrence Tidewater Association, with delegates from fourteen middle and northwestern states will have a three-day meeting at Detroit, July 22-24 to boom the projected St. Lawrence River power and navigation development. In addition to many addresses on the commercial desirability of the project, mainly by men of political prominence, there will be several papers on the engineering features of the scheme. These will include, "The Railroad Point of View" by W. L. Ross, of the Toledo, St. Louis & Western R.R.; "Terminals, Transfer Costs and Coastwise Trade" by R. S. MacElwee, of the Department of Commerce; "Navigation and Waterway Commerce," Maj. Gen. L. H. Beach; "St. Lawrence Power Possibilities," Gardner S. Williams; "Port Facilities," by Charles Evan Fowler.

Tents for Canadian Engineers During Open-Air Convention

The Calgary Branch of the Engineering Institute of Canada will hold a meeting at Banff Aug. 14-18. The committee in charge has arranged with the Government for the use of military bell tents, with cots, mattresses and blankets provided, and will serve meals in camp. Visitors are requested to bring bedlinen and towels. Any one wishing to make reservation at hotels is at liberty to do so. The camp will be located near the Banff Springs Hotel, on the Bow River, within five minutes' walk of the golf course. It will accommodate those who arrive the night of Aug. 13 and meetings will begin Aug. 16. The committee extends to all engineers interested, and particularly to those who will be returning from the Portland convention of the American Society of Civil Engineers, a cordial invitation to attend this open-air meeting and bring their families. Notify F. E. Emery, secretary, Western Professonal Meeting, care of Gorman, Clancey & Grindley, Calgary, not later than July 25 as to tent or hotel accommodations.

Colorado Petitions for Tunnels

An initiative and referendum petition has been completed in Colorado asking for a vote on an amendment to the State constitution which will provide for the construction of the three summit tunnels described in *Engineering News-Record* of April 8, 1920, p, 716. This amendment provides for a bond issue of $18,550,000 for the construction of the Moffat, Monarch and San Juan tunnels, which are to be owned by the State and are to be of such size as to permit the passage of trains, automobiles and army trucks. Railways refusing to make operating contracts may be required to use the tunnels by order of the State Railroad Commission, which Commission may bring suit to enforce such order. Although over 16,000 signatures were required, the petition was initiated and completed in less than thirty days and was ready some time before the date for filing, July 1. The vote will be taken in November.

Canadian Water-Works Section, with 100 Members, Formed

At the Montreal convention of the American Water Works Association, June 22 to 24, a Canadian Section with about 100 members, was formed. The following officers were elected: Chairman, Alexander Milne, St. Catherines, Ontario; vice-chairman, F. H. Pitcher, Montreal; secretary-treasurer, H. G. Hunter, Montreal.

Architect-Engineer Merger

(*Continued from p. 43*)

8. That the expenses of the state federation be defrayed by a per capita tax on all federated clubs and societies, provided that there shall be no duplication of payment by reason of individuals belonging to more than one federated society.

9. That the present Joint Engineering Board together with a committee of one member from each of the societies represented at the meeting or invited to it, who shall be appointed or elected by each of the respective societies, be constituted a committee on organization, to draw up a constitution and by-laws, and prepare all details necessary to carry into effect these resolutions.

10. That this conference fix the time and place for another conference at which the committee on organization shall report and the organization be perfected and put into effect.

The meeting refused to take any action on the method of election of members to the board of directors of the proposed federation that would tie the hands of the committee that will draw up the proposed constitution and by-laws; but a motion carried that it was the sense of the meeting that the board should be composed of delegates elected by the constituent societies in proportion to the members paying their per capita tax through said society.

Discuss Membership Qualifications

The greatest part of the discussion took place on the clause enumerating what societies should constitute the proposed federation. One faction contended that only local independent organizations should be allowed to federate, holding that every engineer and architect should, from personal pride, be a member of such organizations; the other division held that a man should not be forced into a local society against his personal desires in order to become a member of the state federation. Considerable doubt was expressed as to the autonomy, in state affairs, of the local branches of the national societies. The Minnesota Chapter of the American Institute of Architects, however, was recognized as being an independent local organization, being affiliated with the Institute for action in national affairs only.

The Minnesota Joint Engineering Board met in Duluth the morning before the convention, voting to admit the state chapter of the American Institute of Architects to membership. This action, together with the co-operation of the architects in the afternoon meeting and the assurance that they will join with engineers in the state federation, is regarded as a big step toward professional unity in the state and forecasts the presentation to the state legislature of a license bill, modeled after the one prepared by the committee of Engineering Council.

The entertainment provided for the visitors by the Duluth Engineers' Club, consisted of a forty-mile trip around the city by automobile, a dinner dance in the evening, attended by about 250, and a boat trip up St. Louis River to Fond du Lac and return on Sunday morning.

Prof. Hughes New Engineering Dean at Harvard

Hector James Hughes, professor of civil engineering, Harvard University, has been appointed dean of the Engineering School, succeeding Comfort A. Adams, who recently resigned to become chairman of the Division of Engineering of the National Research Council. Dean Hughes graduated from Harvard with the degree of A.B. in 1893 and received the degree of S.B. from the Lawrence Scientific School in 1899. During this period of five years he worked part of the time in the office of the town engineer of Brookline, Mass. In 1899 he joined the Chicago, Burlington & Quincy R.R. as assistant engineer, maintenance of way at Chicago, and the following year was made resident engineer of that road at Burlington, Iowa, in charge of construction. Two years later he was for a short period designer with the American Bridge Co, Pittsburgh.

In 1902 Dean Hughes was appointed instructor in civil engineering at Harvard, from 1903 to 1913 he was assistant professor, during 1913-14 associate professor and he has been professor since 1914. For many years Dean Hughes has been the head of the Harvard Engineering Camp at Squam Lake, N. H., where summer courses in surveying, topography, railroad location, etc., are given.

Arlington (Va.) Sanitary District

At the last session of the Legislature of the State of Virginia a bill passed creating a Sanitary District of Alexandria County, Virginia, and providing for water and sewerage districts to be known as "Arlington Sanitary District."

The three members of the Board of Supervisors of Alexandria County are designated as the Sanitary Commission and are empowered to divide the county into sub-districts upon application of a certain number of qualified voters in one or more of said districts. The board is authorized to make surveys, investigations and estimates of cost for water supply and sewerage and if authorized by a majority vote in the district to issue bonds and have the same constructed and the cost assessed against the district in which the immprovements are made.

David J. Howell, senior member of the firm of David J. Howell & Son, civil engineers with offices in the Union Trust Building, Washington, D. C., has been appointed by the Board of Supervisors of Alexandria County, Va., acting as the Sanitary Commission, as the Chief Engineer of "Arlington Sanitary District."

Mr. Howell is also the general manager of the Alexandria Water Company and his firm as the engineers of this company constructed their large Barcroft dam and storage reservoir and filtration plant.

Mr. Howell, as one of the engineers under the "Board of Engineers on Deep Waterways," had charge of the surveys and investigations on the Eastern Division of the Oswego-Mohawk Route through New York State and was also the engineer in charge of the surveys, investigations, estimates and report of the Barge Canal under Edward A. Bond, State Engineer of New York. His firm has had an extended practice in municipal matters since its establishment in 1887.

To Examine Civilian Engineers For Navy Commissions

In order to fill about 30 vacancies in the commissioned grade of assistant civil engineer, Corps of Civil Engineers, U. S. Navy, with the rank of lieutenant, junior grade, applications are being received by the Bureau of Yards and Docks, Washington, D. C., from candidates who desire to take preliminary and physical examinations for these commissions. The preliminary examination is to determine the general fitness of the applicant, based on papers submitted covering college record, testimonials, references and professional experience. The candidate is not required to report in person for this examination. Those who qualify in the preliminary and physical examinations (physical examination by a board of medical examiners will be made of those who qualify in the preliminary examination) will take the final oral and written examinations at Washington.

The candidate must be an American citizen, between the ages of 21 and 34, and must have received a degree in engineering from a recognized college or university. He must also have had not less than a year's practical and professional experience after graduation. The annual salary begins at $3,200, with increases up to $9,600, depending upon length of service, and promotions.

Progress On Philadelphia-Camden Bridge Project

(Special Correspondent)

Latest developments give hope of some early progress of the project for a Delaware River bridge to connect Philadelphia and Camden. Hitherto virtually no headway was detectible, in spite of the fact that all New Jersey legislation affecting the highly popular Hudson vehicle tunnel enterprise was so drawn as to refer equally to the Delaware bridge. In magnitude this latter undertaking would rival the East River bridges; in fact, if it should be necessary to keep the piers outside the harbor lines an even greater span would probably be required.

After the organization meeting of the New Jersey-Pennsylvania bridge commission, held in December, 1919, nothing has been done, despite persistent prodding by the Philadelphia and South Jersey members. Now it appears that the next move lies with Governor Sproul of Pennsylvania, head of the joint commission. The situation was cleared up considerably recently by a hearing before the bridge committee of the Philadelphia city council, although there developed a somewhat acrimonious discussion between the council members and certain New Jersey commissioners who had the hardihood to tell the Philadelphians that it was they who were holding up progress.

The hearing was on a bill sent to council by Mayor Moore, the effect of which would be to commit Philadelphia to its proportionate share of the cost of the bridge as Pennsylvania and New Jersey have already been committed by state legislation. The council took the stand that it could not pledge the city's credit to the task until the cost should be known; previously the wildest guesses, inspired and uninspired, had been current in the Philadelphia press. It had been stated that if the council would not appropriate funds until it knew what the project would cost, and if the commission could not determine cost until it had funds, there could be no progress. At the hearing, however, the city solicitor stated officially that an initial appropriation of $250,000 made by the 1919 council did not lapse and is available, together with an equal sum appropriated by the Pennsylvania legislature and twice as much appropriated by New Jersey for investigation and construction. Also the representatives of the auditor generals of both states made it clear that the city has until June, 1921, to match a further appropriation of one and a half millions by the states, by finding an additional half million itself.

At the end of the hearing council members stated that it was up to the bridge commission to present its estimates and designs, an opinion that seems to have been concurred in by the press and the citizens generally. Governor Sproul is the one to issue the call to the commission, and now that the national Republican convention is out of the way there is good reason to expect that the bridge will be the next order of business at Harrisburg.

Motor Traffic Laws and License Fees Subject of State Survey

Under the provisions of an act passed by the present legislature, Governor Edwards has appointed a special commission to survey the motor vehicle traffic laws and the motor vehicle fees of New Jersey, with a view to supplementing legislation relating to traffic and fees. The commission consists of State Highway Engineer William G. Thompson, Motor Vehicle Commissioner William L. Dill, Senator Thomas Brown, of Middlesex County; Assemblyman Henry G. Hershfield, of Passaic County; and Horace A. Bonnell, of Newark. Mr. Thompson's resignation as chief engineer of the highway department, takes effect on July 1 and his place on the commission will be filled by Watson G. Clark.

Court Upholds Engineers in Drainage Case

Drainage projects in Illinois may be abandoned on payment of "court costs," and the Supreme Court has given a decision to the effect that these costs must include the fees of engineers and attorneys. In the case of the Cane Creek Drainage District, the lower court of McHenry county held that the fees were not a part of the court costs necessary to be paid in order to permit of abandonment. The action of the lower court is reversed by the Supreme Court, which declares that the order deprived the men of their rights under their contracts with the commissioners as engineer and attorney for the district. Engineers can now undertake drainage work in Illinois without fear of losing their time and pay because property holders decide not to proceed with the project.

Hydro's Chippawa Canal Work Shut Down by Strike

As the result of a protracted dispute over wages and hours the men employed on the construction of the Chippawa Canal, around Niagara Falls, by the Ontario Hydro-Electric Power Commission, went out on strike on June 16. They were receiving 40c. per hour for an 8-hr. day and 60c. for overtime. The commission offered a new scale of 50c. per hour for a through 1?-hr. day, but the men demanded an 8-hr. day with extra pay for overtime. The commission thereupon decided on a complete stoppage of work on the Canal, which went into effect on June 21. The number of men affected is 2,200, many of whom have left the neighborhood to seek work elsewhere.

Detroit Calls for Bids on 20-Mile Street Railway Improvement

Detroit's municipal street railway, provided for by the $15,000,000 bond issue passed on April 5, has been launched with the calling for bids on about 20 miles of street railway tracks, including excavating, concrete foundation, ties, rails and all track equipment.

Work has already been started on one line, the Charlevoix-Buchanan crosstown line. The new lines are designed to supply some of the much needed east and west crosstown service, and to relieve traffic in the congested factory districts now inadequately served as well as overcome the necessity for riders going down town to the City Hall to transfer to other parts of the city.

The work and materials will be let under three classes, (1) foundation work which comprises excavating, concrete foundation, tile draining and crushed stone backfilling; (2) oak ties; and (3) steel work, including all the required steel from rails to spikes. T-rails weighing 91 lb. per yard are specified. The main quantities involved are 95,080 cu.yd. of excavation, earth or other material; 115,230 sq.yd. of 8½-in. concrete foundation; 6,665 cu.yd. of ½-in. crushed stone backfill; 55,000 oak ties; and 4,400 tons of steel rails. The municipal work is being done by the Board of Street Railway Commissioners, for which William C. Markham is engineer.

The fact has been brought out that Michigan seems to have no legislation contemplating public ownership of such a utility as the city proposes to construct, and the Michigan Public Utilities Commission has asked the Attorney General for an opinion regarding its powers with regard to the project.

A map of the Charlevoix-Buchanan route has been submitted to the state commission, showing where the new line will cross the Detroit United Railway's lines and the various steam railroad lines. The question of the proper safety devices to be installed has arisen. If the lines in question were being constructed by a private corporation, it is conceded that the commission would have power to decide on what safety devices should be installed at the crossings and to apportion the expense. Ordinarily this would be to require the new line to install the devices at its own expense and divide the maintenance costs equally between the intersecting lines.

It is believed, however, that the law does not provide the commission with power to direct a municipality constructing its own lines to pay the charges that might otherwise be assessed against a private company.

Montreal Water Board Announces New Appointments

The newly created Montreal Water Board, composed of A. E. Doucet, director of Public Works, chairman; Walter J. Francis and R. S. Lea, has made the following appointments to its engineering staff: Charles J. DesBaillets, engineer in charge; F. E. Field, assigned to work in connection with pumping stations and filtration plant extension; F. Y. Dorrance, assigned to work of completion of aqueduct and the several bridges which cross it; M. Tison, A. Jette, A. Leroux, L. O'Sullivan, P. M. Chaussé, W. W. Dickson and N. Belanger, whose duties are divided upon the work assigned to Mr. Field and Mr. Dorrance. All of the staff, with the exception of Messrs. DesBaillets, Tison, O'Sullivan and Chaussé were formerly members of either the aqueduct or filtration works of Montreal.

Safety Engineers Meet in Chicago

At the summer meeting of the engineering section of the National Safety Council, held in Chicago on June 24, the safeguarding of machinery was the main subject of papers and discussions. Particular attention was given to power presses, as the Council has undertaken the preparation of a power press safety code for the American Engineering Standards Committee. A dinner was given jointly by the National Safety Council, the Chicago Safety Council, the Illinois Manufacturers Association and the Western Society of Engineers.

Activities of the A. A. E.

The Phoenix (Ariz.) Chapter was addressed, May 3, by A. L. Harris, who spoke on the Paradise-Verde irrigation project. He recommended that two dams be built, one at the Horseshoe dam site and the other at Camp Verde dam site, both located in Yavapai County, which would add about 93,000 acres of productive land to territory in the vicinity of Phoenix. He said that only 50 per cent of the Verde and

The Albany (N. Y.) Chapter, at a recent meeting, elected the following officers: President, G. P. Graham; vice-presidents, V. L. Ostrander and L. W. Irish; secretary, R. N. Barrett; treasurer, R. E. Hartman.

The Philadelphia Chapter was recently addressed by Gifford Pinchot, Pennsylvania state forester. Mr. Pinchot advocated the restoration of waste lands in Pennsylvania. He stated that one-sixth of the state is a waste from forest fires, keeping out of the pockets of the people not less than $80,000,000 a year. At the present time, he said, the timber produced in the states does not supply the demand, and the yearly freight bill on lumber imported from other parts of the country amounts to $175,000,000.

The Milwaukee Chapter, May 5, elected the following officers for the ensuing year: President, N. Prakken; vice-president, T. R. Minert; directors, H. W. Israel and H. C. Schmidt; treasurer, William Tubesing; secretary, C. S. Gruetzmacher. A call for a meeting to organize a state assembly has been issued to other chapters and clubs in Wisconsin. The state organization is desired to handle the proposed engineers' registration bill and the provision for a state map bureau.

The New York Chapter, at its meeting of May 12, elected the following officers: President, R. H. Jacobs; first vice-president, C. P. Abbott; second vice-president, F. H. Judd; secretary, L. B. Smith; treasurer, E. L. Miller.

The association announces the formation of state assemblies in Washington and Nebraska. Seven chapters of the former, May 22, sent delegates to Tacoma, who elected G. W. Osgood temporary president and W. D. Smith secretary. The next meeting will be Aug. 24 at Everett, where a revision of laws relative to county engineers will be considered. The Nebraska Assembly, May 29, at Lincoln, elected as president, W. R. McKeen, president McKeen Motor Car Co.; vice-presidents, Prof. Clark E. Mickey, University of Nebraska, and Roy N. Toll, city commissioner, Omaha; treasurer, George W. Bates, city engineer, Lincoln; secretary, Watson Townsend, assistant engineer, Union Pacific.

CIVIL SERVICE EXAMINATIONS

United States

Structural Engineer, $1,800 a year. Form 1312. Applications should be filed not later than July 27.

Psychological Investigator in Employment Tests, $3,000 to $3,800 a year. Form 2118. Applications should be filed not later than July 27.

Senior Engineer, Bureau of Valuation, Interstate Commerce Commission, $1,920 to $2,700 per year. Make application before July 20.

Canada

Application forms may be obtained from the office of the Employment Service of Canada, or from the Secretary of the Civil Service Commission, Ottawa, and must be filed not later than July 16.

Shipyard superintendent, Sorel, P. Q., $3,000 to $3,540 a year.

Hydraulic engineer, $2,700 to $3,180 a year.

Junior Hydrometric engineer, $1,680 to $2,040 a year.

Junior engineers, $1,680 to $2,040 a year.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Portland, Ore., Aug. 10-12.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Sept. 13-17.

The Colorado Section, Am. Soc. C. E., at its annual meeting, June 12 elected the following officers: President, Oliver T. Reedy; vice-president, A. N. Miller; secretary-treasurer, John S. Meads.

The Western Society of Engineers, June 21, heard a paper by T. L. Condron on "State Registration of Engineers," which dealt with the present Illinois law and with the proposed uniform law drafted by a committee of Engineering Council. Stress was laid upon the present lack of uniformity by which engineers engaged in interstate practice are confused as to the rights and responsibilities. Evidence of experience and attainments was suggested as even more important than ability to pass an examination. There was some discussion as to land surveyors, it being claimed by S. L. Greeley that the proposed law is unjust to them. Mr. Condron held that surveying is a branch of engineering and does not need special mention.

The Society of Municipal Engineers of Philadelphia, at its meeting June 23, adopted resolutions expressing its desire to co-operate with the experts who are making a survey of the classified service of that city. Resolutions of appreciation were also adopted for Henry H. Quimby, chief engineer, Department of City Transit, on his retirement as president of the society. An election of officers resulted as follows: President, Frank E. Maize; vice-presidents, Charles Frommer, James S. Shute and Seth M. VanLoan; secretary, Charles H. Stevens; treasurer, William J. Logan.

The Nashville (Tenn.) Engineering Association, through a committee of which Hunter McDonald is chairman, is working to raise an endowment fund of $500,000 for the engineering department of Vanderbilt University. The association is also endeavoring to secure $10,000 immediately for the purchase of machinery to be used in the instruction of engineering students. The committee feels that this amount should be raised at once, since the government is selling engineering machinery on hand for 15 per cent less than cost, and pieces from that lot could be used to great advantage in the engineering department of the university. The association will bring the proposition for an endowment fund before the various civic and business organizations of Nashville, in the hope that the city will contribute at least $200,000, leaving $300,000 to be secured from outside sources.

PERSONAL NOTES

LIEUTENANT-COLONEL EDWARD BARTOW, chief, Illinois State Water Survey, has resigned to accept a position as head of the department of chemistry, State University of Iowa. While in France, Colonel Bartow was in charge of water analysis laboratories for more than two years. For several years he was secretary of the Illinois Water Supply Association, which eventually was absorbed as a section of the American Water Works Association.

ALBERT H. JEWELL, principal assistant engineer, Michigan State Board of Health, will succeed Charles A. Haskins, whose resignation is noted elsewhere in these columns, as chief engineer of the Kansas State Board of Health. He served during the war as lieutenant in the Sanitary Corps at Camp Custer, Mich., for a few months and later as water supply officer with one of the Engineering Regiments in France. Previously, he was chemist at the Toledo filtration plant.

C. C. WESTFALL is engineer of bridges of the Illinois Central R.R., and not C. I. Anderson, as was stated last week. The information concerninf the appointment we now learn was erroneous.

ARTHUR F. BARNES, formerly dean of engineering, New Mexico State College, has become associated with Barglebaugh & Whitson, architects and consulting engineers, of Dallas, El Paso and Houston, Tex., as mechanical and industrial engineer and manager of their New Mexico-Arizona district.

J. RALPH VAN DUYNE has been appointed chief engineer of construction of the Passaic Valley (N. J.) Sewerage Commissioners, succeeding the late William M. Brown. Mr. Van Duyne was deputy engineer at a salary of $6,000. The new appointment carries with it an increase of $1,500.

L. L. ROGERS has severed his connection as field engineer of the Lakewood Engineering Co.'s paving department. Previous to his service in that company, he was a member of Roger Brothers Construction Co., highway engineers, Los Angeles, and he is now returning to California to re-enter the road constructing field, rejoining Roger Brothers, with headquarters at Los Angeles.

LIEUT.-COL. EDWARD M. STAYTON has been made city representative on the Board of Control of Kansas City (Mo.) Railways, of which Philip J. Kealy is the other member. He replaces R. P. Woods, who recently resigned to devote his time to the Kansas City, Clay County & St. Joseph Ry., of which he is vice-president and general manager. Colonel Stayton entered the army, shortly after returning from service on the Mexican Border, as major of the 110th Engineers, and was later made lieutenant-colonel. Since his return from France, he has been consulting engineer for the location and construction of highways in Clay and other counties in Missouri. He will assume his new duties about Aug. 15.

CHARLES A. HASKINS, chief engineer and director of the Water and Sewage Laboratories, Kansas State Board of Health, has resigned to associate himself with Black & Veatch, consulting engineers, Kansas City, Mo. His resignation will become effective about July 1. Mr. Haskins has been connected with the Kansas State Board of Health for nine years, with the exception of a leave of absence in 1915, spent with the United States Public Health Service in the investigation of the pollution of coastal waters. He served during the war as a captain in the Sanitary Corps, detailed to the office of the surgeon-general on special investigations of water and sewage problems.

HAMILTON & BARBER is the name of the new firm, established by Peter D. G. Hamilton and George H. Barber, civil engineers, which will specialize in designs, details and plans for structural steel and ornamental iron work. The firm's offices are at 50 Bromfield St., Boston.

P. W. ELMORE, assistant engineer, Indiana Division, Baltimore & Ohio R.R., has been made assistant division engineer, with headquarters at Toledo; J. W. PURDY, assistant engineer, Ohio Division, has been made assistant division engineer, with headquarters at

Chillicothe, Ohio, and MARK H. BEARD has been made assistant division engineer, Cleveland Division, with headquarters at Cleveland.

L. H. BOND, assistant engineer, Illinois Central R.R., has been appointed district engineer of the Northern lines, with headquarters at Chicago.

J. H. SYDENSTRICKER has been appointed road engineer of Monroe County, W. Va.

ALBERT L. UPHAM has resigned as field engineer with Stone & Webster at Hartford, Conn., and is now located at New Britain, Conn., representing Brown & von Beren, architects, of New Haven, during the construction of a building for the Besse-Leland Co.

P. H. CASSIDY has resigned as superintendent of construction of bridges, power plants and substations for the Eastern Pennsylvania Railway, Light, Heat & Power Co., of Pottsville, Pa.

C. V. SWEET and L. V. TEESDALE, of the U. S. Forest Products Laboratory, Madison, Wis., have resigned to enter the forest service of the Government of India, their special duty being to investigate commercial methods of seasoning timber.

E. E. CHADWICK, recently assistant engineer on filter design and construction, Minneapolis water department, has been elected city engineer of Winona, Minn. He succeeds Henry E. Wolff.

H. G. PERRING, consulting engineer, and engineer to the Board of Commissioners of Public Grounds and Buildings of Pennsylvania, has been appointed chief engineer of Baltimore, Md. He will have charge of the engineering details of the water-front development and general improvement plans for Greater Baltimore, for which work loans have been authorized. He will receive an annual salary of $7,000.

MAJOR HARRY D. WILLIAR, JR., who served in Europe with the First Engineers, First U. S. Division, has resigned as district engineer in charge of the Washington office of the Asphalt Association. He has been appointed assistant chief engineer of the Maryland State Roads Commission.

OLDER & QUINLAN, consulting engineers, Monadnock Block, Chicago, have merged their engineering practice with the practice of Arthur W. Consoer, under the corporate name of the Consoer Engineering Co. Clifford Older is president of the company, George A. Quinlan, secretary and treasurer, and Mr. Consoer vice-president and business manager. The company will conduct a general engineering business at the above address, Mr. Older and Mr. Quinlan continuing their consulting practice.

F. A. DANFORTH, topographic engineer, U. S. Geological Survey, has completed the survey of the Salt Lake quadrangle, Texas, and the control of the Fort Stockton and Free quadrangles, Texas. He will sail for Hawaii, July 10. A. O. BURKLAND, topographic engineer in charge, and R. M. WILSON, assistant topographer, left June 5 for Honolulu to begin the co-operative topographic survey of Hawaii.

CHARLES E. PARRY, formerly principal assistant city engineer of Allentown, Pa., is now located in Philadelphia as designing and construction engineer for the Municipal Disposal Co.

FRED BROWN, until recently engineer of the Hastings (Mich.) Table Co., has been appointed city engineer of Muskegon, Mich.

O. D. CHRISMAN has resigned as city engineer of Springfield, Mo., to open a civil engineering office in that city. G. W. Culler, of the city engineering department, will succeed Mr. Chrisman.

CHRISTOPHER J. SHERIDAN, recently assistant city engineer, has been appointed deputy city engineer of Yonkers, N. Y. He succeeds the late George L. Christian.

H. F. JOHNSON has resigned as resident engineer of the Wyoming State Highway Department to become office engineer of the Midland Bridge Co., at Kansas City, Mo.

COPE, RAND, MEANS Co. is the name of a new engineering firm established by T. H. Means, irrigation engineer, and E. L. Cope, consulting engineer, both of San Francisco. Lieutenant-Colonel L. H. Rand, Corps of Engineers, U. S. Army, formerly at San Francisco and recently transferred to Camp Dodge, Iowa, also has an interest in the firm. The firm will specialize in hydraulic and structural engineering, with offices in the Holbrook Building, San Francisco.

W. J. SWEGMAN, superintendent and mechanical engineer of the Wabash Portland Cement Co., has joined the staff of J. C. Buckbee Co., engineers, Chicago.

A. F. HEINZE has become the manager of the newly organized American Professions Supply Co., 58 W. Washington St., Chicago.

J. L. PIFER & CO., civil, mining and municipal engineers, Herrin, Ill., has gone out of business and sold its equipment to Pfeiffer & Mallams, consulting engineers, of that city. Mr. Pifer has accepted a position in Tacoma, Wash.

EDWARD A. ROTH, formerly concrete engineer for E. I. Du Pont de Nemours Co., at Wilmington, Del., has opened architectural and engineering offices in the Drexel Building, Philadelphia.

THOMAS L. WILLIS has tendered his resignation as city engineer of New Orleans, La., on account of ill health. He will be succeded by W. Beauregard Davey, chief engineer of the Orleans Parish Levee Board.

S. J. CHAPLEAU, civil engineer, Ottawa, has been appointed to act as representative for Canada on the Board of Control, the formation of which was recommended by the International Joint Commission for the construction of compensating works in St. Mary's River by the Michigan Northern Power Corporation and the Algoma Steel Corporation.

Obituary

MATTHEW GAULT, superintendent of the Sewer Department, Worcester, Mass., died in that city June 26. He was 53 years of age, and a graduate of Dartmouth, 1890. He entered the employ of the city of Worcester under F. F. McClure, city engineer. For many years previous to 1907 he was the assistant engineer in charge of sewer work. In 1907 he succeeded H. P. Eddy as superintendent of sewers. From 1911 to 1913 the experimental work on behalf of Imhoff tanks and trickling filters was under his direction, as well as the recent activated sludge experiments.

Business Notes

THE CONNEAUT SHOVEL CO., Conneaut, Ohio, has acquired additional land immediately west of its plant at Conneaut, on which a new rolling mill will be built.

THE BRIGGS CO., Lansing and Flint, Mich., announce the opening of another branch office at 43 Pearl St., Grand Rapids, in charge of L. B. Wood.

THE NATIONAL ENGINEERING SERVICE CORPORATION, W. K. Palmer, president, announces the opening of an Eastern office at 30 Church St., New York City, in addition to its Kansas City and Chicago offices. J. F. Kaufman, special engineer of the corporation, from the operations office at Kansas City, is now in charge of the New York office, at the same time directing industrial work which the corporation has in hand at Newark, N. J.

THE WATSON-STILLMAN CO., New York City, announces the following changes in personnel, owing to the retirement from active interest in the management of A. F. Stillman: E. A. Stillman remains as president, with supervision of sales; Carl Wigtel, chief engineer, has been elected vice-president; J. D. Brocks, treasurer; A. Parker Nevin, secretary; LeRoy T. Brown appointed works manager; J. W. Delano, assistant works manager and W. H. Martin purchasing agent. The offices of general manager and superintendent are discontinued and G. D. Kershaw and J. F. Lary are no longer connected with the company.

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DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

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Labor Efficiency Decrease

ASSERTIONS that labor efficiency has decreased materially of late are many and positive. Almost everyone knows or at least feels strongly that these assertions are based on experience but supporting data are scanty. Who has specific proof, based on reliable records of labor efficiency before, during and since the war?

Council Endorses Federation

AS NOTED in the news section last week, Engineering Council has endorsed the plan of organization of the Federated American Engineering Societies. This action, following closely upon the Organizing Conference last month, is timely and constructive for it removes the possibility of having two organizations working at cross purposes. Council, however, has gone further than a mere approval of the federation plan; its executive committee has been definitely instructed to co-operate with the Joint Conference Committee in effecting a permanent organization for the federated societies and to assist in any way possible the work begun at the Organizing Conference. While Engineering Council has done some excellent work, it has been felt for some time by members of the profession that it was organized on lines not calculated to produce the results desired. The demand has been insistent for some body more democratic than Council and more directly responsible to the membership of the societies which it represented. With the Federated American Engineering Societies definitely organized there will be no reason for the further existence of Engineering Council. In endorsing the federation, therefore, Council in a way sounds its own death knell, but in so doing it gives evidence of the new spirit of co-operation and solidarity which is developing throughout the profession and which will make it possible for engineers, in the future, to speak with a united voice and to insure for their message a respectful hearing.

Variety in Building Laws

IN ANY such discussion of structural requirements as that given on another page in an article on wind loads —an article, by the way, which concludes a most valuable series of analyses of building code requirements by the same author, based on many years of practical dealing with codes—the wide divergence between the provisions made by various municipal and other authorities to govern building work stands out strikingly as a puzzling fact. It is as well, in thinking of this, to bear in mind that there are such things as geographical differences, affecting not merely the intensity of wind storms, character of soil and possibility of earth disturbances, but also the current methods of engineering practice. However, making all possible allowance for these factors, and for the likelihood of strict or less strict supervision of plans by the public authorities, it is patent that the larger part of the difference between various codes is quite arbitrary, arising from the compilers' whims or lack of information. The most important service that discussions like Mr. Fleming's can do the technical community (and the public as well) is to lead toward more rational ways of dealing with natural forces and building methods, so that we may in time get somewhere near uniformity in requirements throughout the country. It is by no means certain that absolute uniformity would bring any particular benefit. Now that the Engineering Standards Committee has entered upon the course of developing safety codes, which in the end are bound to include municipal building ordinances within their scope, it seems probable that the attempt will be made some time in the future to create a single standard building code under technical auspices. Whether the formulation of such a code will result in its general adoption by municipal legislatures remains to be seen; and, as we have intimated, the argument is by no means one-sided. But it may be taken as certain that a standard code would do useful service as a model.

Lobbying of the Right Sort

CONNOTATION and usage to the contrary notwithstanding, the word "lobbyist" is not necessarily a term of reproach. On some matters legislators have to be advised and urged toward action for the public good, either to offset the evil or unwise influences which are always at work or to supply needed information. Fortunately engineers collectively are beginning to recognize the distinction between a good and a bad lobby; witness the active work in favor of the proposed Department of Public Works. In the final passage of the Federal Water-Power Bill the mass action of the profession did not come into play, but there were a few individuals who carried on a private fight. Prominent among them and practically alone as a representative of the civil engineering profession was Hugh L. Cooper. Colonel Cooper, it is well known, is interested in some large hydro-electric developments which have been awaiting the passage of the law. But in spite of this his engineering advice was repeatedly accepted by congressmen on whom it was sometimes forced, but by whom it was more often sought. For ten years his time and money have lavishly gone to the furtherance of proper power legislation, and now that, so far as Congress is concerned, the issue is successfully terminated proper credit should be given him by those, engineers and public alike, who will profit by the opening up of the nation's water-power resources.

Highways and Heavy Haulage

SHARP increases in motor vehicle transportation, the appearance now and then upon the public highways of excessively loaded commercial vehicles, and the failure of many so-called durable pavements have drawn wide attention recently to the question of how far motor

vehicles should influence the design of modern pavements. The most recent state to become alarmed over the condition of its highways is Ohio, which has suffered greatly within the past few months. Recent transportation conditions have contrived to give great impetus to the commercial motor vehicle on short and medium-distance hauls. In fact, many communities have depended largely upon the motor truck for their supplies of farm and dairy products. In some states the heavy war traffic of 1918 has been reported doubled by 1920 commercial traffic. A cry has consequently gone up from various states insisting upon weight regulations for vehicles as a means of safeguarding the highways. It appears that, in the breaking up of highways, motor trucks and poor drainage facilities share the responsibility. Weight regulations must, therefore, be enforced to absolve the motor truck. Only intensive study and careful design, followed by proper construction, can eliminate poor highway drainage. But just what that limitation in truck weight should be is a question that automotive and highway engineers are to solve. There is apparently no adverse criticism regarding the lighter trucks, those below a 3½-ton capacity, the mass of criticism of truck weights being directed against heavy units. Highway technic which endeavors to discover what design will meet reasonable demands of highway transportation is in a formative period. Until that design is determined it is apparent that regulation is the only alternative whereby existing mileages can be saved. And it must be remembered that not only are the demands of highway transportation to be taken into account, but that financial considerations rule as well. If 25-ton loads are to form the basis on which highway engineers design modern pavements it is apparent that only the smallest mileages can be constructed. There is that middle ground: A thorough co-operation between those who build the highways and those who construct the vehicles using them, and expenditures based on economic necessity

Ship Railways: 700 B. C. to 1920 A. D.

ANCIENT and modern history of the engineering development of the ship railway for transporting vessels across necks of land is brought to mind by the description of the marine railway or slipway at Astoria, Ore., for hauling vessels out of the water to be repaired or cleaned, described in our issue of June 10, p. 1157. The ship railway and the marine railway belong to the same type, though employed for different purposes.

Historically, the ship railway dates back to about 700 B. C., when the Greeks built such a line to transport their galleys across the Isthmus of Corinth in order to avoid the long and dangerous southward passage. This line is said to have been in use for more than 300 years. Some other ancient temporary works of this kind were mainly achievements in military or naval welfare. There is record of lines built by the Greeks in 831 A.D., by the Venetians in 1438 at Lake Garda, and by the Turks in 1453 at Constantinople. In American history there stands prominently the Portage Railway, of about 1840, for the transfer of canal boats across the summit of the Alleghenies. Coming down to more modern days, in the decade of 1880-1890 the project for an Atlantic-Pacific ship railway across the Isthmus of Tehuantepec, in Mexico, was advocated vigorously and was a subject of interest and controversy in engineering circles as an alternative to or a rival of the several isthmian canal projects of that time. A few years later the Chignecto ship railway in Nova Scotia, at the head of the Bay of Fundy, was commenced, but financial troubles led to the abandonment of the work. Of a smaller class are the Dalles-Celilo boat railway for transferring river vesels around the rapids of the Columbia River, and the boat railways for transferring small craft over dams and levees.

The Tehuantepec project deserves particular attention because Captain Eads was its engineer and promoter, and it had the endorsement of such men as Octave Chanute, Henry Flad and E. L. Corthell. For transportation purposes on such a large scale the shipyard railway or slipway had to be developed along somewhat different and original lines. Instead of raising the cradle into contact with the ship by hauling the cradle up an incline, Captain Eads proposed to raise it vertically by a submersible pontoon traveling in guides. For hauling over a long distance the cradle was to be mounted on railway trucks instead of rollers, and chain or cable haulage was to be replaced by locomotive traction. Further, some better support than the ordinary bilge blocks would be needed to prevent straining or racking of the hull of a large steamer during the land passage. To meet this requirement a system of equalized hydraulic jacks was devised, a combination used successfully in recent years for moving large bridges.

Ships of 5,000 tons were provided for in Captain Eads plans. Since his day, however, there has been such increase in the size and weight of ships that many of the vessels which now go through the Panama Canal would still have to go around Cape Horn if the Tehuantepec ship railway were the only means of interoceanic communication. The same condition might exist if we had only a canal of the dimensions proposed in the projects contemporaneous with the ship railway. But the railway was so much the cheaper that it would have been easier to supersede it by a large canal than to enlarge or replace an existing canal. Difficulty of finance appears to have been the main obstacle which this ship railway project, like several canal projects, could not overcome. What might have been the history of isthmian transportation if the railway had been built can be only a matter of conjecture.

Whatever may be the possibilities and limitations of the ship railway, there is no doubt as to the practical value of the marine railway for shipyard work. Although a 5,000-ton load limit is assumed by the author of the article already mentioned, it seems not improbable that such railways may be developed for larger capacities and still show advantages of economy as compared with either fixed or floating drydocks. Foundation conditions and cost are prime factors in such development.

War conditions have been the cause of a rapid introduction of marine railways for shipyard work in this country, coincident with the revival of the American shipping industry. Their continued use will be a part of the maintenance work on our new merchant marine and may lead to further developments in size and in operating methods. It may be that engineers will again consider the possible application of the ship railway for transportation in commercial or military service, not necessarily for liners or battleships but perhaps for transfer of coasting vessels or the smaller class of war vessels between fields of operation in separated waters.

Another Turn in Rail Study

WITHIN the past two years the discovery of a new method of rail study, "deep etching," or pickling, which revealed a startling condition of the interior metal of many rails, wakened hopes of new progress toward greater railway safety. Later, when it was demonstrated that the peculiar internal defects revealed by pickling are due to numerous fine cracks in the steel, and when various observations had made it highly probable that this internally cracked or "shattered" condition of the metal is closely related to the occurrence of transverse fissures, such hopes were strengthened. It seemed that nothing remained but to find the cause of internal cracking and then to cure it, in order to eliminate the most troublesome and dangerous type of rail failure. But the reassuring prospect is now made rather more remote by conclusions drawn from further studies of rails, and if those conclusions are confirmed the whole rail subject may revert to its unsatisfactory status of three or four years ago, when each new fact brought to light in rail study seemed to introduce greater confusion.

In summarizing elaborate investigations made in connection with a Virginia train wreck caused by a transverse fissure, J. E. Howard, of the Interstate Commerce Commission, virtually declares the theory that fissures are caused by "shattered" metal in the rail head to be unfounded. He cites some bad cases of transverse fissure that occurred in rails free from the internal cracks revealed by deep etching; and obviously it is hard to reconcile the theory with such observations. But in his report and in a subsequent paper read at the meeting of the American Society for Testing Materials two weeks ago he goes beyond refuting the theory, and suggests that its very opposite may be true, namely that shattered rail-head metal may be more resistant to fissuring than solid metal. This disconcerting view, put forward quite insistently in the wreck report, is stated in the later paper much more cautiously, as merely a question entitled to consideration and study; yet for the moment at least it is the newest thought in the field of rail study and must be reckoned with.

Transverse-fissure breaks, it is agreed, are repeated-stress fractures that start from some minute defect in the metal. The service stresses in the rail should, however, be greatest at top of head and bottom of base, whereas the center of a transverse fissure is always located in the interior of the head. For this reason, when Mr. Howard first announced his discovery of transverse fissures, eight or nine years ago, he pointed out the controlling influence of the cold-rolling action of the wheels, which distorts the surface metal of the rail and transfers the zone of maximum tensile stress to the interior. Now he couples with this effect the influence of initial strains in the interior of the head caused by the shrinkage of the rail during cooling after it leaves the rolls, in the process of manufacture.

The rail metal cools first on its outer surface and the shell thus becomes rigid; and when the hotter interior metal then shrinks, longitudinal tension in the center of the rail head is set up. Such action does take place no doubt, but in naming it as a prime factor in transverse fissuring and attributing fissures to "the united action of the primitive shrinkage strains and the augmented cold rolling strains," Mr. Howard sets up a wholly new conception of the mechanical action of rails.

But directly connected with this new view is a conclusion drawn from the peculiar fact that in a rail whose interior is "shattered," the zone of shattering ends half an inch or so from the (hot-sawed) end of the rail, just as it does not approach nearer the sides and top of the rail than half an inch or so. M. H. Wickhorst, engineer to the railways' committee on rail study, confirms this observation, and both Mr. Howard and Mr. Wickhorst conclude that the shattering develops after the hot-sawing and is a manifestation of the shrinkage which occurs during the cooling of the rail. Mr. Howard goes farther in his reasoning, and considers that in those rails in which shattering develops during the shrinkage, the strains that would otherwise be set up are relieved, and that in consequence sound rails have greater initial stresses and are more susceptible to failure by transverse fissuring. Therefore, "the diffusive action of a certain number of shattering cracks might at times ameliorate conditions, retard or possibly arrest the formation of transverse fissures."

With all possible allowance for the harmful effect of initial strains, it is not easy to understand how a thoroughly checked and cracked mass of material can be more resistant than solid material to the tearing-apart action evidenced in transverse fissuring. Mr. Howard's conclusions are of undoubted weight, in view of his long study of rail fissures and his rare skill as an investigator. But unless his theory can account for the fact that fissures tend to occur in heats, for the greater susceptibility of heavy over light rails, and for the protective effect of reheating blooms before final rolling—all facts that point the finger of suspicion at ingot conditions—it is obviously so imperfect as to be merely a speculative hypothesis.

The most uncomfortable feature of these latest views is that they lead again to putting the blame for transverse fissures on rail service rather than rail quality. In his wreck report Mr. Howard goes so far as to say: "The idea is not tenable that unbreakable rails can be made, ignoring service stresses; that rails must be made as a mill problem which will not fail in the track under the increasing weight of rolling stock." This is in substantial opposition to the views on which present work on rail specifications is being carried on. Railway engineers, while recognizing the existence of high service stresses, fully established by the work of the Track Stress Committee, point to many facts that acquit stresses of primary responsibility for failures: the simple fact, for instance, that rail failures are not proportioned to traffic weight or density. Such facts argue against the new views just as they have overthrown prior attempts to explain rail failures.

In time it may be possible to place the subject of railway track on the basis of design, and to limit the stresses caused by trains in the same way that bridge stresses are limited. But for the present we believe that the problem must be regarded essentially as one of rail quality—finding out what defect causes some rails (very few) to fail. From this point of view the study of "shattering" of rail-head metal still appears highly promising, indeed the most promising in the whole rail field, despite Mr. Howard's recent conclusions. And it may indeed turn out that the early acquittal of shattering cracks from responsibility for transverse fissures was premature. Even the conclusion that shattering is caused by shrinkage may prove to be in error, and the mechanical actions of the steel-mill rolls may yet be shown to play a part in determining rail quality.

Structural Design and Ventilation of Liberty Tunnels

Two Tunnels 59 Ft. Apart Provide Separate Two-Line Roadways—Light Traffic Likely for Many Years—Ventilation

IN the Liberty Tunnels through the South Hills, now under construction, Pittsburgh will have the largest highway tunnel yet built. It is notable both in its size of cross-section and in its length; it provides two separate roadways, each for two lines of traffic with space for street cars, and its length from portal to portal is well over a mile, being 5,715 ft. After the adoption of the general route, reported in *Engineering News-Record* of July 24, 1919, p. 166, the project as originally outlined was thoroughly revised in the course of working out the details. A wide four-line tunnel was contemplated a year ago, but this plan has been superseded by the present one for two separate two-line tunnels. The profile of the route was improved by eliminating the summit and steep grade laid out last year, and substituting an unbroken flat grade of 0.329 per cent. The enterprise is significant in its engineering phases on the traffic as well as on the structural side. Providing adequate ventilation to purify the tunnel air of the dangerous exhaust gases from automobiles was one of the most important problems of the planning.

Ground Conditions and Lining—The tunnel lies in good shale. The top of a ledge of especially firm sandstone that has been used extensively for producing local building stone occurs near springing-line elevation. The tunnel practically follows the strata. It was to be expected that blasting in construction would loosen the roof in places sufficiently to cause large overbreakage, but not enough to develop any material rock loading on the structure of the tunnel. The lining was therefore designed empirically as a 24-in. arch of concrete, lightly reinforced along the intrados to forestall any possible cracking. The cross-section of each of the two tubes is of horseshoe outline with semi-circular roof arch 13 ft. 3¼ in. in radius and sidewalls 7 ft. 2 in. high above crown of roadway.

To fill the space back of the lining rock packing as customary is provided for, but this is required to be cemented solid with grout pumped through pipes set in the lining. The two tubes are 59 ft. apart on centers, leaving about 27 ft. of undisturbed rock between the separate excavations.

Abandoned coal workings about 150 ft. above the tunnel drain the upper part of the hill over the tunnel, but the rock below the workings probably contains water. As it was feared that wet places might be encountered in the excavation, especially near the portals where the ground is presumably most broken, it is required that for 600 ft. length at each portal, and wherever else the engineer might find desirable, membrane waterproofing shall be placed on the outside of the lining concrete.

According to the contract plans of A. D. Neeld, engineer in charge of the tunnel construction for Allegheny County, the tunnel excavation is to be timbered with arch sets of 12 x 12 timbers outside the neat line of the concrete lining, these sets to be spaced as may be found necessary for the support of the rock. When the contractor, Booth & Flinn Ltd., of Pittsburgh, started on the work, it was found that with the price of timber at $65 per M. it would be cheaper to use 8-in. Bethlehem H-beams cut to form segments as for timbering. The substitution has been approved by the engineer, and in view of the greater permanency of the substituted material the I-beams will be allowed to project 6 in. inside the exterior neat line of the lining. The excavation and hence also the overbreakage will probably be much reduced by the change.

Traffic Conditions—A district of purely residential character is to be served by the tunnel. The suburbs West Liberty, Beechview, Brookline, Dormont, Mt. Lebanon and adjacent territory, which lie beyond the south portal, are not likely to become sites for industrial development in future, and but little development of traffic beyond a growth of the passenger vehicle traffic is looked for. The only freight transport through the tunnel will be that necessary for building materials and for the domestic services of the district. It was believed unwise to build a tunnel of less than one two-line roadway in each direction, but the maximum capacity of the tunnel will probably not be utilized for many years to come. Before traffic outgrows this capacity another tunnel may be built, reaching another part of the South Hills district.

According to calculations checked by traffic studies on Pittsburgh thoroughfares the tunnel capacity is estimated at 1,690 vehicles per hour in each direction, at the maximum. This traffic corresponds to two lines of vehicles, both traveling at 15 miles per hour, vehicles 100 ft. apart in each line. A traffic count made on Bigelow Boulevard, the principal automobile thoroughfare between downtown Pittsburgh and the east end, conducted during a recent stoppage of street-car traffic, when presumably the road traffic was heaviest, showed a maximum of 1350 vehicles passing in one direction in one hour. This traffic occupied half the width of the 40-ft. roadway, and so is considered fairly comparable with the possible traffic in one roadway of the tunnel. It will be seen that the tunnel capacity has been estimated

FIG. 1. SOUTH PORTAL OF WEST TUBE, LIBERTY TUNNELS, FROM BELL TAVERN

at a higher figure. The ventilation calculations were based on this estimate of capacity.

Ventilation—Tests of automobiles for carbon monoxide emission and physiological experiments on the susceptibility of human beings to carbon monoxide now being conducted under the auspices of the Bureau of Mines, supplied the essential data for the calculations on ventilation. As this is the first large highway tunnel in which the problem of dealing with automobile exhaust had to be solved, there was no precedent to guide the planning. While the assumed data differ from those used in the design of the Hudson River vehicle tunnel at New York, the results are said to be substantially identical.

It was believed that with the above-noted spacing of vehicles (100 ft. in each line), corresponding to 114 automobiles in either tube of the tunnel at any one time (in maximum traffic), heaviest load would be fairly represented by assuming a gross weight of two tons per vehicle. The monoxide emission was taken as 3.0 cu.ft. per ton-mile. Since a vehicle of two tons traveling at 15 miles per hour represents a transportation unit of ½ ton-mile per minute, the carbon monoxide emission under these conditions would be 1.5 cu.ft. per vehicle per minute or 170 cu.ft. per minute for each tube of the tunnel. From the curves showing the physiological results it was considered that a carbon monoxide content of 6 parts per 10,000 at the exit (or half that quantity average) would be allowable. Therefore it would be necessary to supply 280,000 cu.ft. of fresh air per minute to each tube.

After consultation with Charles S. Churchill it was decided to use the system designed by Saccardo for ventilating tunnels in Italy. This system with some modifications Mr. Churchill has used in ventilating a large number of railroad tunnels in the United States. Air is blown in at one end of the tunnel by means of suitable lateral nozzles facing toward the other end of the tunnel, and the tunnel itself is utilized as ventilation duct. It was at first intended to take advantage of the prevailing winds, which are from the south, by ventilating from south to north in both tubes, but this was reconsidered as it would mean ventilation against the traffic in one tube. The final decision was to ventilate with the traffic. As the total air pumpage, distributed over the cross-section of the tube, 468 sq.ft., means a velocity of air current of only about 6 miles per hour, there is a likelihood that the traffic will aid in driving the air through the tunnel. Two pumping plants, one at the entrance end of each tube, will be designed for handling the entire quantity of air required at maximum traffic. An emergency maximum pumpage of 280,000 cu.ft. per minute per tube, or a normal maximum of 200,000, has been assumed for the design of these plants.

A pair of nozzles in the side walls of the tunnel near the entrance end, leading from an air chamber formed in an enlargement of the tunnel excavation surrounding the lining, will give a discharge area for ventilation air of 68 sq.ft. (for one tube). With the normal pumpage the discharge velocity at the nozzle will be 2,940 ft. per min., or about 33 miles per hour, and with the maximum pumpage the discharge velocity would be 4,210 ft. per min., or about 47 miles per hour; this maximum would be needed only in cases of emergency. The mechanical details of the ventilating plant have not yet been worked out. The figures given are tentative and subject to change after the Bureau of Mines has completed its investigations.

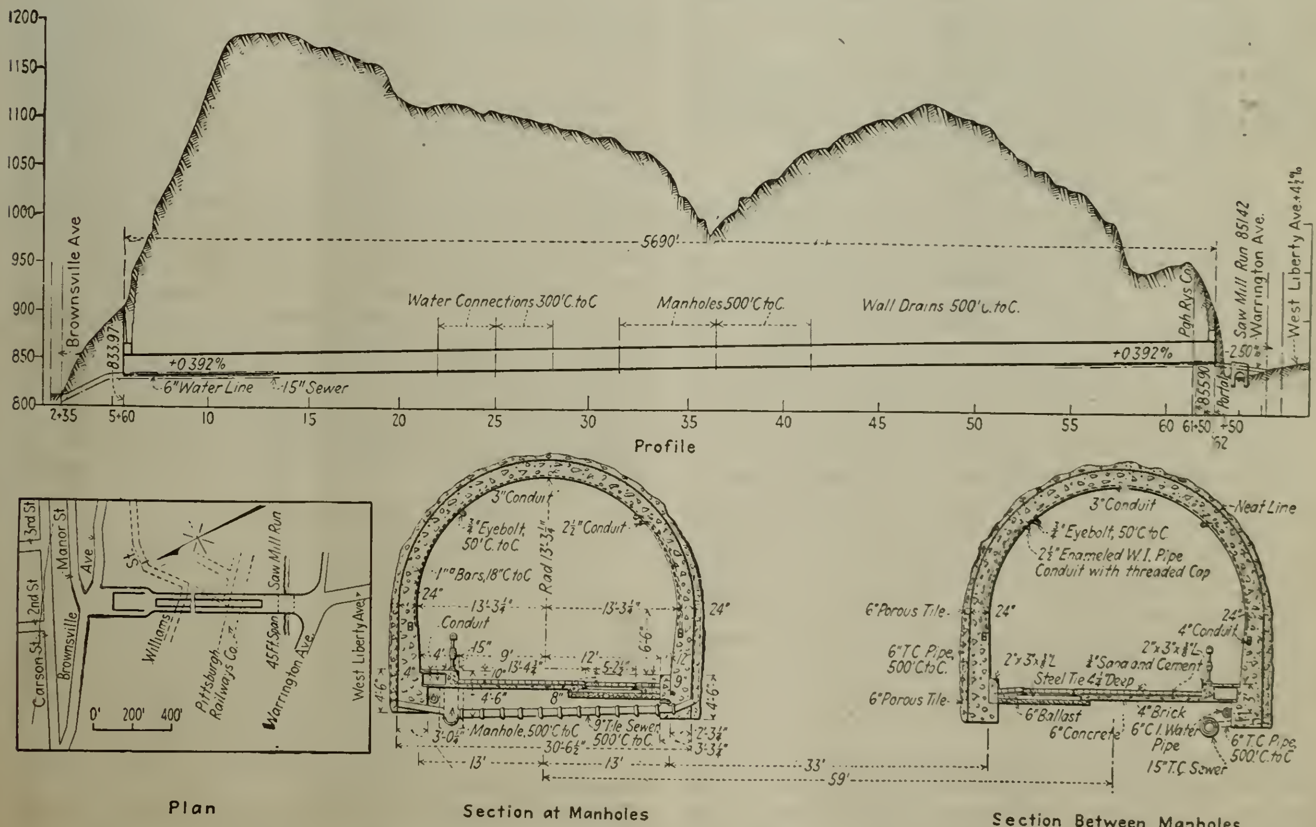


FIG. 2. PROFILE AND CROSS-SECTION OF DOUBLE-TUBE HIGHWAY TUNNEL THROUGH SOUTH HILLS, PITTSBURGH; LENGTH 5,715 FEET

Factory Floors for Special Uses

Types Recommended by Experiences in Navy for Acid-Subjected Floors and for Different Kinds of Storehouses and Workshops

By H. S. Rinker
Expert Aid, Navy Yard, New York

This paper appeared in "Bulletin No. 31," Public Works of the Navy, April, 1920, which is issued under the cognizance of the Bureau of Yards and Docks and the Corps of Civil Engineers, U. S. Navy.

THE urgent impetus given by the war necessities of the Navy's shore stations resulted in a strong demand for more and better industrial buildings, and the advance in design has been commensurate with the requirements of the times. The old-fashioned way of arranging the interior of any building, walls and roof, which might fall into the possession of the department requiring accommodations, has changed.

This has brought with it the question of special design—of making a building just as much a part of a special service as a machine tool or piece of equipment. We now make storehouses, machine shops, galvanizing plants, foundries, plate and angle shops, smithies, each for its own purpose, each with the special construction—steel, concrete, wood, or composite—which adapts it to its purpose.

This revolutionary departure in frame, lighting, crane, and elevator equipment is accompanied by a corresponding need for floors of such special construction as to fit into the purpose of the building as exactly and with the same adaptability as the other portions of the structure.

While discussing the question of floors in general, the conclusion was forced on the writer that the matter had been given but little detailed attention, the general opinion being that for a shop the floor should be either creosoted wood block, or concrete, usually with some surfacing process included. The average engineering imagination has no further to go to find a satisfactory type. But when the special problem requires a special solution the adaptability of these types is not always marked.

Problems which have recently come to the writer's attention are those of floors for storage-battery storage and overhaul buildings, galvanizing plants, light machine shops, and buildings for toilet and locker rooms.

Floors for Storage-Battery Buildings

The first of these problems to arise was the question of floors for storage-battery buildings. The requirements in this case are that floors shall be dense enough to resist deformation under the concentrated weight of the battery units, ranging to 1,000 lb. per square foot; shall be impervious to moisture, capable of withstanding attack by the chemical agents and products incidental to charging, discharging, and handling storage batteries; and shall still remain plastic long enough to resist abrasion or fracture by reason of the handling of the battery cells.

The main consideration, that the floor shall be and remain inert to chemical action, is filled to an admirable degree by a special acid-resisting asphalt block. The problem was submitted to one of the leading asphalt-block manufacturers, in connection with the storage-battery building at the Philadelphia yard, and was solved satisfactorily, as has been proved by severe tests, both at the laboratory of the company and at the yard. The asphalt blocks selected are 8 x 4 in. in surface dimensions, and admit of repairs by simply lifting and reversing the injured block or blocks. The manufacturing pressure is 4 tons per square inch, which insures a product of such density that standing loads have no effect.

The asphalt blocks are laid upon a ½-in. 1:4 cement-mortar bed. Ordinarily no jointing material other than sand is required, as they soon weld under traffic to a continuous surface. This action is hastened by the fine sand which is spread over the surface of the floor and allowed to work into the joints.

In those localities in which traffic is insufficient to produce this sealing action one of two methods may be adopted to insure a moisture-proof acid-resisting point. One of these is the use of an asphaltic filler. This, however, is open to the objection of extra expense, and conceivably might also result in some stickiness on the floor surface. The other method consists, briefly, in applying a surface coat or thin wash of liquid asphalt, which fills and seals all the joints. In the case of the Philadelphia yard it was considered that the traffic would not be entirely sufficient to close the joints. Should the application not be considered necessary at first, this surface coat may be easily and quickly applied at any time.

In all these cases the concrete subfloor and the mortar bed are laid perfectly true to the necessary drainage grades, and the finish grades follow the subfloor grades to vitrified earthenware drainage cesspools set at appropriate points, which in turn connect with vitrified-pipe drains.

Making the Sub-Floor Acid Proof

Replying to an inquiry as to methods of positively sealing the floor so as to preclude the possibility of acid reaching the concrete sub-floor, the manufacturers referred to above made the following statement:

We note that the department which will use this building is interested in the manner in which the joints of the asphalt block may be sealed, so that no acid can pass through to the concrete floor below. The maltha to which our letter refers is a heavy petroleum oil having an asphaltic base. In order to secure a flux for the Trinidad asphalt which is used in the block, we refine the above maltha until it becomes solid. It then has a consistency similar to rubber and imparts to the block its peculiar resiliency. This flux or asphaltic residuum from maltha is pure bitumen, and acid acts upon it only very slightly and with extreme slowness. The melting point is about 140 deg. F., and it is this material that we suggest for a paint coat. The maltha or its residuum, for we use the terms interchangeably in our own process, should be heated to about 400 deg. F., and a coat spread upon the surface of the blocks. This coat should be made as thin as possible and should be squeeged. A thin layer of fine, clean sand should be spread over the entire surface and allowed to be worked in by traffic. The surface to be coated should be dry and clean, and the process of coating should be as rapid as possible and performed while the material is hot. Any excess sand may be brushed off after the paint coat is cooled. You will note that by this means a floor is obtained which is entirely impervious to moisture. Care should be taken with each of the above processes.

There is no limestone in these blocks, the aggregate being composed of trap. It is necessary in the manufacture of a block to use a certain amount of dust as a filler. This dust is trap-rock dust. We note that the bed on which the blocks are to be placed will not be more than ¼ in. thick. Our invariable procedure is to use a mortar bed usually about ½ in. thick. There is no reason why ¼ in. would not suffice if the mortar bed can be struck off to a true and even level in such a thin layer.

The case of the galvanizing plant, copper shop, and the floors around the plate-pickling tanks is fairly similar to the above, but with one important exception. The acid and alkali baths introduce the same chemical problems as before, but the presence of heat in the metal baths and the weight of the plates handled make it advisable to pave the floor immediately around the metal-bath tanks with a vitrified brick of selected attributes, set in asphalt, and the rest of the floor as above.

Asphalt Block for Shop Floors

For the structural and light machine shops the plain compressed asphalt block seems to offer a solution of the problem. This conclusion is based on the reports received concerning the experimental floor laid some three years ago in the boiler shop of the Brooklyn Yard, Building 28, a floor which has been enthusiastically indorsed by all who have examined it or worked on it. When laid on the dry mortar bed without jointing material, with a little sand to give side bearing, the floor is ideal in its adaptability, ease of repair, and low first cost. This block should be 2 in. thick and of a 4-ton compression density.

The forge shop, on the other hand, seems to be still available as a field for the creosoted wood block. Its peculiar drawbacks—the necessity for jointing with pitch and the consequent "bleeding," so noticeable when it is used

for outside work—are reduced to a minimum here by reason of the protection from sunlight afforded; and the sand and iron scale, always present, soon become so indurated by incorporation into the ends of the wood fibers as to make a resulting surface entirely different in appearance and action from the same material when exposed to weather conditions.

Such a floor is available for shops with small fires and handwork without any special protection from hot forgings dropped on it, provided the forges are furnished with an area of sanded surface adjacent to the fires. Where large furnaces are located, the provision of an appropriate area paved with granite block or lug brick is advisable. This, however, should be reduced to a minimum for the sake of the workmen.

In toilet rooms the granolithic floor is still, all things considered, regarded as worthy of first choice. When it is made integral with the floor, properly floated, and steel troweled at least three times, as it should be, it answers every purpose. In all cases it should extend in unbroken construction at least 8 in. up on the side walls, with a sanitary cove at least 2 in. in radius. The receptors and drainage grades for showers and toilet fixtures can be made integral in this surface finish, terminating in brass cesspools connected to the drainage system.

This material, however, does not seem to be necessary in the locker rooms, where edge-grain or end-grain wood flooring may be used with entire satisfaction. The continuous mastic sheet floor, however, would seem to be the most desirable for this situation, as it lends itself to cleansing with water or antiseptic solutions as well as the granolithic finish, and also admits of the integral sanitary cove at the junction of wall and floor, without presenting the chill and unyielding surface of concrete.

The cost of the 1¼ in. compressed asphalt block used in the battery building at the Philadelphia Navy Yard are approximately as shown below:

	Per square yard
8 x 4 x 1¼ in. block at plant	$1.35
Freight and laying	.35
Concrete base and mortar bed	1.00
Asphaltic seal for joints	.20
Cost per square yard at Philadelphia	$2.90

This is by far the cheapest floor on the market today, as by comparison with recent figures its first cost is less than that of either brick or wood block, and its maintenance expense negligible

Water-Works Repairs and Replacement

IN THE course of a discussion on the legitimate use of water prepared for the recent convention of the American Water-Works Association, George A. Johnson, consulting engineer, New York City raised some questions regarding posible water-works economies in other lines than water waste restriction during the present period of high prices. He said:

Is it possible that in the downily prosperous days of the past we replaced at high cost where we could just as well have repaired at small expense? Have we laid new mains, built storage reservoirs and installed new pumping units in order to obtain more water when we could have accomplished the same end effectively by searching out and stopping unnecessary waste of water, installing meters, cleaning mains to restore their original capacity thereby cutting down friction losses and saving the coal pile and generally attending strictly to our job?

There seems to be real occasion for serious debate respecting whether the war period, and the manner in which we lived through it, has not furnished a lesson which most of us refuse to understand, namely, that it really is possible to get satisfactory service on a restricted program of water-works extension, machinery replacement and the like, if we pay more attention to economy in all lines and exploit the more economical potentialities at hand to a far greater extent than we did before the war. It seems to be deplorably true that quite on the contrary, as an average proposition, we have followed the line of least resistance when water consumption threatened to exceed supply.

Effect of Inert Powders on Concrete Srength

Tests Showing That Hydrated Lime and Other Powders Except Slag Tend Slightly To Decrease Compressive Strength

TESTS reported by Duff A. Abrams, of the Structural Materials Testing Laboratory at Lewis Institute, before the recent meeting of the American Society for Testing Materials give some rather unexpected results regarding the strength of concrete to which has been added inert powdered admixtures, mainly hydrated lime. As stated in the paper, "The use of hydrated lime in quantities up to 5 or 10 per cent of the weight of the cement has gained considerable vogue due to the feeling that it improves the workability of concrete, or increases the strength and watertightness. Published tests may be found which appear to support the above conclusion. However, it will be seen that these more thorough tests show the error of the statement with reference to strength and workability. Water-tightness was not studied in this investigation."

The tests have been made over a period of four years and involve nearly 20,000 test pieces. The report is confined to powdered admixtures which are essentially inert in the presence of water and cement as contrasted with liquids or soluble materials, and while the major portion of the tests were made with hydrated lime seventeen other materials were also used in order to determine the general effect of inert powdered admixtures.

Tests were made mainly on 6 x 12-in. concrete cylinders, although some tension and compression tests of mortar were used. Wear tests were made in the Talbot-Jones rattler, and bond tests were made in one series. Studies of evaporation and absorption were made on concrete containing hydrated lime and other admixtures. The mix varied from a 1:2 to 1:9, with wide variations in consistencies, and size and grading of aggregates, and the age tests varied from three days to one and one half years.

The general conclusions as stated in the paper are as follows:

1. In general the addition of powdered materials reduced the strength of concrete approximately in proportion to the quantity of admixture. Some exceptions are noted.

2. In usual mixtures each 1 per cent of hydrated lime (in terms of the volume of cement) reduced the strength of concrete 0.5 per cent. The reduction in strength caused by replacing cement with an equal volume of hydrated lime was about 1⅔ times that caused by adding hydrated lime.

3. High calcium and high magnesium limes produce the same effect.

4. The addition of 1 per cent of the following powdered admixtures in terms of the volume of cement reduce the strength of 1:4 concrete at 28 days by the following percentages:

Brick, 0.08; clay, 0.22; whiting, 0.24; sand, 0.37; natural cement, 0.38; limestone, 0.39; lava, 0.40; fluorspar, 0.43; kaolin, 0.47; kieselguhr, 0.48; tufa, 0.51; hydrated lime, 0.56; ironite, 0.60; yellow ochre, 0.68; mica, 1.10; pitch, 1.50; gypsum, 4.00. For the same conditions the addition of 1 per cent of cement *increased* the strength of concrete about 1 per cent.

5. Pulverized slag up to 50 per cent of volume of cement gave a slight increase in strength of concrete (about 0.12 on the basis used above).

6. Rich concrete mixes showed a greater loss in strength due to powdered admixtures than the leaner ones. Very

lean mixes (1:9 to 1:6) and in those with aggregates graded too coarse for the quantity of cement used, the strength was little affected or was slightly increased by admixtures up to 50 per cent.

7. The wetter mixes showed a greater loss in strength than the dry, due to the addition of hydrated lime.

8. The effect of admixtures was in general independent of the age of the concrete.

9. Sand and slag cements gave results comparable to those from powdered materials simply mixed in the concrete.

10. Hydrated lime and other powdered admixtures used in these tests slightly increased the workability of the leaner mixes (1:9 and 1:6) as measured by the slump test. Ordinary mixes (1:5 and 1:4) were little affected; richer mixes (1:3 and 1:2) were made less plastic.

11. The wear of concrete was not sensibly increased by hydrated lime or other admixtures up to 20 per cent of the volume of cement.

12. The bond resistance was affected in the same manner as the strength by the presence of hydrated lime.

13. Hydrated lime had little effect on the absorption of dry concrete, increased the evaporation of water from wet concrete and produced no beneficial effect on the strength of concrete stored in air.

14. The yield of concrete was little effected by hydrated lime or other admixtures; for the usual concrete mixes, 20 per cent admixture increased the yield about 2.5 per cent.

The conclusions of Professor Abrams' paper were attacked quite vigorously at the convention by several of those interested in the use of hydrated lime. C. M. Upham, state highway engineer of Delaware has been making a number of field experiments with hydrated lime in concrete and has been using it in his concrete roads; he stated that his observation of the tables included in the Abrams report showed that while they applied to the high percentages of admixture of hydrated lime, they were not entirely true for such mixtures as are used in actual practice; that is, speaking generally, for a 5 per cent to 10 per cent admixture in a 1:6 concrete. He said that casual examination of the tables seemed to show that in few cases was the strength of 1:6 concrete reduced by a 5 per cent admixture and that in some cases it was increased. Professor Abrams, however, in reply insisted that while some of the strengths of concrete cited were higher with the lime admixture, the general statements and conclusions he thought were borne out by the tests. He stated further that the tests did not bear out the occasional contention that hydrated lime in concrete serves to store up surplus water to be delivered to the cement for hydration at a later period.

Sanitary Control of Water Supplies in Quebec

The Board of Health of the Province of Quebec, said T. J. Lafreniere, sanitary engineer of the Board, in a paper at the annual meeting of the American Water-Works Association, has power to order that publicly owned water supplies be made safe. Local authoriities may incur the necessary expense without authorization by popular vote. Until the passage of legislation in 1919, the board had no such control over privately-owned supplies, which were under the jurisdiction of the Public Utility Commission. The 1919 legislation leaves to the commission the decision as to how the cost of improving the quality of privately owned supplies shall be met. It is probable, Mr. Lafreniere said, that if the water rate payers will not agree to an increase in water rates to meet the added cost of providing safer water, then the municipality will have to carry the burden.

New Rapid Transit Railway for Sydney, Australia

Electric Underground and Elevated City Loop To Connect Suburban Lines and Relieve Street-Car Congestion

Electrification of steam suburban lines and their extension through the city, with a connection across the harbor to the northern suburbs, is the costly project undertaken to provide much needed improvement in the rapid transit facilities of Sydney, New South Wales. It is expected that construction work, interrupted by the war, will be resumed this year. The harbor will be crossed by a cantilever bridge of 1,600 ft. clear span, carrying the suburban tracks, street railway tracks and roadways. The following information regarding the project has been obtained through the Railway Commissioners, the railways and street railways being owned and operated by the government of New South Wales, Rapid growth of population and great development of local traffic have resulted in extreme congestion of the city's transportation facilities. The population grew from 488,000 in 1901 to 520,000 in 1905 and 877,000 in 1910. There was a drop to 771,000 in 1917, but since there has been an increase, so that the present population is probably about 800,000. Street railway passengers increased from 120,974,000 in 1905 to 244,712,200 in 1917, the miles of line being 73 and 113 respectively. For the year ending with June, 1919, the number dropped to 222,111,400, but this was only a temporary check in the steady increase. Railway suburban passengers numbered 89,542,000 in 1919, but this includes the two cities of Sydney and Newcastle. Allowing 75 per cent for the larger city, it had 67,156,500 passengers, many of whom used also the street cars and the ferries

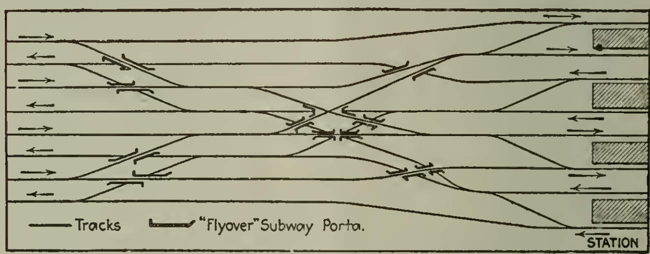


FIG. 1. GRADE SEPARATION OF TRACKS ON RAPID-TRANSIT RAILWAY

as part of their routes. The harbor separates the city from an extensive residential and suburban district on the north, and ten years ago the five main steam ferries carried 13,000,000 passengers annually and two carried 430,000 vehicles. Bridge and tunnel projects for crossing the neck of the harbor were described in *Engineering News*, July 29, 1909, p. 128.

Main line and suburban traffic of the steam railways now terminates at the Central Station, a large terminal one mile south of the business center of the city and 1½ miles south of the Circular Quay on the harbor front, where the ferry service is concentrated. From the quay to the railway station there are four electric car lines on four principal streets, one of these lines ending at the station and the others continuing to districts not served by the suburban railways. The Central Station was opened in 1906, but additional platforms had to be provided in 1914 owing to the

great increase in traffic. An unusual feature of this station (see *Engineering News*, March 30, 1905 p. 327) was the arrangement of the tracks in groups of three between the platforms, the middle track being used to run out the locomotive of an inbound train or to store cars and trains. Transfer tables connected the ends of the three tracks.

Street car service between the station and the ferries has practically reached the saturation point and it is said to be impossible to increase the accommodation during the evening rush hour. In two of the streets, two-car trains operate on a headway of only 17 sec., each car seating 80 passengers but often carrying twice that number. The steam suburban trains of the southern and western districts are handled at the Central Station, which is served by four inbound and four outbound tracks. During the evening rush hour there are 58 outbound trains, generally consisting of ten cars, the traffic being handled at 21 platforms.

To relieve this traffic congestion and to improve the service by reducing the transfer between trains, street cars and ferries, the suburban lines are to be extended beyond the Central Station terminal to form a loop through the city, with branches to eastern and western suburbs now served only by surface cars. Another line from the loop will extend across the new bridge to connect with an isolated suburban line which now terminates at Milson's Point on the northern side of the harbor. When the project is completed, the entire city and suburban service will be operated by electricity and much of the traffic now handled only by street cars will be served by the suburban trains, so that there will be no change of cars between suburban and city points. The general scheme is shown by the map, Fig. 2.

Connection with the main line of the steam railway system will be at Wells St., about ¾-mile south of the present terminal. Here eight tracks will be diverted to a new through station on the east side of the Central Station, a four-track approach leading to the latter, which will be used only for long-distance trains. At the connection, the eight tracks will be alternately inbound and outbound, but at the approach to the new station this arrangement will change to pairs of inbound and outbound tracks, a system of "flyovers" or grade separations being introduced so as to eliminate track crossings at grade. This arrangement is shown in Fig. 1.

Beyond the station, six-tracks on an elevated structure will extend to Campbell St., where the line goes underground on a grade of 1.3 per cent. Four tracks will then diverge to the west side of the loop and two to the east side. At Town Hall station, two of the four tracks will rise and two will continue underground to a double-deck station at Wynyard Square, the elevated tracks continuing across the bridge to North Sydney, where they will go underground as indicated on the map.

From Wynyard Square, the low-level line will swing to the east and, owing to the topography, will emerge at Harrington St., continuing on a viaduct to a combined railway and ferry station at Circular Quay. At Macquarie St. it will go underground again and continue to a connection with the six-track line at Campbell St., thus completing the loop. Beyond the St. James station a double-track branch will lead off to the eastern suburbs, the connection being made by a "flyover" to avoid track crossings of busy lines.

The length of the loop from Wells St. will be a little over 5 miles, with 2½ miles below ground, 2 miles on the surface and the remainder on viaduct. No streets will be closed and all bridges will give ample headway for street cars. The maximum grades will be 2½ per cent and curves will not exceed 9½ deg., except for two short curves of 11½ deg. Transitions or easements will be used at all curves sharper then 4 deg. Underground construction will include both open cut and tunnel, with brick and concrete lining. All excavation will be in the hard Hawkesbury sandstone, which has nearly horizontal beds traversed by occasional thin bands of shale and overlaid by shale and clay. Steel frame construction will be used only where the headway is insufficient for the tunnel section.

Stations on the loop are about 2,600 ft. apart, with 520-ft. platforms, and are planned with a view to high traffic capacity. Allowing for a 30-sec. station stop, an acceleration of 1¼ miles per hour per second and a deceleration of 2 miles per hour per second, each of the six city tracks has a minimum capacity of 35 trains per hour. Both through and terminating trains

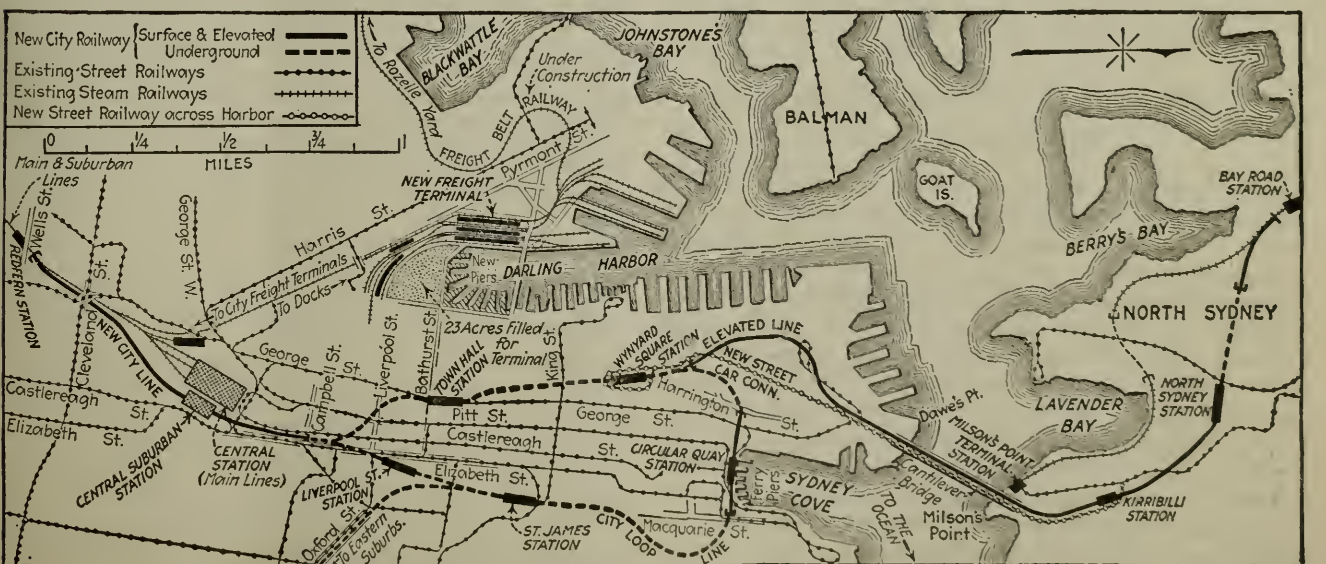


FIG. 2. RAPID TRANSIT LINES AT SYDNEY, AUSTRALIA

are provided for at Wynyard Square and St. James stations. To facilitate exchange of passengers at the Central and Town Hall stations each island platform is served by a pair of tracks for trains moving in the same direction. Ramps and passages are designed to provide for 30 to 35 passengers per foot of width per minute, stairways for 20 persons up and 20 down at the same rate, and escalators or moving stairways for 10,800 persons per hour.

The new elevated Central Station for suburban trains will have four island platforms and a capacity of 210 trains per hour. The ticket offices will be at the street level, in concourses passing under both ends of the station, with stairways to the platform. The Town Hall station under George St., one of the busiest thoroughfares of Sydney, will have two island platforms reached by stairs and subways. Its capacity will be 140 trains per hour. At Wynyard Square station there will be three island and two side platforms at each level, with a concourse between the two levels and approached by subways from adjacent streets. Its traffic capacity will be 200 trains per hour, including those which terminate at this point.

The Circular Quay station, 70 trains per hour, will have two side platforms 28 ft. above the street and approached by stairs and escalators. At the street level will be the ferry house, ferry offices, parcel check room, stores and a large restaurant. This building will have concrete piers sunk to rock at 20 to 55 ft. below the street surface. The St. James station, with two island platforms, will have a capacity of 130 trains per hour, including the branch trains terminating at this point. Liverpool St. station, with two side platforms will have a capacity of 70 trains per hour.

Construction work on this extensive project was commenced in June, 1916, being carried out by contract under the direction of J. J. C. Bradfield, chief engineer of metropolitan railway construction for the Railway Commissioners. Excavated material was used as filling for the freight terminal and docks at Darling Island, further up the harbor. Work proceeded until June, 1918, when the government considered it advisable to suspend operations temporarily owing to war conditions and the difficulty of obtaining plant and material. The estimated cost is £3,750,000, or about $18,750,000 at normal rate of exchange. This cost is exclusive of the Sydney Harbor cantilever bridge.

Port and Railway Terminal Works at Sydney, Australia

ADDITIONAL railway and harbor facilities for Sydney, New South Wales, are being provided at Darbor, West of the city and at the head of the landlocked bay on which the city is situated. An area of 23 acres at the inner end of Darling Harbor has been reclaimed by filling. Double-deck steel and concrete freight sheds are being built on long piers for ocean steamship service, and will be served by a waterfront railway connecting the city terminals with the freight belt line. At Glebe Island a grain elevator with a storage capacity of 6,500,000 bushels is under construction. In order to keep switching movements clear of the harbor work a freight yard with capacity for 3,000 cars has been built at Rozelle, the junction of the lines to the docks and to the grain elevator.

A freight belt line to serve the harbor was built some time ago owing to the very heavy passenger traffic on the main line. The latter has a general southeast direction to the city. The belt line begins at Rookwood, about 20 miles from Sydney, swinging north in a loop and passing under the main line to run south as far as Enfield, whence it runs east for some distance and then turns north, passing under the main line again at Lewisham and ending at the Rozelle yard mentioned above.

At Enfield is a gravity switching and classification yard with about 40 miles of track and capacity for 4,800 cars, the site being large enough to duplicate the capacity. An engine terminal with roundhouses and coaling station of the American type is established here, and the yard is said to be designed largely in accordance with American practice. A branch from the belt line connects with a second short main line from the south, so that freight service to and from the latter can be handled through the Enfield yard and thus kept out of the city terminals. The railway and harbor works are being constructed under the direction of the Railway Commissioners, the railways being owned and operated by the New South Wales government.

Standards of Water Analysis

Extracts from Report, Committee on Official Standards of Water Analysis, American Water Works Association, Jack Hinman, Jr., Chairman. Submitted at Montreal, June, 1920.

THE chief value of fixed standards lies in the simplification of the administrative control of water supplies, in the preparation of guarantees of filter performance and in the facilitating of the attempt to explain technical details to a non-technical body or to the public. A higher standard of relative purity may be required in an arbitrary manner, and in the effort to meet the standards plant operators may bring about a general improvement in water-supply conditions, as has resulted from the establishment of the United States Treasury Department standard with its governmental prestige. Any such standard must be used with discretion and with good judgement. In the hands of those who wish to use the standard in a rule-of-thumb manner, without taking into consideration all known factors, a fixed standard may become a dangerous weapon, able to destroy the good name of a satisfactory water supply.

The present Standard Methods of Water Analysis are prepared by committees of the American Public Health Association with the assistance of committees of the Society of American Bacteriologists, the American Chemical Society, and the referees of the Association of Official Agricultural Chemists. The work was begun about 1895, earlier work having been done by the American Association for the Advancement of Science. While committees of the American Water Works Association do not co-operate in the preparation of the report, the committees chosen by the other bodies have included members of this organization. Of those who have worked on the preparation of the various editions of the Standard Methods, A. P. H. A., 14 are members of this Association at the present time (list of September, 1919). These are Edward Bartow, J. W. Ellms, George W. Fuller, Allen Hazen, D. D. Jackson, George A. Johnson, E. O. Jordan, H. E. Jordan, W. P. Mason, W. F. Monfort, Earle B. Phelps, R. S. Weston, George C. Whipple, C.-E. A. Winslow. These men are probably the ones most likely to have been selected by this organization for similar work, although it is true that they were chosen and their work accepted by another body and one which is not exclusively concerned with the problem of water supply. It must be remembered, however, that that organization is concerned with sanitation and the protection of the health, rather than with the economics of furnishing water.

Your committee recommends that the Association accept the Fourth Edition of the Standard Methods of Water Analysis (A. P. H. A., 1920) as official.

Your committee recommends that unless at least 100 samples are comprised in the series under consideration, the B. coli index be not reported, and that where an adequate series is considered, the number of samples in the series, together with he dilutions used, be stated. For smaller numbers of samples, some method which does not represent the same degree of fictional accuracy is recommended. A common method of reporting is to express the percentage of positive tubes for each dilution, at the same time giving the number of samples and the number of tubes of each dilution planted. Another common method is the fractional method in which the denominator of a fraction represents the number of tubes planted and the numerator represents the number of positive tubes. Obviously the fraction for each dilution-size is given, together with the number of samples.

On account of its governmental prestige, the United States Treasury Department standard has perhaps been more generally accepted in the United States than any other standard. It has become the fixed standard of six states.

While the United States Treasury Department standard was claimed at the time of its promulgation to apply only to the water supply of the trains, and any intention to extend the standard to municipal supplies was emphatically disclaimed, the effect of the condemnation of the supply of a community and the posting of notices in the stations declaring the water unsafe has been to create a local pressure which has in many instances forced the improvement of the local supply. This is a matter of great and far-reaching importance in which it is evident the arbitrary standard of the United States Public Health Service has done much good. Your committee recommends to the members of this Association that they insist upon a thorough and complete sanitary survey, to be made, by preference, by the person who is to make the analysis or interpret the analytical findings, before any important report is made upon the plant under their control, whether the report is to be made by national, state or municipal authority, or for the information of the management of the plant.

Your committee, after full consideration of the question, cannot recommend any series of values as standard values for all classes of waters, nor for the waters of one class throughout America.

In making this recommendation it is not unmindful of the important influence of some arbitrary standards, nor of the possibilities of recent work on the operation of filter plants. In the judgment of the Committee such progress as is likely to be made soon in the matter of standards, is likely to come in the control of water plant construction and performance standards.

The committee would therefore submit the following as its definition, not of a "standard" water, but of a satisfactory one:

A water which is reasonably free from noticeable color, odor, taste and turbidity, which is reasonably free from objectionable salts in solution, which is free from injurious effects upon the human body, and which is produced and distributed in such a manner that its quality is practically certain to be maintained continuously in spite of accidents which can be expected in the operation the plant.

Will Study Low-Carbon Steel Worked at Blue Heat

Work is in progress to determine the effect on the mechanical properties of low-carbon steel, such as boiler plate, of working it at blue heat (300 deg. C.). The effect of low-temperature annealing on such plates will also be determined, and the mechanical properties at elevated temperatures will be measured. Study of the effect of rate of loading will be included in the latter work. For this purpose a motion-picture camera will be used to give records of the simultaneous positions of various moving dials. The Bureau of Standards, Washington, D. C., is carrying on the experiments.

Filter-Alum Making Experience of Montreal Water & Power Co.

Slightly Condensed From a Paper by James O. Meadows, Sanitary Engineer, Montreal Water & Power Co., before the American Water Works, Association, June, 1920.

THE manufacture of filter alum by the above-named company at its filter plant in Montreal, P. Q., is saving the company \$24,500 a year. The actual cost per ton, allowing 20 per cent capital charges, is \$28.64, compared with \$55 for commercial alum. The cost figures are based on the record of the last two years but the general operating data are drawn from an experience of four years.

The alum plant was installed with the idea of keeping the capital outlay as low as possible consistent with proper operation, because at the time it was thought that it would only be used for a comparatively short period of time. The plant consists of an acid storage tank, a dilute acid tank, bauxite weighing hopper, Stedman mixer, and concrete crystallizing tray. No crusher is provided, the filter alum being broken up into suitable sized lumps by hand sledges. (The plant is similar to those at Columbus, Ohio; Springfield, Mass.; Trenton, N. J., and Omaha, Neb.; see *Engineering News*, Jan. 4 and 11, 1917.)

By varying the temperature of the dilute acid the character of the alum can be modified. During the winter months a porous alum is desired because of its greater solubility and this product can be obtained by mixing the bauxite with a low temperature acid. During the balance of the year a filter alum of a more dense texture is secured by using a higher temperature acid. The temperature of the crystallizing tray floor is also a factor to be considered and it is necessary to use a higher temperature acid for Monday's batch because of the lower temperature of the tray floor after the Sunday rest. The temperature of the acid is controlled by agitation with compressed air and by a cooling coil placed at the bottom of the lead-lined dilute acid tank. By using the air and cooling coil for different periods of time a dilute acid of the desired temperature can be obtained.

To secure a uniform product from day to day care must be taken to have the acid strength uniform, the temperature variations slight and the weight of the bauxite charge correct. The analytical work necessary to control the operation of the alum manufacturing plant consists of the analysis of the bauxite, acid and finished product, and the taking of the specific gravity and temperature of the dilute acid before a batch of filter alum is made.

A batch of alum (approximately 7,600 lb.) is made in five mixes, using about one-fifth of the material for each mix, and the time consumed in mixing a batch of alum is about 45 min. Greater speed in mixing and a better mix could have been obtained if a deeper mixing pan with two agitators had been installed. The batch of alum is usually made early in the afternoon and by the next morning the alum cake is ready to be removed from the crystallizing tray. Before the mixture of bauxite and acid is dumped into the tray the fine alum dust remaining in the tray is swept up into a ridge extending directly across the tray and to a height of about 2½ in. When the alum cake is to be

removed from the tray work is started at the alum dust ridge, as this point offers an easy place to pry the slabs of alum from the tray floor. The alum cake is removed from the floor with bars and picks and is broken up with hand sledges. The whole process, including carting to the storage floor above, consuming about six hours.

Records of the alum-making plant for the two years ending May 1, 1920, are presented here, as during this period the cost of bauxite and acid have been rather constant and it was thought that data covering this period would be fairly representative of present conditions. The cost of production for this two-year period is as follows: Bauxite and acid, including freight and cartage, $45,961; wages, $4,220; maintenance, $1,490; interest and depreciation, 20 per cent, $2,400; total, $54,071. During these two years 1,888 tons of filter alum have been produced, making the cost $28.64 per ton. The market price of commercial filter alum (including freight and duty) during this period has been about $55 f.o.b. Montreal and based on this figure the alum making plant has shown a saving of slightly more than $49,000 for the two years. Bauxite cost approximately $24 per ton and 66 deg. Baume sulphuric acid, $26 per ton. The cost of bauxite and acid makes up 85 per cent of the total cost.

In the manufacturing of filter alum at the point of consumption, freight, bagging and cartage is saved on the water, which makes up about 20 per cent of the finished product. Experience over a considerable period has shown that the weight of the filter alum produced is practically the same as the combined weight of the materials that go to make up the products.

At the company's water purification plant the alum solution is pumped to the orifice box and from this point flows by gravity to the point of discharge. Since Hoover process filter alum has been used greater depreciation of the solution pumps, valves, and fittings has taken place, due to the nature of the insoluble matter contained in the alum solution. This depreciation has not been excessive.

The manufacture of Hoover process filter alum has proved successful for the Montreal Water & Power Co. not only because of the saving effected but also because less storage space is required than for commercial alum. The sulphuric acid is produced within a short radius of Montreal and is easily obtainable. This leaves only the bauxite to be secured from a distance. Each ton of bauxite in storage represents about three tons of the finished product.

Timber From Live and Dead Trees

Prejudice exists in certain quarters against the use of timber cut from dead trees, and some purchase specifications insist that only timber cut from live trees will be acceptable. As a matter of fact when sound dead trees are sawed into lumber, and the weathered or charred outside is cut away, there is no method known to the U. S. Forest Products Laboratory by which the lumber can be distinguished from that cut from live trees, except that the lumber from dead trees may be partly seasoned when sawed. All the information available at the laboratory indicates that timber cut from insect or fire killed trees is just as good for any structural purpose as that cut from live trees of similar quality, providing the wood has not been subsequently injured by decay or further insect attack.

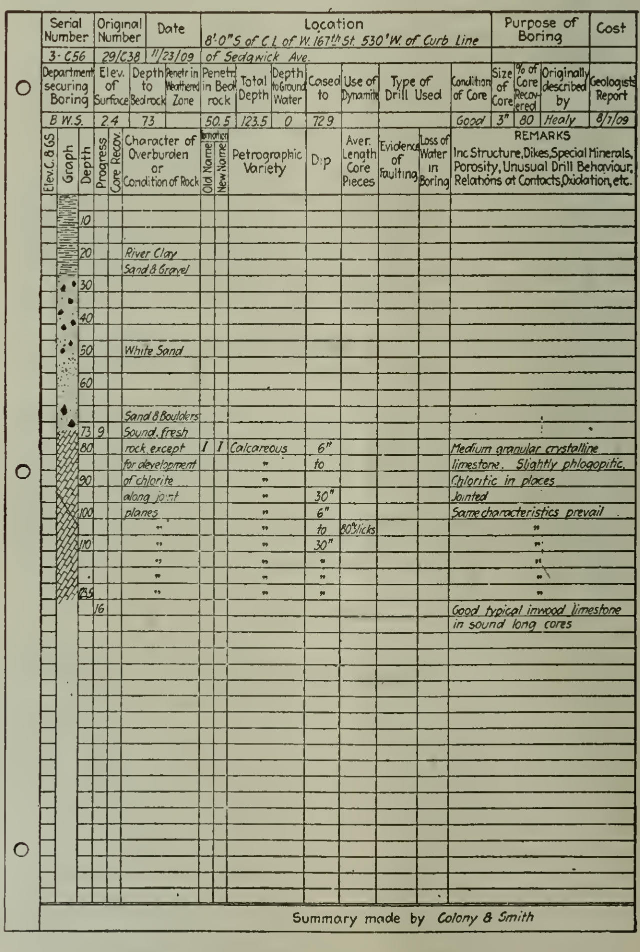
Geology of New York City Revealed in Core Boring Exhibit

Records of 2,000 Holes, Illustrative Maps, Models, Complete Core Sample Collection Form Exhibit in Municipal Building

By M. E. Zipser

Chairman, Committee on Preservation of Core Boring Records, Municipal Engineers of the City of New York

NOT all engineers realize the importance and value of thorough exploratory investigations in engineering projects. In designing the foundations of large buildings and bridges, and in planning the construction of tunnels, subways, sewers and other subsurface structures, a knowledge of the geologic conditions to be encountered is essential if the work is to be carried out safely, efficiently and economically. There are many cases on record where, owing to failure to make an adequate investigation of underground conditions, the work resulted either disastrously or necessitated modifications in plan involving a large increase in cost. There are other instances where, although considerable effort and expense were incurred in making borings, the results were not successful owing either to unintelligent planning of exploratory work, or to improper methods adopted, or to failure of proper interpretation of the materials and data obtained by the borings. Engineers are, therefore, beginning to appreciate more and more the value of the services of a competent consulting geologist in engineering enterprises.



Serial Number	Original Number	Date	Location	Purpose of Boring	Cost
3-C56	29/C38	11/23/09	8'-0"S of C L of W. 167th St. 530'W. of Curb Line of Sedgwick Ave.		

Department securing Boring	Elev. of Surface	Depth to Bedrock	Penetr in Weathered Zone	Penetr. in Bedrock	Total Depth	Depth to Ground Water	Cased to	Use of Dynamite	Type of Drill Used	Condition of Core	Size of Core	% of Core Recovered	Originally described by	Geologist's Report
B W.S.	2.4	73		50.5	123.5	0	72.9			Good	3"	80	Healy	8/7/09

Elev. C. & GS	Graph	Depth	Progress	Core Recov.	Character of Overburden or Condition of Rock	Formation Old Name	Formation New Name	Petrographic Variety	Dip	Aver. Length Core Pieces	Evidence of Faulting	Loss of Water in Boring	REMARKS Inc. Structure, Dikes, Special Minerals, Porosity, Unusual Drill Behaviour, Relations at Contacts, Oxidation, etc.
		10											
		20			River Clay								
					Sand & Gravel								
		30											
		40											
		50			White Sand								
		60											
					Sand & Boulders								
		73	9		Sound, fresh								
		80			rock except	I	I	Calcareous	6"				Medium granular crystalline
					for development			"	to				limestone. Slightly phlogopitic.
		90			of chlorite			"					Chloritic in places
					along joint			"	30"				Jointed
		100			planes			"	6"				Same characteristics prevail
					"			"	to	80°Slicks			"
		110			"			"	30"				"
					"			"	"				"
					"			"	"				"
		123.5			"			"	"				"
			16										Good typical inwood limestone
													in sound long cores

Summary made by Colony & Smith

FIG. 1. COMPLETE DATA ON 2,000 HOLES AS SHOWN HERE ARE AVAILABLE

In New York City, the underground conditions present many difficulties to the designer and constructor. The depth to bed rock varies considerably. In the northern portion of the city the rock in many places lies at the surface. Below Thirtieth Street there are no outcrops and the depth to rock increases as the southerly limit of the city is approached, there being as much as 200 ft. of drift in spots. The nature of the material overlying the rock varies in character. Deposits of boulder, clay and sand are distributed unevenly throughout the city and silt is found beneath the river. The city is underlain by five different rock formations, each varying in quality and having different characteristics. The rocks have been subjected to extensive folding and faulting, resulting in the formation of crush zones and weak belts in several places. At Morningside Park and on the lower East Side, for example, decayed rock more than 150 ft. in depth has been revealed by borings in connection with the city tunnel of the Catskill Aqueduct.

Many Exploratory Borings Made

On account of the complex geology of the city, it has been necessary to make many exploratory investigations of the underground conditions in connection with the many public and private engineering undertakings. There have been thousands of borings made in New York City, at an expense estimated at $3,000,000. Unfortunately, the records obtained from a great many of these borings have, in many cases, been lost or they were destroyed when the purpose for which they were made was served. In other cases, records have not been properly preserved or interpreted and have not been readily available. Some time ago the Municipal Engineers of the City of New York realized that the assembling of all the available data and records relating to borings in New York City, including the preservation of the cores, would serve a very useful purpose in avoiding much exploratory expense in future undertakings by city departments, and in making easily available all existing information in regard to underground conditions. A special committee, under the chairmanship of James F. Sanborn, was appointed for this purpose. The committee, under the direction of Dr. Charles P. Berkey, Professor of Geology, Columbia University, as consulting geologist, has investigated and assembled all the available data bearing on borings and explorations in New York City and the records have been arranged for preservation in permanent form. The work has been supported by the city through the Board of Estimate and Apportionment. The collection of records is housed on the 34th floor of the Municipal Building. The principal parts of the collection and exhibit are:

1. A complete tabulation of records of core borings in New York City.
2. A series of maps showing the locations of these borings and also the rock floor conditions.
3. A collection of representative rock cores, illustrating the rock formations of the city and the conditions encountered underground.

Every core boring in the city that has been available or whose record is considered at all reliable, has been investigated and the facts have been entered upon a regular standard form of record, adopted for this purpose—a separate 8½ x 11-in. sheet. This sheet, one of which is herewith reproduced, carries the record of each boring with all the available data recorded. Approximately 2,000 of these separate boring records are now on file. Records are grouped into series corresponding with the different city departments or the private enterprise or undertaking re-

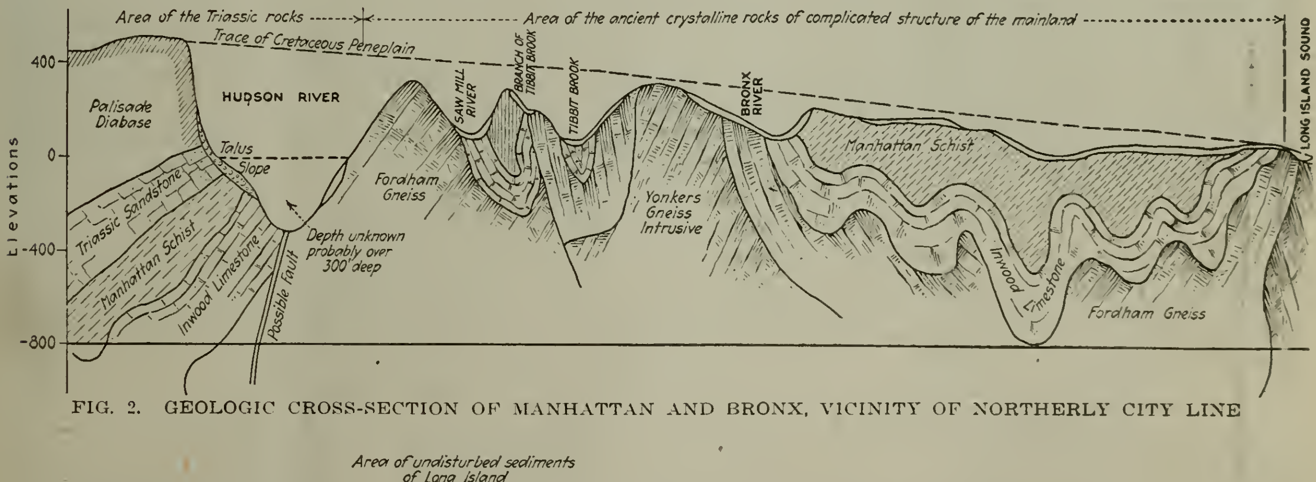


FIG. 2. GEOLOGIC CROSS-SECTION OF MANHATTAN AND BRONX, VICINITY OF NORTHERLY CITY LINE

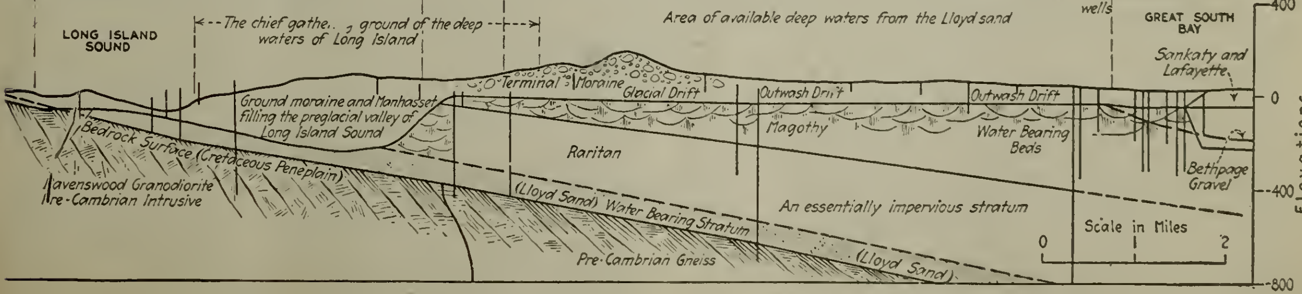


FIG. 3. GEOLOGIC CROSS-SECTION OF LONG ISLAND, VICINITY OF BABYLON

sponsible for the original investigation. The collection of core boring samples includes 570 pieces of core, each labeled as to rock type and variety, and the formation to which it belongs.

In order to find the geologic data of any particular location of the City, inspection is made of an index map, which is a large wall map of New York City, on which have been placed red circles, indicating the approximate locations of the holes whose records are in the collection. The index map is divided into quadrangles or sectional plans numbered from 1 to 35. Having noted the sectional plan number on which the particular borings in question are located, reference is made to the large scale sectional plans on which are shown the exact locations of the borings, each boring having a designation, as C 73, the letter indicating the series in the collection, and the number the succession in the series. By referring to the volume containing the the separate sheets of any series the history of any particular hole is quickly found.

There are also included in the exhibit a relief model and block diagram showing the geologic structure of the city. Many special illustrated photographs, drawings and charts are also shown, and there is a collection of reports, special papers and other references bearing upon the geologic conditions in the engineering undertakings of New York City. Copies of contracts and specifications for borings and relative data are also on file. Sample boxes containing core and loose materials, showing improved methods for preserving boring samples are also on exhibit.

To anyone interested in the underground conditions of New York City, either from the point of view of the geologist or from the standpoint of the engineer or contractor wishing to know the depth to bed rock at any point, or the character of the material overlying the rock, or the nature and condition of the rock, the collection and exhibit will be found very useful. Permission to see the exhibit and consult the records may be obtained by those interested at the office of Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment, Room 1347, Municipal Building. The Committee on the Preservation of Core Boring Records of the Municipal Engineers wishes to make a plea to engineers and contractor to bring to the attention of the committee any information bearing on the geology of New York City and vicinity that may be revealed by borings and excavations, in order that the collection and records may be made more complete and more useful.

How Lumber Is Graded

Grading of lumber is done under a multiplicity of grading rules. H. S. Betts, engineer in forest products, Forest Service, U. S. Department of Agriculture, tells how lumber is graded in a 40-page, 6 x 9-in. pamphlet, *Bulletin* 64, on the subject. Woods are graded largely according to rules prepared by lumber associations, the members of which handle lumber of one or more species that grow in a certain region or are naturally grouped together, with the exception of the hardwoods, which are all graded according to the rules laid down by the National Hardwood Lumber Association, having headquarters in Chicago. Soft woods, on the other hand, are graded according to rules promulgated by more than 16 associations. The bulletin mentioned gives the basic data for the principal rulings.

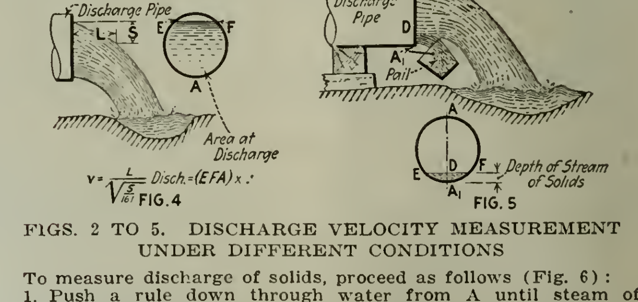
Measuring Velocity of Discharge From Hydraulic Dredge Pipes

By Pierce J. McAuliffe
Consulting Engineer, New York City

Knowledge of the performance of hydraulic dredging equipment is commonly deficient because velocity and quantity of discharge are not known. For this reason there is not as close check on operating conditions, so that best results can not be secured. By use of the simple field method of measuring discharge velocity described in the following, data can be secured that should make dredge pumping subject to the same control of performance as other working plant.

The merits of the dredging pump as a device for excavating and conveying earth, gravel and minerals are widely known, but this machine would be applied to a greater range of activities if the laws governing friction and velocity in dredging pipes were better understood. There are few published data of value, however, to show the velocities required in pipe lines to keep different percentages of solid materials in suspension in the stream of water, and to enlighten us as to the friction that will be caused by these mixtures at the various velocities. It is not surprising that installations of dredging pumps have been made occasionally in which sufficient power or peripheral speed or both have not been provided to produce the velocity necessary in the discharge. Because such installations have been unsatisfactory the machine as a class has frequently been blamed, and as a result artificial limitations have been built up around the dredging pump.

There is an infinite number of combinations of materials that a dredging pump is called upon to mix with water and push through a pipe line; solids ranging all the way from river silt (which may create less friction than water alone) to materials of high specific gravity and irregular shapes, such as coarse granite gravel (which causes the friction to build up to several times that set up by water alone). It is not difficult, therefore, to understand the hesitation on the part of the



FIGS. 2 TO 5. DISCHARGE VELOCITY MEASUREMENT UNDER DIFFERENT CONDITIONS

To measure discharge of solids, proceed as follows (Fig. 6):
1. Push a rule down through water from A until steam of solids in lower sector is plainly felt. Subtracting this depth from the diameter gives depth of stream of solids.
2. Determine velocity in lower sector.
3. Area of lower sector EFA_2, multiplied by velocity gives discharge from lower sector.
4. Catch discharge from lower sector in pail as shown.
5. Measure percentage of solids in contents of pail.
6. Quantity of solids discharged per second = Item 5 × Item 3.

engineer to publish data, which, though they may serve for his individual use, depend largely for their value upon his personal inspection of the materials to be handled.

An important step toward securing reliable data on friction and velocities in dredging pipes will be taken if we discover a simple and readily applied method of determining the velocity of the discharge. The friction can be found quickly from the readings of the pipe-line pressure gages, which are a part of the equipment of practically all dredging pumps. The difficulty has been to say what was the velocity of the discharge and what were the relative quantities of water and solids in the discharge at the time these gage readings were taken.

A number of ingenious tests have been made to determine the velocity of discharge in dredging pipes when pumping water only. But as the meters used or the methods employed in determining the velocity are not applicable when solids are carried in suspension, the data, while useful in calculating the efficiency of the machine when pumping water, are only indirectly helpful in predicting what will happen when the discharge stream is carrying dredged material. Still it is on such tests that the designers of dredging pumps have had to rely to a large extent for guidance.

How widely the discharges may differ under these two conditions is shown by the views *A* and *B* of Fig. 1 both picturing the discharge from the 16-in. Kaw Valley Drainage Board dredge. View *A* was taken while the suction was raised from the bottom of the river, consequently only water was being pumped; *B* was taken with practically the same length of pipeline, the same pipeline elevation and the same peripheral speed of the pump impeller, but the dredge was digging in the regular manner.

Suppose it had been found that the velocity in *A* had been 18 ft. per sec. and that operating as in *B* for an extended period an average of 250 cu.yd. per hour had been delivered, with the same power and peripheral speed that had been required in *A*, a relation between these quantities would have been obtained to guide us in future designs. This might be called a *post factum* procedure, but designers have had to rely for guidance largely upon such methods for getting data.

To make up for the lack of information which was necessary for the intelligent design of dredging pumps and to compile data from personal observations, the writer has for some time used a very simple method for finding the approximate velocity of the discharge, and therefore the quantity of the mixture, passing through a pipe line. Reference to accompanying sketch, Fig. 2, will assist in understanding the method. It is based on two assumptions: (1) That the discharge curve will have a definite form for each velocity through the pipe: (2) That but two forces act upon each particle in the discharge as it leaves the pipe, these being the pressure developed by the pump (converted into uniform horizontal velocity), and the force of gravity causing each particle to become a freely falling body.

In applying this method the end length of the discharge pipe should be approximately level. With a straightedge or square measure the horizontal and vertical co-ordinates of any point on the curve *C* in Fig. 2, reading both *L* and *S* in feet. The time that it has taken a particle at *A* to fall the vertical distance

FIG. 1. DISCHARGE OF 16-IN. DREDGE WHEN PUMPING WATER AND WHEN DIGGING

or S can then be found by the formula $S = \frac{1}{2} gt^2_v$ or $\sqrt{\frac{2S}{g}} = t$, in which t will be the time in seconds. Similarly the horizontal distance that the velocity has carried a particle during time t will be L. Dividing L, the horizontal distance, by t, the time of travel, gives the horizontal velocity of the mixture.

Fig. 6 shows the application of the writer's method to the discharge from a 6-in. pipe. It will be observed that the device used to measure the co-ordinates of the point C on the upper curve AC was an improvised carpenter's square, the vertical leg S of which was equal to the thickness of the pipe plus 6 in., or 516 ft. The length L was found to be 3.166 ft. Applying the formula as in Fig. 2, V becomes 17.7 ft. per sec. A Venturi meter connected to this pipe when this picture was taken registered a velocity of 16.5 ft. per sec. The writer's method, therefore, indicated a velocity about 7 per cent higher than actual velocity. A close inspection of the view reveals that the leg S intercepted only the spray of the discharge. A more careful adjustment would have given a value of 3.08 ft. to L and the answer would then have been 17.4 ft. per sec. or about 5 per cent in excess of the actual velocity. This photograph is one of a series taken during tests made by the Morris Machine Works of Baldwinsville, N. Y. Other tests of the series gave results less than 2 per cent in excess.

In such tests as the writer has had an opportunity to make, the velocity indicated by the upper curve is nearer the actual velocity than is the mean of the upper and lower.

It is usually such a simple matter to pry up the end length of a dredging pipe to a level position that it is not considered worth while at this time to enter into a discussion of the modifications in these calculations that would be necessary for pipes out of level.

Special Conditions.—Fig. 3 represents a condition frequently met with in dredging, where the material has separated from the water and is traveling in the lower part of the pipe at a lower velocity than that of the water. In cases of this kind, where the difference in velocity of water and material is not too marked it is satisfactory to measure the velocity of the upper and lower curves of the discharge and use the mean as the velocity of the mixture.

Fig. 4 shows a condition where the discharge does not completely fill the pipe at the end. In this case the particles in the upper part of the stream will have a slight initial velocity downward by the time they

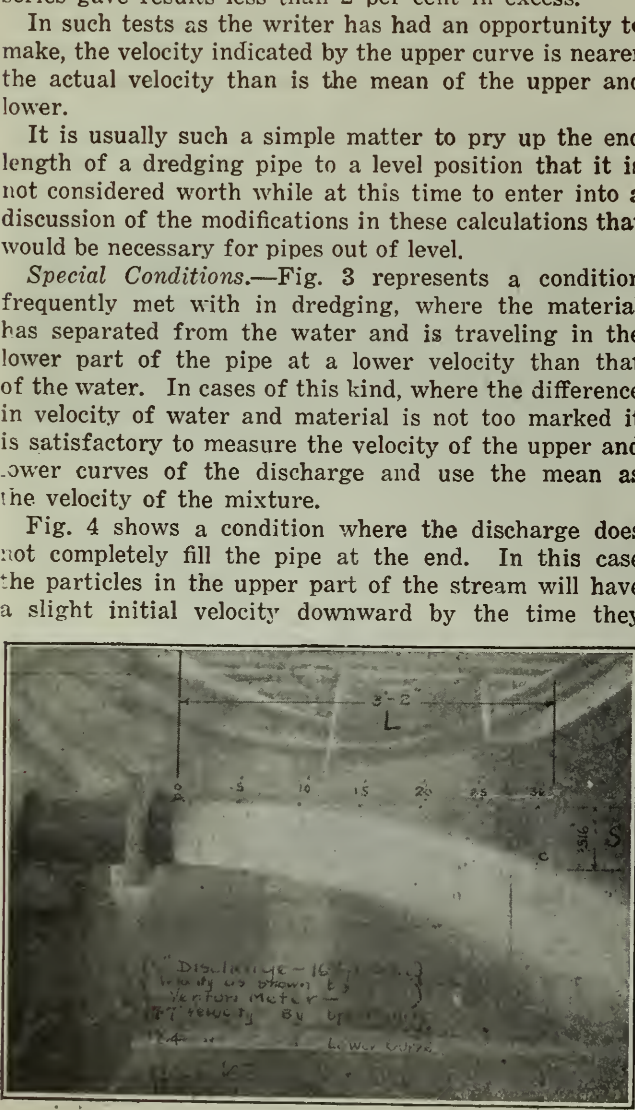


FIG. 6. VELOCITY MEASUREMENT WITH 6-IN. DISCHARGE

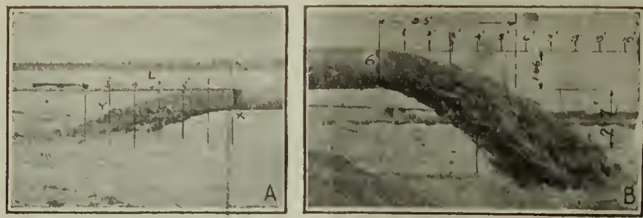


FIG. 7. MEASURING DISCHARGE VELOCITIES FROM PHOTOGRAPHS

are about to leave the pipe, but under ordinary dredging conditions the velocity reading will be sufficiently accurate if the procedure in Fig. 4 is followed.

Where the material has separated and is traveling in the lower sector of the pipe (Fig. 5) the writer has found it convenient to approximate the quantity of solids that is being moved through the pipe by measuring the distance from A down to the surface of the almost solid stream of sand or stone (indicated at D) and then determining the area of the sector that is filled with materials. When the lower end of the rule used to measure AD, touches this body of moving sand it can be felt distinctly. By measuring the velocity of the lower curve of the discharge, the velocity at which the stream of solids is moving can be estimated. The quantity of solids that is being handled can be approximated to a reasonable degree of accuracy from these figures for velocity and area. The water content and mechanical makeup of the stream of solids may be determined from a pail sample.

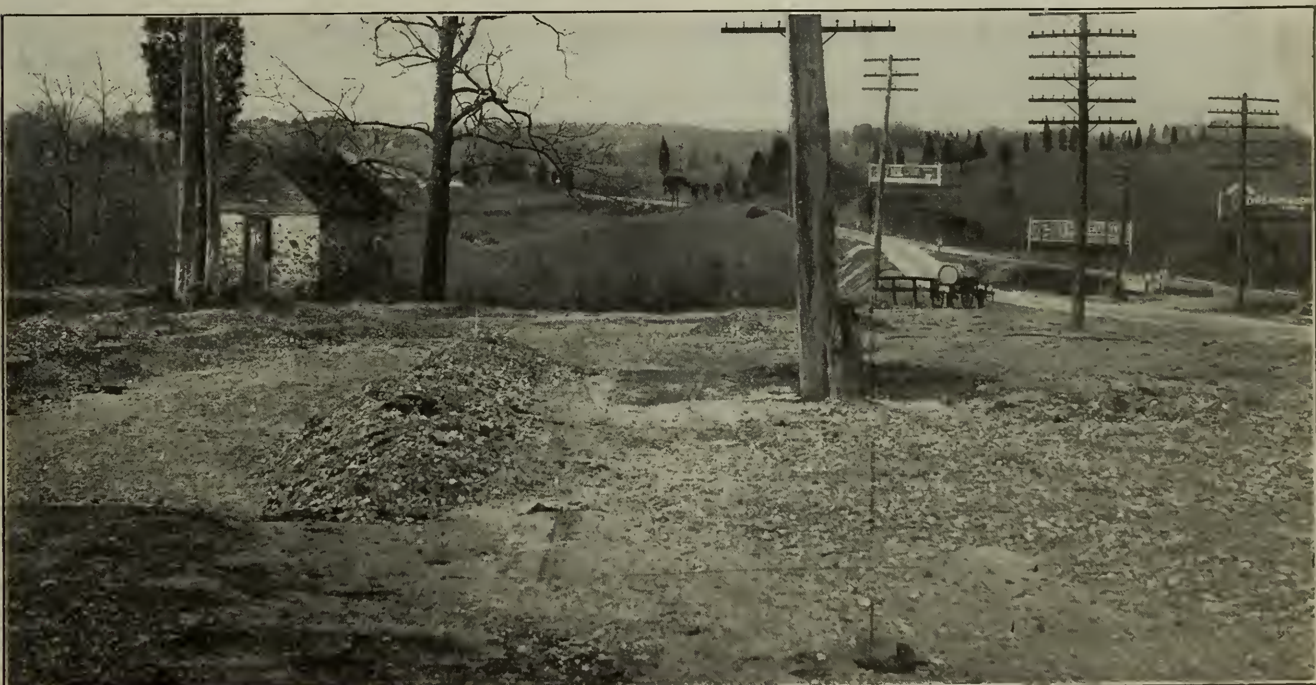
All wide-awake dredging contractors require daily reports from their dredge operators. These reports are of value to show what has been accomplished, but they could be made of far greater value as a guide to the performance on future work if they contained a statement to show the velocity at which the pump pushed the mixture through the discharge pipes, and the friction which resulted from this velocity and mixture. With this information the contractor could tell definitely what his machine would do on longer pipe lines when they would be encountered, and in many cases he would be warned sufficiently in advance that a booster would be required to prevent the job from showing a loss.

While the calculations involved in this method are quite elementary, few dredge operators have been equipped to make them. To permit of frequent readings the writer has supplied a number of operators with devices similar to that shown in Fig. 7, calibrated so that the velocity may be read directly.

A further advantage is that a photograph of a pipe discharge becomes of considerable value (Figs. 7 A and B). Extend the lower line of the pipe shown in A until it intersects the upper curve of the discharge at Y. This discharge was from one of the 10-in. dredging pumps which the Michigan Limestone & Chemical Co. used for the disposal of the overburden and for the storage of the small sized screenings from its huge rock crushing plant at Calcite, Mich. At Y the upper curve has therefore fallen 0.869 ft., this being the diameter plus the thickness of the pipe. Measuring the horizontal coordinate of Y in pipe diameters gives a value of 5 ft. to L and indicates a velocity between 21 and 22 ft. per second.

View B of Fig. 7 shows the 20-in. discharge pipe of the dredge "St. Louis". By the same method as described above the velocity is found to be between 15 and 17 ft. per second.

Relocation of Deadman's Curve, Washington Road Between Baltimore and Washington, D. C., by Maryland Commission



The State Roads Commission of Maryland eliminated this Curve at a cost of $17,000. The upper picture is a view looking north and the lower one looking south. As originally built the road was responsible in ten years for accidents resulting in thirty deaths. John N. Mackall, chief engineer of the State Roads Commission, points out that this is the first instance of expensive construction to abolish dangerous features on main highways.

Wind Loads on Miscellaneous Structures

Wind Pressure To Be Assumed on Billboards, Sky Signs, Fences and Walls, Traveling Cranes, Flags and Flag Poles—Code Provisions and Practical Recommendations

BY R. FLEMING
American Bridge Co., New York City

OCCASIONALLY the engineer meets with problems of wind loads on structures other than those coming under the classification of bridges, buildings, tanks or towers. The question as to the proper amount of wind pressure to be assumed on some of these occasionally-met-with structures will be considered in this article.

BILLBOARDS

According to the Cleveland building code,

> The term bill-board within the meaning of this ordinance shall include all structures, of whatever material the same may be constructed, which are erected, maintained or used for the public display of posters, painted signs, pictures or other pictorial or reading matter, except that the term "bill-board" shall not be applied to such signs as are attached to the roofs or walls of buildings.

The only external force acting on a billboard is the wind, but although the literature about the billboard is extensive comparatively little information is given on the proper wind pressure to be assumed in its design. Probably the most comprehensive review of the subjects of billboards and sky signs is the "Report of the Mayor's Billboard Advertising Commission of the City of New York," a book of 152 pages, dated Aug. 1, 1913. At that time there were about 4,600 facings or 90 acres of advertising surface in the city. Large additions have been made since. In the Proposed Ordinances of the report there is a clause,

> No structure subject to regulation by paragraph (1) of this section, which shall at any point exceed 7 ft. in height above the ground immediately below it, if erected upon the ground, and no such structure whatever erected upon a roof . . . shall be erected or maintained unless it shall be designed and constructed in such manner as to sustain a wind pressure of at least 40 lb. per sq.ft.

This recommendation was never enacted into law. Quite in contrast with the drastic recommendation of the New York report is the provision of the "Model Billboard Ordinance" given in the August, 1917, issue of *Pacific Municipalities:*

> Every billboard having an advertising surface of more than 20 sq.ft. shall be made to withstand a lateral wind pressure of 20 lb. per sq.ft.

In their respective ordinances San Francisco specifies 20 lb. per sq.ft. wind pressure; Chicago, 25 lb.; Cleveland, Indianapolis and Seattle, 30 lb.; Milwaukee and Omaha, 40 lb.

The writer considers 20 lb. per sq.ft. wind pressure on the exposed surface of billboards to be ample. The reason for a greater pressure being prescribed in some ordinances is the desire to protect passers-by. But 20 lb. pressure means a velocity of about 70 miles per hour and no pedestrian can stay on the street during such a wind. A man weighing 150 lb. presents about 8 sq.ft. of surface to the wind, with a centroid about 3.5 ft. from the ground; when he braces himself with one foot 2.5 ft. ahead of the other he can withstand a pressure of $\left(\frac{150 \times 2.5}{8 \times 3.5}\right) = 13.4$ lb. per sq.ft., and with a pressure of 20 lb. per sq.ft. he can not keep his feet.

In the words of the building code recommended by the National Board of Fire Underwriters, any letter, word, model, sign, device or representation in the nature of an advertisement, announcement or direction, supported wholly or in part over or above any wall, building or structure, is called a sky-sign.

SKY SIGNS

The sky sign is so closely related to the billboard that it might seem the same pressure should be used for both. However, the sky sign is usually in a more exposed location than the billboard. Again, the velocity of the wind and consequently the wind pressure increase with the distance from the ground. For these reasons building codes assign a greater wind pressure to sky signs than to billboards.

The code of New York City allows metal signs to extend up to 75 ft. above the roof of fireproof buildings, but limits the portions of such signs covered and exposed to wind pressure to 35 per cent of the total area. Wind pressure is specified at not less than 30 lb. per sq.ft. The Chicago ordinance limits height to 60 ft., surface exposed to 50 per cent of frame area, and wind pressure to not less than 30 lb. Augusta, Detroit, Minneapolis and Rochester also specify 30 lb. pressure, under varying regulations regarding height and proportion of exposed surface. Indianapolis restricts the height to 40 ft., the surface exposed to 40 per cent and wind pressure to not less than 35 lb. Seattle limits height to 45 ft. and surface exposed to 50 per cent, and specifies wind pressure at not less than 40 lb. The Spokane code calls for a wind pressure of 40 lb. but is silent on height and percentage of exposed surface.

The writer would restrict the height of sky signs to 60 ft., the surface exposed to 50 per cent frame area and assume wind pressure at not less than 25 lb. per sq.ft. of exposed surface when the sign is on buildings 6 stories high and less, and 30 lb. when on buildings more than 6 stories high. The stresses in members of the steel frame of the building due to wind on the sky sign should be added to other stresses. This is not always done; sky signs are often erected upon the roofs of existing buildings with but little examination of the strength of supporting members.

In proportioning sky signs the Chicago rule may safely be followed:

> For stress produced by wind forces combined with those from live and dead load, the unit stress may be increased 50 per cent over those given above, but the section shall not be less than required if wind forces be neglected.

FENCES AND WALLS

A Chicago building ordinance limits the height of fences and walls to 8 ft. if constructed alongside a street or alley or within 8 ft. of such street or alley and parallel thereto. The ordinance continues:

> No single or isolated wall of any material whatever,

which forms no part of a building or structure that may be lawfully erected, shall be constructed upon any portion of a lot where the distance from such wall to the lot line is less than the height of the wall, unless such isolated wall shall have lateral supports on at least one side of same with braces extending to the top of the wall and is so constructed that it shall be capable of resisting a horizontal wind pressure on every part of same twice as great as buildings under the provision of this chapter must be designed to resist.

The wind pressure specified in the Chicago Code for buildings is 20 lb. per sq.ft. of exposed surface. Walls similar to the foregoing are therefore required to withstand 40 lb. per sq.ft. This is excessive. Isolated walls usually stand by virtue of the moment of stability of their own weight. A 12-in. wall 8 ft. high built of brick weighing 120 lb. per cu.ft. would be blown down at a pressure exceeding $\left(\frac{8 \times 120 \times 0.5}{8 \times 4}\right) =$ 15 lb. per sq.ft. A 12-in. wall 7 ft. high would be blown down at a pressure exceeding $\left(\frac{7 \times 120 \times 0.5}{7 \times 3.5}\right) =$ 17.1 lb. per sq.ft. An 8-in. wall 6 ft. high would be blown down at a pressure exceeding $\left(\frac{6 \times 80 \times 0.33}{6 \times 3}\right) =$ 9 lb. per sq.ft. Walls of these heights and thicknesses are quite common and do not blow down. The writer thinks that an assumed wind pressure of 20 lb. per sq.ft. is sufficient. Because walls may become defective with age there should be added to this assumption the provision that the overturning moment due to wind pressure shall not exceed two-thirds of the moment of stability.

With this provision a brick wall if 8 ft. high should be not less than 17 in. thick; if 7 ft. high not less than 15.9 in. thick, and if 6 ft. high not less than 12.7 in. thick.

Sides of Buildings

More than a score of buildings codes have the provision:

> Every panel in a curtain wall shall be proportioned to resist a wind pressure of 30 lb. per sq.ft.

How shall it be determined whether or not a given panel fulfills this provision?

Tests to determine the strength of hollow tile for building walls were made in 1914 under the direction of Professor Van Ornum of Washington University, St. Louis (a synopsis of the tests is given in the *Engineering News*, Vol. 73, p. 428, March 4, 1915. Through the courtesy of The Laclede-Christy Clay Products Company the writer is enabled to quote from the original report).

Pressure was gradually applied by a hydraulic jack with a broad base to the middle of a 13-in. brick wall 10 ft. by 10 ft. laid in *lime* mortar bonded at the top to a concrete slab and at the bottom to a concrete footing. When a pressure of 2,500 lb. was reached the horizontal mortar joint at about half height opened for its full length on the tension face. A 12-in. wall of Denison interlocking tile of the same dimensions laid in *cement* mortar failed in like manner at a pressure of 5,000 lb. A "wind pressure test" was made on two parallel tile walls laid in cement mortar. The walls were 14 ft. long by $21\frac{1}{2}$ ft. high, 7 ft. 10 in. apart out to out, and were joined by a line of wooden joists at a height of $9\frac{1}{2}$ ft. above the footing and by another line at the top. At an average uniform pressure of $14\frac{3}{4}$ lb. per sq.ft. on each wall, horizontal tension cracks showed themselves in the mortar joints near the base.

This test was made for a specific purpose and too general conclusions can not be drawn from it. Yet, quoting from Professor Van Ornum's report,

> It is neither a simple matter, nor entirely satisfactory, to attempt to reason from the conditions and results of this experiment to the practical stability that the same walls would have shown if they had had the support (which masonry walls in actual structures always have) of continuous walls or partitions, or both, extending transversely between them. There is no possible doubt that the resistance would have been many times as great; . . . Brick walls would have furnished about $2\frac{1}{3}$ times as great a resistance to overturning, due mainly to their greater weight. But because the lime mortar of the ordinary brick wall has a strength averaging only one-sixth to one-tenth that of Portland cement mortar as used with the tile, the aggregate resistance that would have been recorded if they had been 13-in. brick walls, instead of 12-in. tile, would probably have been not far from the same.

Window sash and glazing form an important part in the side of a modern building. This is especially true of the steel sash used so largely for industrial buildings. The writer has been given the details of a test made by a firm of engineers. The largest standard unit of steel sash, about 6 by 12 ft., of 14 by 20 in. lights, 5 lights wide by 7 lights high, was laid flat with its 4 edges resting on a solid frame. It was then covered with sheet metal and uniformly loaded with sand. At a load of 18.2 lb. per sq.ft. the maximum deflection was $\frac{21}{32}$ in. At a load of 25.4 lb. per sq.ft. the maximum deflection was $\frac{31}{32}$ in. When the load was removed the permanent deflection was $\frac{3}{32}$ in.

The tests cited—the only ones available to the writer—are not sufficient to warrant any positive statement as to the wind-resistive strength of a panel in a curtain wall. The New York building code specifies that masonry walls supported at each story by girders may be 12 in. thick for the entire height of the building. This practice is followed by 40 or 50 cities. Other cities increase or decrease the thickness of the wall, making it depend upon the height and width of the panel. So few, if any, failures of curtain walls are recorded that present practice is justified by its results.

Traveling Cranes

The traveling crane is closely related to bridges, towers and similar structures with respect to intensity of wind pressure and the area on which it acts. The "Code of Safety Standards for Cranes" of the American Society of Mechanical Engineers specifiies:

> Calculations for wind pressure on outside cranes shall be based on not less than 30 lb. per sq.ft. of exposed surface.

The same clause is found in "General Requirements for Safety" (1918), U. S. Steel Corporation.

It is noted that nothing is said as to what shall be taken as the area of exposed surface. The writer recommends that for outdoor traveling cranes a wind pressure be assumed of 30 lb. per sq.ft. on the entire projected area of the windward truss plus one half the projected area of the leeward truss. When plate girders are used in pairs not farther apart than $1\frac{1}{2}$ times the depth of the girder, the projected area of only one girder need be considered.

Care should be taken that traveling cranes, when not in use, are sufficiently anchored to prevent their being moved by wind pressure. Several cranes have been wrecked from being set in motion because the fastenings gave way during a strong wind.

Crane makers do not usually specify working stresses. Two large makers have in their specifications the respective sentences "Factor of safety not less than 5 in all parts of the crane" and "The crane will be designed throughout to have a minimum factor of safety of five when under full load." Some government specifications require that live loads be increased 20 per cent for impact and specify working stresses of 16,000 lb. per sq.in. for tension and 16,000—70 l/r for compression, with the provision that for bracing and combined stresses due to eccentric loading the permissible working stresses may be increased 25 per cent.

The writer recommends that outdoor traveling cranes be proportioned for working stresses of 16,000 lb. tension and 16,000 — 70 l/r compression for combined dead and live load (plus 25 per cent impact). When combined with wind load these working stresses may be increased 25 per cent.

Wind loads and stresses for gantry cranes and coal or ore handling bridges are more troublesome. These structures are often of considerable height and span. Sometimes they are in locations exposed to unusually severe winds. The problem before their builders is two-fold: first, to make them light enough to require a minimum amount of power to move them and second, to make them strong enough to carry the required loads and resist any probable wind. Coal and ore handling bridges have been wrecked by wind. A storm at Superior, Wis., May 25, 1914, destroyed the largest coal handling bridge in the world: a span of 552 ft. with a height of 140 ft. from rail to top chord. It would have been interesting to determine from working drawings the wind force necessary to blow over this and other traveling bridges that have met a like fate.

A number of gantry-type yard cranes recently constructed for a shipbuilding company afford an illustration of the complexity of requirements often presented by outdoor cranes, and assumptions made in the design that appear to the writer to be commendable. The gallows frames consist of two A-towers each on two trucks 50 ft. apart and running on a single rail. The rails are 89 ft. center to center. The overhead connecting part consists of two plate girders 8 ft. deep and 12 ft. apart on centers and overhanging 29 ft. at each end, thus being 147 ft. long from end to end. A rail the full length of each girder provides a runway for two hammerhead-shaped traveling towers with a trolley arm 45 ft. and counterbalance arm 22 ft. 9 in. long. Each tower has a truntable base enabling it to revolve through a complete circle. The height of towers is 23 ft., thus making a height of 102 ft. from ground rail to top of towers.

Wind pressures as follows were assumed on the steel frame of the gantry: For wind blowing in a direction parallel to the ground track, 30 lb. per sq.ft. on the surface of the windward girder and tower legs plus one-half the surface of the leeward girder and tower legs; for wind blowing in a direction at right angles to the ground track, 30 lb. per sq.ft. on the projected area of each tower plus one-half the projected area of all the cross frames between the girders. In combining wind loads with dead-plus-live loads, 10 lb. per sq.ft. was used instead of 30 lb., as it is unlikely that the cranes will be in operation during a wind blowing at more than 50 miles per hour (equivalent to a pressure of 10 lb. per sq.ft.). To the wind loads on the gantry were added those on the towers. These were given by the builders of the towers, for each tower, as 12,000 lb. and 5,000 lb. respectively for wind at right angles to and parallel with the arms. These loads were used in combining wind loads with both dead and dead-plus-live loads. They are moving loads and were considered for any location of the towers on their track and for any position of either tower on its turntable base.

The working stresses used were 12,000 lb. per sq.in. tension for combined live and dead loads and 15,000 lb. per sq.in. tension for wind plus dead and wind plus dead plus live loads. Compressive stresses were taken at 10,000 and 12,500 lb. per sq.in.

Flags and Flag Poles

The Bureau of Yards and Docks, U. S. Navy, made tests in 1916 to determine the pull of flags due to wind. The results showed that the total horizontal resistance of a flag exposed to a steady current of air can be approximately represented by the formula: $R = CAV^{1.9}$, where R is resistance in pounds, A is area in square feet, V is velocity of wind in miles per hour, and C is a constant equal to 0.0003. For convenience the equation may be written $R = 0.0003AV^2$. This is about one-twelfth ordinary normal pressure. Assuming a velocity of 100 miles per hour, the value of R is 3 lb. per square foot of flag area.

The Building Code of the City of Seattle has a section reading:

> Every flag pole . . . shall be so braced, supported or stayed as to be capable of withstanding a computed wind pressure of 100 lb. per sq.ft. of pole surface.

Whatever is meant by "square foot of pole surface," the requirement is unreasonable. It was probably the compiler's intention to assume a pressure on the pole large enough to include that on the flag, but this is illogical. A wind pressure of 25 lb. per sq.ft. on the vertical projection of the pole and 3 lb. per sq.ft. on the area of the flag is sufficient.

Railway Tunnel for Postal Service To Be Built in London

A 9-ft. tunnel about 6½ miles long for carrying automatic railway trains to transport mail is about to be built in London, bids having just been called for. Plans were developed some years ago, and in fact the operating system was worked out by the help of an experimental line reproducing both grades and curves of the proposed railway. The tunnel is to extend from the Paddington District post office to the Whitechapel post office. It is to carry two tracks of 24-in. gage, and the trains operating on these tracks are to be handled by remote control. On account of the necessity of avoiding other tunnels and subsurface structures, the depth of the tunnel below ground surface will vary from 28 to 87 ft. At stations, says *The Engineer* of London, from which this information is taken, the tracks are to be separated about 20 ft., to accommodate elevators and mail chutes between them.

Combined Deferrization, Softening and Filtration Plant

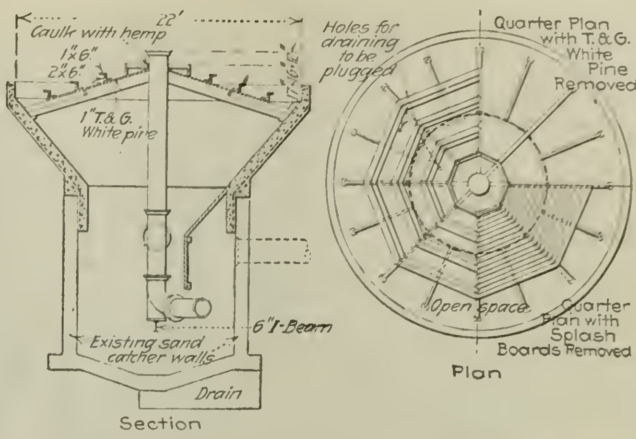
Permanent Plant at Camp Funston Treats Well Water Fully in Winter, but Removes Iron Only in Summer—Has Film Aërator

By Webster L. Benham

Of Johnson & Benham, Consulting Engineers, New York and Kansas City; formerly Utilities Officer and Constructing Quartermaster, Camp Funston, Kan.

THE WATER SUPPLY for Camp Funston, Kan., which is located on the military reservation of Fort Riley, is obtained from eight 24-in. wells, 40 ft. to 72 ft. deep. Although the water is clear and colorless, it has a large iron content, ranging from 3 to 5 p.p.m., and an alkalinity of about 300 p.p.m. The permanent hardness, which ranges from 30 to 50 p.p.m., is relatively low. The water contains a low number of bacteria even for a well water. All counts have been made on agar which would probably indicate a number somewhat lower than counts made on gelatine. Occasionally the number is high and at rare intervals intestinal bacteria have been found.

The hardness caused excessive formation of scale in the boilers at the camp, thus entailing considerable power losses and trouble. The camp had 17 central heating plants and, as there was no return system, water of condensation was not returned to the boilers, with the result that there was wasted during the winter months 500,000 gal. per day. Continual cleaning of the boilers and heaters was necessary. A great deal of trouble and expense was incurred in the replacing of range water-backs, and the amount of soap used in the laundry and lavatories was excessive. The presence of considerable iron in the water discolored materials washed in it, gave an unpleasant taste and affected the quality of ice made at the refrigeration plant. It was discovered that growths of the iron fungus Crenothrix occurred in the mains of the distributing system. Some broken pipe revealed the fact that there was gradually accumulating a slime on the interior of the pipes of the districution system which was of cast-iron construction throughout. For these reasons an appropriation of $60,000 was obtained more cheaply for the deferrization and softening of the water. As an added precaution the water, after being filtered, has been treated with liquid chlorine.



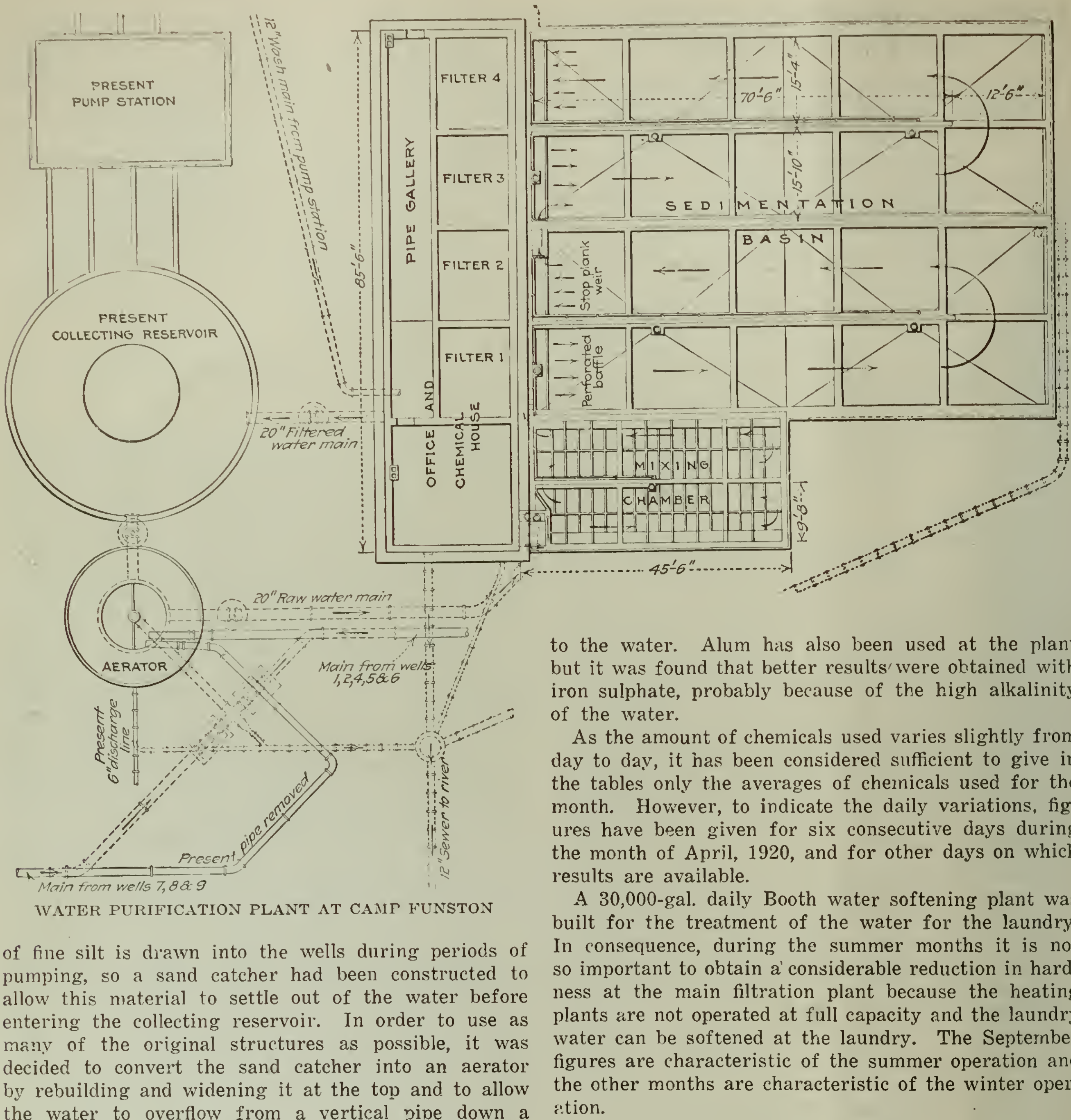
AERATOR BUILT ON TOP OF OLD SAND CATCHER

Inasmuch as it was realized that Camp Funston would undoubtedly remain a permanent training camp, the plant is of permanent construction throughout, being of reinforced concrete and brick. It was realized that it might become necessary at some future time to obtain a permanent supply from the Kansas River and the plant was designed with the idea in view that it might be used to treat river water.

Convert Sand Catcher Into Aerator—A small amount

RECORDS OF OPERATION, FILTRATION, WATER SOFTENING AND DEFERRIZATION PLANT AT CAMP FUNSTON, KAN.

	Date 1919	Filter Hours	Length of Run Hours Max.	Min.	Ave.	Rate Mil. Gal. per Acre per Day	Units Washed	Per Cent. Wash Water	Grains per Gal. Alum	Lime	Soda Ash	Iron	Parts per Mil. Liq. Cl.	Parts per Million: Alkalinity Raw	Fil.	Incrustants Raw	Fil.	Total Iron Raw	Fil.	Free CO_2 Raw	Fil.	Bacteria per C.c. Agar at 37° C. Raw	Fil.	Tap
	Sept. 2	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	....	....	....	10	150	...
	Sept. 8	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	....	....	....	50	16	8
	Sept. 17	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	....	....	....	2	5	3
	Sept. 25	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	....	....	....	1	15	3
	Sept. 30	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	....	....	....	14	17	3
Ave.	Sept.	25.9	12.9	11.6	12.6	115.0	0.75	1.10	....	5.77	0.37	....	.....	290	207	34.2	34.2	3.8	0	19.8	0.31	...	..	...
	Nov. 4	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	....	....	....	26	2	3
	Nov. 10	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	....	....	....	57		39
	Nov. 20	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	....	....	....	147	88	128
	Nov. 24	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	....	....	....	125	70	100
	Nov. 30	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	....	....	....	200	65	90
Ave.	Nov.	20.2	13.2	6.15	9.7	136.2	0.5	0.89	0.97	5.44	1.31	0.37	.....	290	178	30.3	6.0	4.5	0	20.7	0	...	.	...
	Dec. 4	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	....	....	....	200	65	90
	Dec. 23	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	....	....	....	18	22	12
Ave.	Dec.	21.9	13.4	6.9	10.2	132.9	0.5	1.02	0.93	3.63	1.60	....	0.294	287	175	43.0	14.2	3.2	0	17.3	0	...	..	...
	1920																							
Ave.	Jan.	22.0	14.1	6.5	10.1	133.8	0.38	0.73	....	7.65	2.09	0.70	.....	295	159	49.8	22.8	3.6	0	17.1	0.13	...	..	...
Ave.	Feb.	29.2	15.5	8.5	11.0	121.4	0.4	0.80	....	8.46	2.10	0.69	.....	297	140	46.8	30.9	2.6	0	18.0	0	...	..	...
	Mar. 15	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	....	....	....	3	2	1
	Mar. 27	....	....	....	....	.....	....	....	....	....	....	....	.....	.....	.....	....	....	....	....	....	....	5	6	4
Ave.	Mar.	24.4	15.5	8.19	11.8	113.9	0.54	1.1	....	8.66	2.08	0.69	.....	296	143	39.6	20.9	3.2	0	17.1	0	...	..	...
	April 1	24.0	16.0	8.0	12.0	124.8	0	0	....	8.66	2.07	0.68	.....	300	150	40.0	20.0	4 0	0	17.6	0	.	..	
	April 2	27.0	16.0	11.0	13.5	79.4	0	0	....	8.46	2.10	0.70	.....	290	144	41.0	19.0	0.4	0	18.0	0	..	..	.
	April 3	18.0	12.0	6.0	9.0	100.6	0	0	....	9.45	2.10	0.84	.....	298	144	40.0	19.4	2.4	0	18.0	0	...	..	
	April 4	26.0	14 0	12.0	13.0	130.6	0	0	....	8.40	1.98	0.70	.....	300	144	42 0	21 0	4 4	0	17.6	0	..	..	
	April 5	34.0	22.0	12.0	17.0	95.8	0	0	....	8.68	2.15	0.70	.....	300	150	44.0	22 0	5.4	0	19.0	0	..	..	..
	April 6	31.0	16.5	14.5	15.5	104.5	2.0	4.6	....	8.68	2.10	0.68	.....	296	150	40.0	20.0	4 8	0	17.0	0	12	8	10
	April 12	30.0	18.0	12.0	15.0	103.6	0	0	....	8.23	2.08	0.70	.....	290	140	40.0	20.0	0.4	0	17.6	0	14	10	7
	April 19	24.0	13.0	11.0	12.0	132.8	2.0	3.7	....	8.47	1 97	0.69	....	290	140	43.0	21.0	3.2	0	19.0	0	9	8	5
	April 26	39.0	24.0	15.0	19.5	92.9	2.0	3.0	....	8.73	2.16	0.69	.....	300	150	40.0	20.0	4 4	0	20.0	0	12	8	9
Ave.	April	28.3	16.8	11 5	14.4	113.1	0.53	0.91	....	8 42	2.04	0.68	.....	298 6	147.2	41.5	20.1	4.0	0	18.0	0	..	.	...



WATER PURIFICATION PLANT AT CAMP FUNSTON

of fine silt is drawn into the wells during periods of pumping, so a sand catcher had been constructed to allow this material to settle out of the water before entering the collecting reservoir. In order to use as many of the original structures as possible, it was decided to convert the sand catcher into an aerator by rebuilding and widening it at the top and to allow the water to overflow from a vertical pipe down a series of baffle ways or cascades. Thus the water is spread out in a series of thin sheets or films and the resulting oxidization precipitate the iron in the water. It was felt that practically as good results could be obtained by allowing the water to mix with the air in thin films rather than in the finely divided state that mght have been obtained by using sprays. The use of sprays would undoubtedly have resulted in an over-oxidization which would have been difficult to eliminate later in the process of treatment.

The main plant, consisting of a reinforced-concrete mixing chamber, settling basins, four 750,000-gal. daily rapid sand filters, pipe gallery and clear well under the filter plant, together with the brick filter house, was located directly east of the aerator, as shown on the drawing. From the aerator the water flows by gravity to the dosing chamber, where, under winter conditions, lime, soda ash and iron sulphate are added to the water. Alum has also been used at the plant but it was found that better results were obtained with iron sulphate, probably because of the high alkalinity of the water.

As the amount of chemicals used varies slightly from day to day, it has been considered sufficient to give in the tables only the averages of chemicals used for the month. However, to indicate the daily variations, figures have been given for six consecutive days during the month of April, 1920, and for other days on which results are available.

A 30,000-gal. daily Booth water softening plant was built for the treatment of the water for the laundry. In consequence, during the summer months it is not so important to obtain a considerable reduction in hardness at the main filtration plant because the heating plants are not operated at full capacity and the laundry water can be softened at the laundry. The September figures are characteristic of the summer operation and the other months are characteristic of the winter operation.

As the routine operation of the plant is done largely by inexperienced soldier labor, it has not been found practicable to obtain an accurate adjustment of the rate


SAND CATCHER CONVERTED INTO THIN FILM AERATOR

of application of the chemicals to the water in accordance with the hardness of the water to be removed, and average rates based upon the volume of water treated have been adopted. The water from the several wells varies somewhat in character and, if it were possible, it would be more satisfactory to vary the rate of application of the chemicals according to the well or wells used. The variation in character of the water from two of the wells is shown by the following analysis:

	Well 7 P.p.m.	Well 8 P.p.m.
Iron	7	0.3
Incrustants	67	20.0
Alkalinity	350	296.0
Carbon Dioxide	18	14.0

The following table shows the periods of detention of the water in the mixing chamber and sedimentation basins based on the average and maximum consumption for which the plant was designed:

Volume of Flow, G.P.D.	Hours in Mixing Chamber	Velocity Through Mixing Chamber, Ft. per Min.	Hours in Sedimentation Basin: 1 Basin	Hours in Sedimentation Basin: 2 Basins	Velocity Through Sedimentation Basin Ft. per Min.
2,000,000	0.61	3	2.7	5.4	1.0
3,000,000	0.4	5	1.9	3.7	1.5

The velocity of flow through the mixing chamber is about 5 ft. per minute when the plant is working under maximum conditions, but at the present time, because of the decreased population, the velocity is much less, and some slight deposits occur which must be removed at intervals. The sedimentation basins are arranged either for selective or multiple operation. At the present time the detention period in the settling basins has been increased to 12 hr. when one basin is in use and to 24 hr. when both are in operation. Satisfactory sedimentation of the flow has been obtained in these basins. The deposits are allowed to accumulate to a maximum depth of 3 ft. in the basin, giving an average depth of 18 in. over the whole bottom before the basins are cleaned. As the basins are not covered, algae growths, especially with the present low flow, have occurred in the basins. A luxurious growth of Spirogyra appeared when alum was being used as a coagulant.

It has been found necessary to clean each filter at intervals of about 2½ days when a loss of head of 8½ to 9 ft. has been reached. As water under 70 lb. pressure is available for washing, it has been found unnecessary to use air. The percentage of wash water given in the table is occasionally somewhat high for filters treating water without turbidity, thus showing that there is probably more water used than is necessary. The water is treated with liquid chlorine in the suction main of the pumps at a rate of 0.3 parts per million.

Results of Treatment—During the summer, little reduction of permanent hardness is effected, but the iron and free carbon dioxide are materially reduced. During the winter months, the alkalinity and permanent hardness are reduced slightly more than one-half, which would be considered satisfactory from a practical and economical standpoint, but it is possible that at certain times more chemicals are used to produce the results than are necessary. The analyses show no iron in the treated water, but this is probably due to the fact that the methods of analysis used are not sufficiently sensitive to indicate small amounts of residual iron.

The results of bacterial analyses show that the number of bacteria in the raw water is small and that a slight increase sometimes occurs in the plant. Occasionally, a high count for a well water is obtained, especially when it is considered that the counts are made on agar. Intestinal bacteria are almost uniformly absent from 0.1, 1 and 10 cc. samples.

In general, a satisfactory iron removal and softening is accomplished, and a water of safe, sanitary quality is being obtained. A considerable saving in the amount of soap has been effected, the amount of coal used at the central heating plants has been decreased and the disagreeable taste and odor due to iron in the water have been eliminated. The previous trouble experienced by the discoloration of laundered goods and shrinkage of woolens has almost entirely disappeared.

Mississippi River Floods of 1920

By Alfred J. Henry
Of the U. S. Weather Bureau

The spring flood in the Mississippi above St. Louis was the most severe at Dubuque, Ia., since 1888 and at Davenport since 1892. This flood had its origin in the melting of the snow cover in Minnesota and Wisconsin during the last half of March. The snow-water flood had not passed below La Crosse, Wis., when a rainstorm passed over the watershed augmenting the flood flow very materially. The flood was most severe in the stretch of the river forming the border between Illinois and Iowa. Levees on both sides of the river near Muscatine, Ia., gave way and about 85,000 acres of rich agricultural lands were overflowed. The probable loss in prospective crops is placed at $3,500,000. Fortunately no lives were lost.

Lower Mississippi: The spring flood of 1920 in the lower Mississippi was the second great flood in recent years that was confined between the levees. (A small break occurred on April 17 about 75 miles below New Orleans, but it was soon repaired.) The crest stages in this flood fell about 2 ft. short of the 1916 flood but the duration of the high water was considerably longer. In this respect the 1920 flood set a new record for that stretch of the river between Greenville, Miss., and the Passes.

The 1920 flood, both as to magnitude and duration, was in some measure due to the weather conditions six months earlier. The heavy rains in October and November, 1919, caused a rapid rise in the streams of the lower Mississippi drainage and this rise was further augmented by the rains of December of that year. As a result the mean stage of the Mississippi at Memphis for December, 1919, exceeded the previous mean high water record by 8.1 ft.; at Vicksburg the river on Dec. 31, 1919, stood within 2 ft. of the flood stage, and although it fell after that date the fall was arrested before a stage of 25 ft. was reached.

Beginning on Jan. 13, 1920 a series of three separate flood flows mainly from the Ohio passed down the river the second of which crested at Vicksburg on April 20 at a stage of 50.8 ft., 3.1 ft. short of the highest stage of record. The river was continuously above flood stage at Vicksburg from April 4 to June 13, or 71 days. At New Orleans the river was continuously above flood stage from April 15 to June 22, or 69 days, and the crest stage fell short of the previous high water by only 1.6 ft.

Some Observations on Man-Power Engineering

Mental Attitude of Worker Must Be Known—Every Laborer Wants (1) A Job That Pays a Living Wage; (2) A Home; (3) Leisure; (4) Freedom in Using His Leisure—Must Arouse Interest in Work and Avoid Paternalism

By Charles F. Dingman
Engineer, Flynt Building & Construction Co., Palmer, Mass.

MAN-POWER ENGINEERING is a term suggested in a most excellent article by Frances A. Kellor, Associate Managing Director of the Inter-Racial Council, in *Engineering News-Record*, March 11, 1920, p. 517. Miss Kellor points out that, as the greatest returns from the use of any other power are obtained by the application of engineering principles, the greatest returns from human labor will be obtained by approaching its use as an engineering problem.

Man-power cannot be separated from the man, so the problem of its most effective use is rendered vastly more complex than any other power engineering problem and presents phases which seem to baffle all possibility of solution in the light of present knowledge. Yet the crying need of the entire world for greater production of necessary commodities demands that man-power, as well as all other available forms of natural energy, shall be most efficiently and effectively used.

For years we have been reading of the wonderful results achieved through efficiency work and scientific management, yet we are told that in many lines of industry the actual unit production per man-hour is considerably less than it was before the war. Can it be true that all the studies—psychological, physiological, and otherwise—that have been made have failed to find the means of inducing the laborer to yield up his full productive power?

Must Know Worker's Mental Attitude

Before we can discover those engineering principles whose application will enable us to secure the greatest return per unit of energy expended, it is necessary for us to know something of the worker's attitude of mind toward his work and what will induce him to apply his labor-power most effectively. The one important fact that the average student of man-power engineering fails to grasp is that the worker, as does every other human being, considers it his most important function to live and to enjoy himself and that his work is only a means to that end. The sooner employers and others divest themselves of the idea that a worker's sole function is the production of commodities, the sooner will we have an end of the labor problem.

Parenthetically, it may be well to observe that, although it does not always occupy the center of the stage as at present, the labor problem is always with us. Most of the time, however, the problem belongs to the worker and is a problem of finding how to dispose of his labor power so as to procure a living for himself and family. At present, the labor problem seems to belong to the employer and consists in first obtaining anl retaining a sufficient supply of the right kind of laborers and then in inducing those laborers to produce their full quota of product. The function of man-power engineering is primarily to solve the labor problem for the employer, though, as we shall see farther on, its correct solution will be equally as beneficial to the laborer as to the employer.

Before we can adopt the measures which will result in the greatest productivity from each laborer, we must find out what the worker expects to get when he sells his labor-power. In other words, why does the laborer work at all? Primarily, he works for food, clothing and shelter for himself and family, but unless actuated by a desire for something more than those rudimentary needs he seldom develops a capacity for any great productivity. It is the desire for something beyond. something that lifts him above a mere animal existence, that inspires the laborer to put forth the supreme effort. And it is because capitalists, managers, welfare workers and others have only vaguely sensed that idea in the past that we have such an acute production problem at present.

Four Things Every Laborer Wants

What every laborer wants, and this applies to all races and types, is: (1) A job that will return him a wage, properly adjusted to the cost of living. (2) A home. If he be married his ideas of a home will probably differ materially from those of a single man. (3) Leisure. (4) Freedom to use that leisure according to the dictates of his own individual temperament. These wants are basic, but every nationality has its own particular group of wants which were developed as a result of their "old country" environment and, in addition, every individual has peculiar wants of his own. It is only by learning what those wants are and how to utilize them that we can secure the maximum production from the laborer and I believe that we shall find that management has to date developed but a small fraction of the total productive power that the laborer will yield when he is approached in the proper manner.

The purpose of man-power engineering is to determine those conditions under which the laborer will sell and deliver the greatest amount of productive labor power for the given wage. Generally speaking, that set of conditions which permits the greatest play of individuality, arouses the greatest amount of interest in the work, best satisfies the actual human wants and yet avoids all paternalism, will also secure the greatest productivity.

We often hear the statement made that the reason for the existence of the present labor problem is that the employer, because of the great increase in the size of the industrial unit, no longer finds it possible to become intimately acquainted with all of his employees but is separated from them by the managerial organization. I do not believe this has any basis in fact. I have known strikes to occur in mills where the owner made it a part of his daily program to meet and talk with every worker in the plant. I have known employers who were always at loggerheads with almost every man in their employ. If the employer is a good leader of men he can inspire the laborers with a desire to increase their output and show them how to do it;

otherwise he might better stay in the office. The men are not half so keen about meeting the employer each day as they are to have the management recognize the fact that they are human beings and to see that they are treated accordingly.

The laborers want homes. Unless men can find suitable homes within reasonable distance from their work, their productive efficiency is bound to suffer. Different people and different nationalities have widely varying ideals as to how to furnish and how to keep a home, but it may be considered axiomatic that people who have a comparatively high standard of home life will possess corresponding standards of workmanship and productivity.

One of the most effective measures for insuring a well maintained rate of productivity is to make sure that there is always a sufficiency of the proper kinds of houses available in which the workers may make homes for themselves. There need be no taint of paternalism attached to an industrial housing program, even though it may not be possible to show a profit on the housing account or though it may be necessary to charge the loss on the housing account to production costs. The need of houses has become so great in many industrial communities that men have to travel long distances to their work and their productivity suffers accordingly. Beside this, the high rates of fare which they must pay in traveling back and forth make deep cuts into their wages and breed further dissatisfaction.

Leisure and Freedom to Use It

The workers want leisure. Physiologists and psychologists are all agreed that functions are performed with greater intensity and efficiency when periods of activity are alternated with proper periods of rest. This means that the working day must be long enough to secure the maximum results and yet not so long that the accumulating fatigue reduces the hourly rate of production until a long day's work produces less than a short day's work.

Stopping work at Saturday noon is becoming almost the universal practice in manufacturing establishments. This half holiday fills a need that no Sunday can fill because it gives the worker a chance to visit many places that would be closed on Sunday or to enjoy sports which might not be approved of on Sunday. Every reasonable opportunity which the worker has for forgetting his job helps increase the intensity with which he will attack it upon his return to work.

The workers want freedom to use their leisure as they see fit. It is true that great good may be accomplished by tactfully leading the laborer into making a better use of his leisure periods but when intrusive efforts are made to coerce him into liking the recreations someone else has picked out, he is very likely to assume an attitude of sullenness.

In this connection there is another factor to be considered. The provision of company club-rooms and other personally conducted recreations may be beneficial to an individual industry located in a small town by making the workers satisfied to stay in that place but, if that is all they accomplish, their effect upon industry in general may be decidedly negative since we are all agreed that the essential need at this time is not so much satisfaction as it is increased production. It is quite possible to carry this sort of welfare work to the point where the worker may become over-coddled, to his own personal injury, as well as to that of the industry.

Satisfied people, when the satisfaction comes as a result of things which are done for them rather than from things which they do for themselves, have a tendency to lose interest in putting forth any greater amount of effort than is absolutely necessary.

Interest in Work a Factor in Production

There is another factor—want does not seem to be the proper term for it—that governs the productivity of all men, but it does not ordinarily come into play in wage labor until the wants previously discussed have been fairly well satisfied. That factor is interest in the work.

It is easily demonstrable that, where an actively sustained interest in the work exists, a person can and will perform tasks that would ordinarily be impossible. Interest will ward off fatigue and quiet dissatisfaction, yet to arouse interest in some of the monotonous tasks which form important parts of modern industry seems well nigh impossible. It is here that the real problems of man-power engineering are to be found.

Interest in the work is inspired in as many different ways as there are different employers and employees. Here I believe is the explanation for the failure of many apparently scientific attempts to increase production. The persons making these attempts have properly evaluated all of the mechanical factors, yet because they considered the laborers merely as so many units forming a group, instead of a number of highly differentiated individuals, they failed to get that interest.

This is one of the reasons why comparatively high wages, bonuses, profit sharing, etc., do not always continue to produce big results, even though a sufficiently high wage to properly support life is necessary to maintain any interest at all. This is why the reputed labor policy of Lenine is bound to fail. It is said that he insists upon absolute submission to the director of the industry and absolute concentration upon the work during working hours. Because he is operating with men who have had to submerge their individualities for so long, men who believe they have cast off the yoke of the oppressor and are now working for an industrial commonwealth, which is themselves, he may succeed for a time; but sooner or later he will have to change his policy and learn how to maintain interest. Lenine may keep the workers from doing anything but work during working hours, but he cannot make them take an interest in their work by merely commanding it.

This matter of sustained interest requires a careful study of the individual personality of every laborer and every executive in the plant. There are certain types of executives whose attitude quickly destroys interest; among them are those who maintain an air of superiority when in company with the workers, those who feel that they must be spoken to in a certain particular manner, those who cannot exercise sufficient control over their emotions. There are other types who seem naturally to enthuse those who work with them. There are men for whom laborers will gladly leave other jobs and for whom they will work harder and for lower pay than they will elsewhere. These are the men who never forget that the laborers are just as human as they are themselves.

In studying how to arouse and sustain the interest of the laborer we must learn what his individual ambitions are and learn to tie the work which he is doing up to his ambitions. For instance, some men are interested in security in their old age. Old age pensions appeal to these men while they hold no interest at all to the strong individualist who is out to make a big success.

Bonus payments and profit sharing have their particular appeals to certain types of workers but tend to lose their effectiveness unless administered with the greatest fairness and unless means are used to show up the effect of the daily product upon the payment which results therefrom. The most recent studies of profit-sharing schemes seem to show that, while they may produce highly satisfactory results as regards the men occupying positions of at least some authority, they generally fail to arouse any deep or sustained interest in the rank and file of employees in any large industry. On the other hand, bonus payments based upon either individual or group production and figured over comparatively short periods of time, preferably every day, show the worker just how his effort is affecting his income. Remarkable results have been achieved by this method.

Workers as Partners in Industry

Perhaps the most enlightening information that has been published on this important subject of enlisting the worker's interest is contained in a pamphlet entitled "Human Relations in Industry," by R. B. Wolf, published by the Associated Industries of Massachusetts. Mr. Wolf tells us of the remarkable change which was wrought in a pulp mill when the management took the workers into their confidence and showed each man just how his work affected the work of every other man in the plant and how it affected the total output of the plant. The next step was to arouse a friendly competition among the men; not to see who could produce the greatest quantity, but to see who could produce the best quality of goods. As a result of these measures he found the workmen taking the keenest sort of interest in their product and suggesting changes in plant and in methods that would enable them continually to improve their product and increase their output. He tells us that they increased the yield of pulp from the wood by 17 per cent, a highly commendable performance from a conservation standpoint, and saved, in one year, $340,000 in raw materials.

What Mr. Wolf accomplished was to put the workers in the position of associates with the management. He says nothing in his pamphlet about "shop councils" or other species of formal shop democracy, but each workman was given a chance to exercise that creative ability which is one of the traits distinguishing men from animals.

Here, then, seems to be the answer to the country's greatest problem. The worker who sells his labor power must be given an opportunity to deliver it in the most effective manner and this can only be accomplished by providing him a means of self-expression in every task. This instinct for self-expression is possessed in a greater or less measure by every human being and to it the race owes practically all of its development. Yet so little has its importance been appreciated that the great aim in organizing modern industry seems to have been to arrange matters so that only a chosen few should find opportunity for self-expression. Those who have failed to find that opportunity we have been pleased to consider as lazy, shiftless or lacking in ambition. Yet, who is there who cannot think of at least one instance of a man, who was building himself a reputation for worthlessness, suddenly being thrust into a position which called forth his powers and made a man of him?

It is the man who can get away from the idea of forcing the worker into doing things his own way, the man who can lead the worker with the idea of "let us do this," who can induce the worker to put his own self into the work, and can show him how the materialization of his ideals and the achievement of his ambitious will follow from it, that is the true man-power engineer.

Turbine Case Blowout Repeated at Wachusett Power House

Accident of 1919 Duplicated on Similar Water Wheel—Failure of Case Due to Water Ram from Shift in Governor Control

ON FEB. 17, 1919, the upper section of the cast-iron scroll case of turbine No. 2, one of four similar wheels in the hydro-electric power station of the Wachusett dam of the Metropolitan Water-Works of Boston, Mass., blew out, following the changing of the governor from automatic to hand control. Repairs were made and order placed for revision of the governor system of all the units, but before the latter could be accomplished a precisely similar accident occurred to turbine No. 4 on May 3, 1920. Some studies are still under way following the latter accident, but sufficient data have been made available by William E. Foss, director and chief engineer of the Water Division of the Metropolitan District Commission, to warrant a description of the two failures.

The working floor of the Wachusett power house, just behind the Wachusett dam, is about 92 ft. below high water in the reservoir. The plant includes four 1,000-kw., 13,800-volt, alternating-current generators directly connected with horizontal-shaft hydraulic turbines which operate at a speed of 400 r.p.m., and two 60-kw., 125-volt, direct-current exciter generators also operated by turbines. Each of the main turbines is provided with a type Q Lombard governor arranged for automatic or hand operation as desired. The water-supply for each unit enters the gate chamber through ports in the upstream face of the dam and after passing the screen enters a vertical circular wall 7 ft. in diameter through two openings, each 6 ft. high and 2½ ft. wide. From the bottom of the circular well the water flows through a horizontal cast-iron pipe 4 ft. in diameter for a distance of 115 ft. to a point under the turbine and rises vertically 15 ft. to the base of the scroll case. Vales and gates are provided at the dam and at the base of the riser pipe.

On Feb. 17, 1919, the machinery at the power station was started about 6:30 a.m. and had been running smoothly with exciter No. 2 and units Nos. 1, 2, and 4 in operation for nearly an hour when the operator noticed that the oil feed pump of turbine No. 2 was not working properly, and with the helper proceeded to

prime the pump with the turbine running. Upon throwing off the pump belt, however, some trouble developed and the operator went to the switchboard and threw the load off the No. 2 unit. As he was returning the helper pulled out the governor clutch to change from automatic to hand control and immediately a section of the upper part of the scroll case, having an area of about $17\frac{1}{2}$ sq.-ft., blew out as shown in the left hand of the accompanying two views.

The water flowed out of the opening in the scroll case under a head of 70 ft. and caused considerable damage in the powerhouse and in the superintendent's office, which was on a mezzanine floor off of the power room. The operators managed to get to the top of the dam and to shut off the flow by the main sluice gate within a half hour.

The details of drying out the electrical apparatus which had been flooded were somewhat involved, but the satisfactory performance of the machinery was achieved soon after the accident.

In the opinion of the engineers of the plant the break was caused by the sudden closing of the wicket gates at the turbine, which occurred while changing from governor to hand control. Experiments made on one of the other turbines following the accident showed that the governor could be cut out without any tendency for the wicket gates to close for varying gate openings up to five-eighths of the full opening. At this point, however, the gates closed suddenly, with a resulting water ram. In one of the turbines, for instance, a water ram is shown of 5 to 10 lb. in connection with operation under governor control and of 60 lb. when the clutch is pulled with a wicket-gate opening of 63 per cent.

Examination of the broken casting showed that it was slightly less than the designed thickness, which was about $\frac{15}{16}$ in. at the center of the break. There were indications of internal strain of the casting at the hub or thick section formed by the guide vanes. A new casting was obtained for repairing turbine No. 2 with a thickness 20 per cent greater than that of the original design, and the guide vanes were cored to prevent internal strains in cooling. For future contingencies consideration was given to the installation of air chambers, of storage tanks, and of dash pots on the gate-closing mechanism, but for various reasons these were not adopted. However, the operators were instructed not to attempt to cut out the governors with the turbines in operation, and arrangements were made to change the hydraulic governors from the closed to the open system to insure greater reliability. In the closed system the oil used in operating the governor is entirely inclosed and gradually decomposes and breaks down, corroding the delicate parts of the mechanism and forming gritty precipitates which interfere with the satisfactory operation of the governor. In the open system the oil is pumped from and returned to an open sump tank provided with the necessary strainers. With this arrangement the oil remains in its original condition and the operation of the governor is thought to be more reliable, especially after a shutdown for repairs or for any other reason. The order for this revision has been placed, but the change had not been made prior to the second break which occurred on May 3 of this year in turbine No. 4.

At this time trouble developed with the governor when starting up in the morning and the assistant operator put the unit into service by hand control and blocked the gates. Later, when the head operator arrived, the governor was adjusted and preparations were made to shut down the unit and put it into service again under governor control. In connection with this manœuver, the head operator slipped and fell against the governor stand and the break followed. This break was in practically the same place on turbine No. 4 as the first break on turbine No. 2. The two views herewith show the similarity of the breaks. Neither of the operators remember just how it happened as both were knocked down by the escaping water and received injuries which required hospital treatment. There is every reason to conclude, however, that the operators lost control of the gates and allowed them to close suddenly, although there is no indication of water ram pressure on the recording pressure gage chart. The damage resulting from the second accident was of about the same nature and extent as from the first accident, which cost about $8,000, and the work of repairing is being conducted along similar lines.

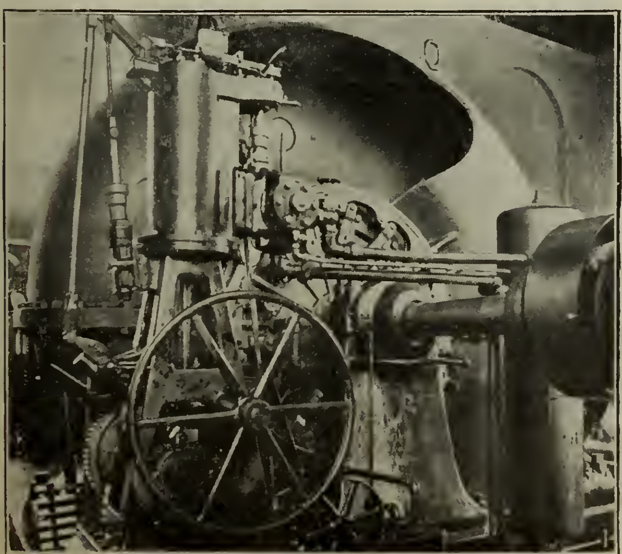


FIG. 1. BREAK IN TURBINE CASING NO. 2, FEB. 17, 1919

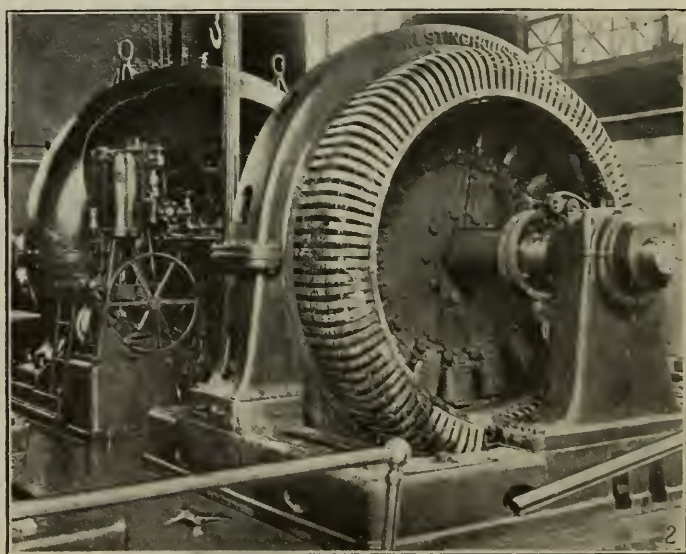


FIG. 2. BREAK IN TURBINE CASING NO. 4, MAY 3, 1920

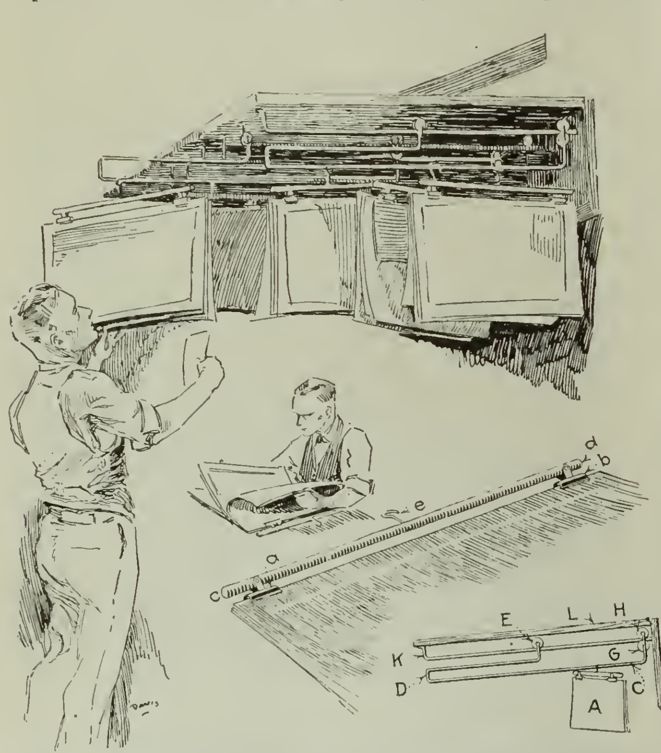
A System of Filing Drawings

By Nelson Hall
Detroit, Mich.

In every drafting room there is the problem of filing drawings so they can be readily found when wanted. Many systems have been devised all of which have more or less merit. Some are better suited to one drafting room than another. For a particular shop the following system was devised and will be described so that any one interested can make the equipment necessary.

Take two heavy paper clips *a* and *b* as shown in the sketch. The stiffer they are the better. Solder these to a rod *c-d* which is about $\frac{3}{32}$ in. in diameter and about 15 in. long. At the middle of *c-d* solder hook *e* so the whole can be hung up conveniently.

A wire stretched across the room or a cabinet makes an excellent place to hang packs of drawings in the above clips as shown. But drawings hung in the open have a tendency to curl and to gather more or less dirt, so when this system is used permanently a cabinet should be made on the plan of a wardrobe trunk or a clothing store fixture for holding suits of clothes. *A* is a set of drawings held by hook *C* to slide on rod *D*. *D* is supported by roller *E* in front and rollers *G* and *H* at the back. These rollers run on rod *K* which in turn is supported by *L*. Rod *K* is the full depth of the cabinet.



SCHEME FOR FILING BLUEPRINTS

When a pack of drawings is to be selected the carrier *D* is drawn forward so the labels can be read. By keeping the drawings packed in a case they will stay straight and remain clean.

For the shop in mind the standard sheets were 18 x 24 in. Larger drawings were 36 x 36 in. and 36 x 48 in. These folded into 18 x 36 in. and 18 x 24 in., so all the clips were made for sheets 18 in. wide.

In developing an idea many drawings are made that are only good for reference, but they must be kept as they mark the progress and are often useful in establishing dates. It is convenient to have a clip for drawings as they become obsolete and another for the "live" or working drawings. In our practice of developing we often label our clips in this manner. Mach. No. 10, Obsolete; Mach. No. 10, Working; Mach. No. 10 Tools; Mach. No. 10 Patterns. These divisions meet our requirements very nicely.

If a machine shop foreman wants some information we take down clip labeled "Working" and we have all the drawings that pertain to the machine shop in book form so they can be leafed or scaled as shown in the drawing. Should a discussion arise in the pattern shop the draftsman takes clip labeled "Patterns" and goes to this pattern shop with all the information available to make his decision.

Each shop and the work under development determines how the classification of drawings should be carried out. Often machines are developed that have not enough drawings to fill one clip, while others have more tool drawings than can be held in one clip. The great advantage comes from having all the drawings together so they can be leaved, measured, taken out and replaced as often as needed with least possible trouble.

Paving Cost Comparisons

An investigation by the Chicago Board of Local Improvements of paving costs in other cities indicates that Chicago in 1919 paid from 8.2 to 50.8 per cent less for its paving than eight other large cities. Officials of the Board and the city council and representatives from the county and city real estate boards and the Chicago Association of Commerce recently visited the cities in question to gain cost information which will be used in hearings before the Board, at which citizens may protest on paving programs. The prices for completed pavements found are given in the following table:

All of the cities above mentioned, with the exception of Chicago, pay contractors in cash. Chicago pays in special assessment vouchers which are subject to 5 per cent discount. This amounts to 21c. per square yard on asphalt, 27c. on brick, 33c. on creosoted wood block and 31c. on granite.

City	Asphalt		Brick		Granite		Creosoted Wood Block	
	Cost per Sq. Yd.	Per cent Inc. over Chicago	Cost per Sq. Yd.	Per cent Inc. over Chicago	Cost per Sq. Yd.	Per cent Inc. over Chicago	Cost per Sq. Yd.	Per cent Inc. over Chicago
Chicago	$4.15	....	$5.24	....	$5.98	....	$6.24	....
Detroit	5.10	22.9	6.85	30.7	7.00	17.5	*	....
Buffalo	5.14	23.8	5.41	3.1	*	....	*	....
Boston	4.52	8.9	*	....	*	....	6.89	10.4
Borough of Manhattan, N. Y.	5.51	32.7	...	....	8.53	42.6	*	....
Pittsburgh	4.85	16.8	5.20	0.8	6.35	6.1	*	....
Philadelphia	4.14+	15.2+	*	....	7.29	21.9	7.04	12.8
Baltimore	4.49	8.2	*	....	*	....	*	....
Washington	6.26	50.8	*	....	*	....	*	....

+ This is compared with Chicago Type "B" pavement costing $3.59.
* None laid in 1919.

What Can a Community Afford To Rid Itself of Malaria?

Based on a Paper by L. M. Fisher, Associate Sanitary Engineer, U. S. Public Health Service, Columbia, S. C., in Public Health Reports, May 28, 1919.

THE amount that a community is justified in spending to prevent malaria, considered from an economic standpoint only, is determined by the returns obtainable for the community upon such expenditure. If all malaria losses are figured up for the year and capitalized, the result indicates an amount for which the community would be justified in bonding itself to effect permanent relief if a bond issue were necessary, or a cash expenditure if a bond issue would not have to be resorted to. From the result thus obtained a sum must be deducted the interest of which would pay for the maintenance charges on the permanent work.

Thus, if the malarial losses were say $8,000 a year for the community, then figuring interest and sinking fund charges at 8 per cent, the losses capitalized would amount to $100,000. If maintenance of ditches, etc., would cost $2,400 a year this sum capitalized at 6 per cent would amount to $40,000. The community would therefore be justified in bonding itself for $60,000 or in raising and spending $60,000 in cash. Whatever additional value the community would place upon the comforts of being free from mosquitos, enjoying a good reputation as a healthful, energetic, enterprising town can be added to the sum of $60,000 above referred to.

If the community had a population of 3,000 the per capita first cost would amount to $20, but if the result sought, namely, the elimination of malaria, were accomplished the expenditure would undoubtedly be justified, although the per capita cost is high compared with costs in some places.

Let us assume that:

1. B equals the population in the community and
2. C is the per capita first cost of malaria control work, then
3. PC is the total cost of the work. Now if,
4. I is the interest and sinking fund charges in per cent, then
5. PCI is the total annual interest and sinking fund charge in dollars. If
6. M is maintenance in per cent of first cost, then
7. PCM is total annual maintenance charge, and
8. $PCI + PCM$ = total annual cost, interest and maintenance. If
9. R is per cent of population infected, then
10. PR is the number of infected persons in the community. Now if
11. V is the annual loss in dollars per person infected, then
12. PRV is the total loss to the community before control, and equals the average annual gain after complete control, and
13. $PRV - (PCI + PCM)$ is the total saving for the community $= P[RV - C(I + M)]$ and
14. $[PRV - (PCI + PCM)] \div P$ is the net average annual gain per capita $= RV - C(I + M)$ and
15. $[PRV - (PCI + PCM)] \div PC$ = annual dividend to community on first cost $= RV \div C - (I + M)$. Now if only partial control is effected and we let
16. F represent the percentage of control as 65, 85, 90 per cent, etc., then (12) will become
17. $PRVF$ = average annual gain under partial control. This factor F will appear in each of the equations following (12) and equation (15) will take the form,
18. $(RVF \div C) - (I + M)$ = annual dividend to community on first cost.

From this equation it is evident that, the greater the infection the greater the dividend; the greater the annual loss per person infected the greater the dividend; the greater the percentage of control the greater the dividend; and the less the per capita first cost the greater the dividend. The per capita cost alone does not determine the wisdom of undertaking the work. It must be considered along with the other factors.

By making a malarial survey, preparing an estimate of first cost and maintenance cost, estimating annual losses and probable degree of control and substituting for the factors in equation 18 an approximation of the dividend resulting from the control work can be effected. As illustrating that the dividend may be greater even though the per capita first cost is greater the following table is submitted:

	Town A	Town B
Assume		
Population infected, per cent.....	10	85
Losses per person infected, dollars	5	5
Degree of control, per cent.......	100	100
Cost per capita, dollars..........	1.5	10.
Result		
Dividend in per cent, from formula 18	18	27.5

Illinois Asks Proof of Engineers' Ability

That greater weight should be given to the professional attainments of applicants for registration as structural engineers in Illinois is the opinion of the committee of examiners under the Illinois law. On this ground the committee has recommended to the Director of Registration that submission of evidence of qualifications should be required as part of the examination specified by law. This situation was stated by T. L. Condron, a member of the committee, in a paper on "State Registration of Engineers," read before the Western Society of Engineers.

The Illinois structural engineering act as revised in 1919, provides for the examination of all applicants except those licensed or registered in another state or country where the requirements are equal to those of the Illinois law. This act says little about the scope of the examination, but does provide that the State Department of Registration and Education may adopt rules and regulations relating to the enforcement of the law. The examining board holds that ability to pass an examination is not adequate proof of the fitness of applicants to receive certificates of registration. Its action in advocating evidence of work and experience is in line with the proposed uniform registration law recommended by the committee of the national Engineering Council.

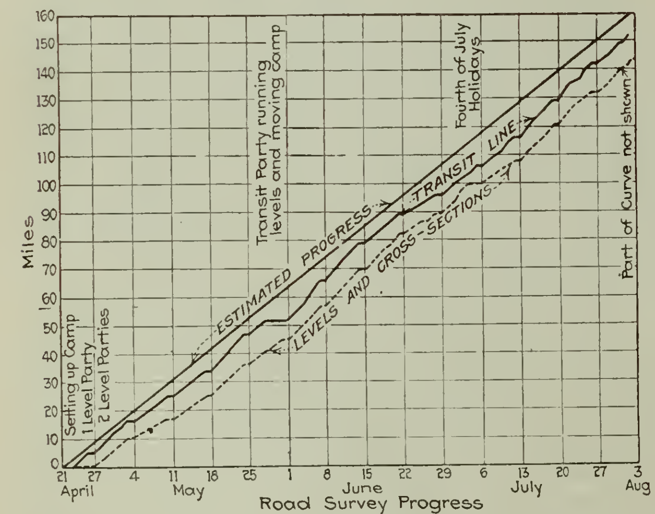
Illinois now has three registration laws, applying to structural engineers, architects and land surveyors. As the last applies only in Cook County, owing to population limitations, the State Department of Registration has declined to undertake its administration, and this has been assumed by the county authorities.

Graphical Records for Progress in Highway Surveys

By John E. Fontaine
Field Engineer, Morgan Engineering Co., Memphis, Tenn.

IN *Engineering News-Record* of Feb. 12, under the heading "Graph Records Progress of Road Survey Parties," R. T. Brown describes an excellent system of progress reports. The writer has used graphical reports for a number of years but has found that the plan of platting the curves in the office as a record for the chief engineer does not fully realize the possibilities of the graph. The object of recording the progress of surveys is, of course, to enable the proper officials to keep in touch with the work of the field men and to remedy any failure on their part to maintain the standard rate ... for them. Some pre-determined rate of speed is necessary for any intelligent criticism of a progress curve, and this is made the basis of the scheme for a progress curve used on a recent road location survey in Arkansas.

The plan in brief is as follows: The field engineer is required to submit an estimate of the rate of progress to be attempted on the survey, and, if this meets with the approval of the chief engineer, it becomes the ideal rate of speed to be sought by the field parties. The field work then becomes a game in which all the field men have a part. Where two or more parties are engaged on the work competition may be stimulated by plotting separate curves for each party. The field engineer makes the game interesting by plotting the day's work after supper and posting all concerned as to their success or failure in keeping up to the standard.



The writer has found this plan highly successful in keeping his party "on its toes" and the result has been a good rate of progress under adverse conditions. The charted progress on the survey referred to is shown. One transit and two level parties were employed on the work. Transit line was run, staked, offset on section lines, and referenced, profile was taken, bench marks set and check levels run, and all the lines were cross-sectioned across a 100-ft. strip. About 30 per cent of the line was in woods and the remainder was over existing roads. Bad weather caused a loss of more than the 25 per cent allowance which was included in the estimate.

Cost-Plus Contracts for Water-Works Construction

By George W. Fuller
Consulting Engineer, New York

Extracts from paper read before American Water Works Association, Montreal, June, 1920

THE writer believes that water-works construction which reasonably can be deferred should not be contracted for at present. In the case of many water-works projects the existing works can with propriety be patched and overhauled in a manner similar to that adopted by the individual who under present stress makes use of old and patched clothes. But some water-works construction must go forward. Under these circumstances it is important to discuss briefly the cost-plus form of contract with a view to seeeing if the burden of uncertainty in some respects cannot be shifted from the contractor to the owner, to the advantage of all concerned. In fact, if construction work is to go forward there are some projects where such steps seem imperative.

Advantages Claimed for Cost-Plus Contracts.—1. The work may be started at any time and is not dependent on the prior completion of the plans.

2. The owner may radically increase or decrease the quantities during construction, with lump-sum fees subject to review.

3. The owner may change the kind of construction during the progress of the work.

4. The contractor will not try to skimp the job, as is often done after finding himself losing under lump-sum or unit-price contracts.

5. There is less need of having accurate preliminary estimates. In unit-price contracts the preliminary estimate is often so approximate as to cause the contractor to gamble on some of the items, with resulting disappointment to the owner in the ultimate cost of the work. Such procedures sometimes cause an unfair result either to owner or contractor or both.

6. Unit-price or lump-sum bids require a set of specification definitions which are not always clear and are sometimes deficient and sometimes overlapping. Such ambiguities may lead to arguments and variations in cost which result in claims and suits for extra work.

7. Cost-plus contracts may save the owner the money which the contractor usually adds to his lump-sum or unit-price bid to cover the complete but actually infrequent enforcement of material tests which cause him delay and expense, or necessitate the carrying of a large stock, entailing interest charges, storage space, rehandling, etc.

8. Cost-plus contracts do away with the substantial sums usualy added in lump-sum or unit-price contracts to cover the following uncertainties: (a) Weather. (b) Foundations. (c) Changes and shortages in labor market. (d) Changes and shortages in material market. (e) Delayed deliveries of materials.

9. For cost-plus work it is the contract and not the specifications which is the crux of the matter from both the owner's and contractor's viewpoint. The writing of the contract is more simple than the writing of the specifications.

10. Cost-plus contracts tend to promote co-operation between the owner and the contractor.

Disadvantages Claimed for Cost-Plus Contracts.—1. There is no way of determining the approximate cost in advance and this upsets budgets where definite appropriations have been made or are required.

2. Competition, the key to efficiency, is killed.

3. Greater opportunity is offered for favoritism on the part of the owner's representative.

4. Where the same contractor has several jobs, the lump-sum and unit-price contracts will get the good workmen and the cost-plus contract will get the drones and misfits.

5. A large general contractor often takes a job on the cost-plus basis and sublets it to several smaller contractors on a lump-sum or unit-price basis. In making the sub-

contractors complete the work on the latter basis the general contractor often treats them unfairly while he himself may be receiving a substantial profit for doing little or nothing.

6. Should work be started before plans are completed, many errors mays have to be straightened out in cases where competent engineers would avoid them if given an opportunity to get out a complete sets of plans and accurate estimates of quantities.

7. Engineers are tempted to be less thorough in their work when they know that there will be no comeback at them on account of extras resulting from their failure to have plans and specifications complete when needed. With cost-plus contracts it may simply be a matter of correcting an error or supplying a deficiency when discovered, but the cost is there just the same, although it may not appear as an "extra."

8. Engineers or other representatives of the owner must do an immense amount of accounting and clerical work in checking payrolls, material bills, etc., and expend much time and energy in expediting the delivery of materials.

9. A premium may be put on extravagances and waste by giving unscrupulous contractors and engineers a chance to take advantage of the owner.

10. The contractor may procrastinate in securing if not refuse to secure adequate tools and equipment as to type and number.

11. A combination of the above disadvantages, although no one by itself may be sufficiently pronounced to permit the owner successfully to obtain relief, may cause grief for the owner, unless protected by a maximum fee to the contractor, and by the assured adequacy of the latter's organization and equipment.

Contract Adjusted to Varying Labor Prices.—Mr. Morris R. Sherrerd, chief engineer of the North Jersey District Water-Supply Commission, in a recent [proposed] contract for the construction of the Wanaque dam provided for an adjustment of certain labor costs after the year 1920, if such costs were 10 per cent above or below normal 1920 prices. This places the burden of changes in material costs on the contractor, but causes the owners to share with the contractor unusual changes in labor costs. The advantage of this type of contract as to labor over cost-plus agreements lies in the fact that the contractor is compelled to exercise the same careful supervision and that there is the same necessity for economical construction methods as is required on lump-sum and unit-price agreements, but he is not obliged to shoulder all responsibility for unexpected price changes.

In the Wanaque dam contract, labor is a controlling item, but on ordinary construction work, particularly on comparatively small jobs, and where the value of labor and material are more nearly equal, there would be less advantage in it. To be more generally applicable the adjustment in prices should, if possible, include material as well as labor, and furthermore the length of time between successive adjustments should also be made to conform to the size of the contract and to the probable duration of construction.

The adjustment of prices is more difficult in the case of materials than for labor, because of the greater number of materials and also because of the variety of materials which might satisfy any particular specification. On this account the furnishing of the principal materials to the general contractor through separate contracts made by the owner may be advantageous in that the risk would be more widely distributed and the adjustment of prices made somewhat more simple and definite.

At a time when transportation facilities are abnormally inadequate the assumption by the owner of the responsibility of furnishing materials cannot eliminate wholly the troubles arising from the enforced intermittent use of the contractor's laborers.

Summary and Conclusions. — Pre-war construction contracts were for the most part, and rightly so, agreements on a lump-sum or a unit-price basis. Cost-plus contracts were used only on certain large work done for private corporations or as a part of other types of agreements.

2. During the war the United States Government construction and much other work was done on a cost-plus basis. Where proposals on a lump-sum or unit-price basis were obtained, the prices were intended to be sufficiently high to insure against loss due to constantly changing prices and the scarcity of labor and material.

3. Since the war, the procedure has been somewhat unsettled, with an effort to do away with some of the disadvantages of cost-plus form and to combine so far as possible the good qualities of both types of contracts.

4. The unit-price contract, under normal stable market and transportation conditions, is the most satisfactory. The lump-sum contract is principally advantageous in that the final cost is definitely known at the outset.

5. Cost-plus contracts, with proper provision for accounting and supervision, may be satisfactory where conditions are not definitely known and in the case of private corporations where well qualified contractors may be selected to work under adequate supervision. Under war conditions cost-plus contracts were necessary and even now they have many advantages.

6. Construction work for private corporations may be successfully carried out with proper safeguards under any of the discussed forms of contract. For general construction work under municipal control the nearer a contract approaches the well-established lump-sum or unit-price contracts, if indeed any departure from such contracts is legal, the more satisfactory will be the results secured.

7. Until such time, however, as the material and labor markets are better established, contracts should in fairness place the burden of uncertainty on the owner and not on the contractor. This may be done as follows: (a) For much municipal work a form of contract may be adopted along the lines proposed by Mr. Sherrerd, and modified as suggested as to labor and material adjustments at proper intervals. (b) For municipal or other work contracts may provide for the furnishing by the contractor of such labor and materials as are reasonably stable, with adjustment for changes in the labor market, and with materials of unstable price furnished by the owner through separate contracts.

8. Construction work not absolutely necessary should be deferred, and materials and labor should be diverted so far as possible to work which is absolutely necessary.

9. So far as possible necessary improvements should be made repairing or enlarging present works, and new works should be confined for the present to immediate needs.

Government Standardization in the Building Field

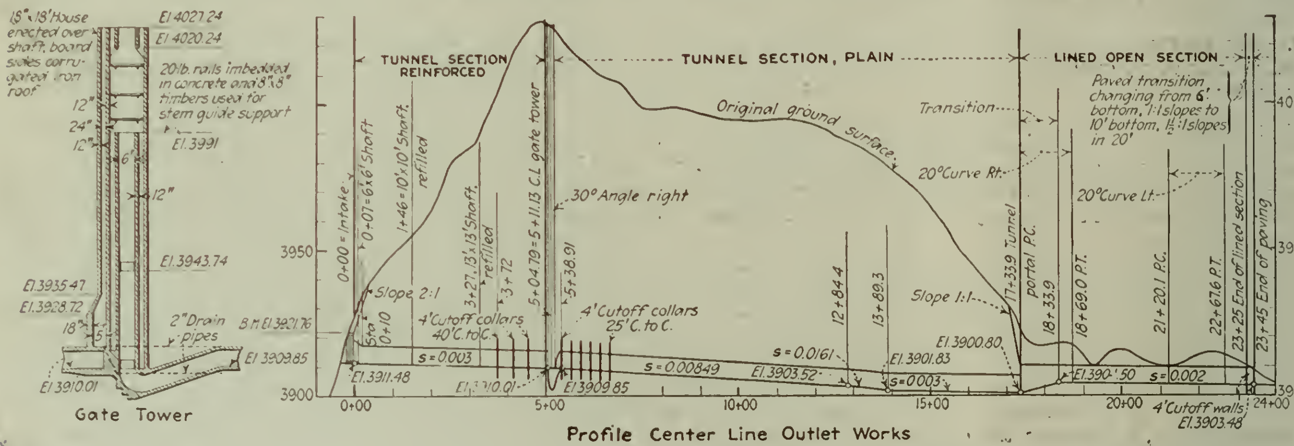
If standard specifications could be prepared and agreed upon in a much larger number of cases than has yet been done, it would greatly facilitate the work of architects and builders. And if building methods and the requirements of city building codes could be thoroughly studied and revised this also would aid in reducing building costs. It seems probable that hundreds of millions of dollars could be saved within a few years if a comprehensive and intelligent study were made of all phases of building including fire prevention and the plumbing, heating, lighting, and hardware equipment of buildings. It would also reduce the cost of repairs and maintenance of these buildings; partly because deterioration would be slower and failures would be less frequent, and partly because repairs would be easier and cheaper to make. The government would do only a portion of this work of research and standardization, as many engineering societies, industrial organizations and manufacturers would co-operate. But the government should take the lead, and do an important part of the research work, and nothing which the government could do would be more useful and constructive or would be more appreciated by the building industries and the public.—From an address by E. B. Rosa, chief physicist, Bureau of Standards, on "The Economic Importance of the Scientific Work of the Government."

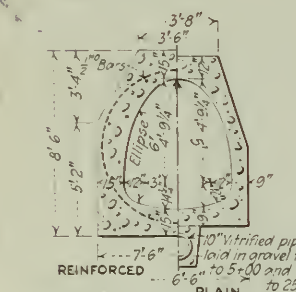
Mountain Lake Siphoned Down To Connect Tunnel Outlet

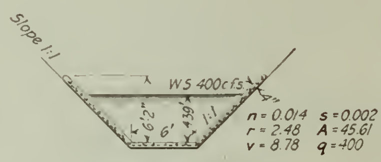
By F. T. Crowe
Manager Flathead Irrigation Project, St. Ignatius, Mont.

A SURVEY of storage possibilities on the Flathead Irrigation Projects, U. S. Reclamation Service, Montana, showed that the creek leading from St. Mary's Lake (renamed Tabor reservoir) was so located and had so rapid a fall that by driving a tunnel 1,750 ft. long with its outlet in the bed of the creek the lake could be tapped at a point 76 ft. below the normal water surface. By placing control gates in this tunnel a storage basin of 12,500 acre-ft. capacity could be secured—one of eight reservoirs on the project.

Two construction problems were apparent: (1) How to meet the danger of encountering such a flow of water in the heading of the tunnel as it approached the lake, with its water surface 76 ft. above the tunnel, that further tunneling would be impossible; and (2) what method of breaking the tunnel through into the lake should be used?







PROFILE AND SECTIONS OF TABOR RESERVOIR OUTLET TUNNEL, FLATHEAD PROJECT, MONT.

To connect the outlet tunnel with the inlet at the lake bottom so as draw this natural lake down 76 ft. the outlet tunnel was carried from its lower end to a point beneath the shore line, a shaft sunk, and the water siphoned off to depth 26 ft. This process was twice repeated; until the water was only 8 ft. above the top of the tunnel, when a hole was blown through from the tunnel heading to the lake bottom.

Test pits and borings indicated that the lake bed was covered with a coating of blue clay and that the tunneling, up to a point about 50 ft. from where it entered the lake, would be through a glacial moraine of sand, gravel and cobble rock. Stream gagings on the outlet creek indicated a flow of from 12 to 150 sec.-ft., the large flow occuring during May, June and July when the deep snow in the mountains was melting.

The construction plan decided upon was to start tunneling at the outlet portal and, if successful, to proceed to a point immediately below the shore of the lake at the high-water line, and to sink a shaft at this point to connect with the tunnel. The next step planned was to place two 24-in. riveted steel siphons, one leg extending out into the lake to a depth of 26 ft., and the other leg down the shaft to the tunnel, having valve control on the lower end. By the operation of these two siphons it was proposed to lower the lake approximately 26 ft. While this was being done the tunnel was to be carried forward until it reached a point immediately below the new shore line, 26 ft. below the normal water surface. Then another shaft was to be sunk at this point to connect with the tunnel. With this accomplished, and the siphons changed to the new shaft, the lake would be lowered an additional 26 ft. The tunnel would then be advanced and a third shaft sunk, the siphons reinstalled and the water lowered to a point about 8 ft. above the top of the tunnel. At this point a heavy shot would be placed in the heading, of sufficient strength to blow an opening to the lake bottom and permit the water of the lake to flow directly through the tunnel.

Tunneling was started in September, 1916, and progressed favorably until reaching a point approximately 500 ft. from the outlet portal, where a body of quicksand approximately 50 ft. through and discharging about 2 sec.-ft. of water was encountered. The heading was immediately breast-boarded and an attempt made to push ahead one board at a time. However, the pressure was so great and the sand so liquid that the later would squirt through any small hole in the heading so rapidly that it was found impossible to use any ordinary methods. Pipes were driven in in an effort to carry off the water and render the sand more stable. This was of no avail. The pipe clogged and became useless.

As a last resort, the heading was driven full of 4- to 6-in. jack-pine poles, about 14 ft. long. This permitted the water to run out between the poles but retarded the sand flow. By driving these ahead as the tunneling advanced and sheeting up absolutely tight and placing heavy timbers under the mud sills the tunnel was driven through the quicksand to the gravel formation which continued until the blue clay was reached under the lake.

Upon reaching the lake shore the tunnel was lined with concrete and siphons installed and placed in operation.

It was anticipated that perhaps some difficulty would

DOUBLE SIPHON LOWERING LAKE LEVEL

be encountered in priming the siphons when the lift was high but this was not the case. With a 2½-in. Pemberthy injector attached to a 20-h.p. boiler carrying 100 lb. steam pressure, it could be primed in seven minutes. The two siphons had a combined maximum flow of 125 sec.-ft.

The general construction scheme of unwatering the lake was followed as outlined with no serious difficulty, the lake being lowered in 150 days.

The high-pressure cylinder gates designed for this outlet by J. M. Gaylord and J. L. Savage, of the Denver office of the U. S. Reclamation Service, are tight and work with ease, having no serious vibration or rotating tendency, as is sometimes encountered with this type of gate.

The work was done under the supervision of the writer, assisted by F. F. Smith, resident engineer, and T. S. Martin, general foreman.

Economies in Car Repair Shop Design

POSSIBILITIES of great economy in the work of railway car repair shops by introducing mechanical handling equipment, in order to reduce manual labor, were suggested in a report and discussion on repair shop layouts at the annual meeting of the mechanical section of the American Railroad Association. The expensive results of a tendency to try and get along with present facilities were pointed out by C. E. Fuller, Union Pacific R.R., who said that economy lies in immediate action to secure adequate facilities for handling work and materials. In his opinion, the cost of work done by hand labor at present wages is not sufficiently realized.

Traveling cranes and gantry cranes will handle material and lift cars, thus reducing trucking and the slow and costly work of jacking cars by hand. With hand trucking, several men are likely to walk with the truck to help in unloading, although one or two men do the pulling. A tractor and truck service would effect a great saving in time and labor cost. Paving the standard gage material tracks, which alternate with the repair tracks in shops and yards, was recommended by the report in order to form roadways for tractor haulage.

The design of the repair shops will depend largely upon the crane equipment and the report recommends that the design should be handled jointly by the engineering and car departments. Whether car repair work should be done in shops or under sheds or in the open yard depends largely upon climatic conditions. It was pointed out by F. F. Gains (Railway Board of Adjustment) that even in the south the winter temperature is relatively low and men can work better in a closed shop properly heated. An indirect heating system can be utilized to supply cool air in summer. Men who have to work without shelter from snow, rain, wind and hot sun produce little effective work. Even a closed shop should be heated in winter so that the men can work in comfort. Plans for a plant with closed shops for turning out 100 cars daily were submitted, the plant to be built in units for 25 cars each. With 25 car spots or repair points, the output will be four and eight cars daily for heavy and medium repairs respectively; for light repairs, 50 spots can turn out 50 cars per 8-hour day.

More Tests on Concrete Elasticity

LAST YEAR at the American Society for Testing Materials meeting Stanton Walker presented a long paper on the modulus of elasticity of concrete as revealed in a great number of tests. Before the recent meeting a paper giving some further information on concrete elasticity was read by G. M. Williams of the United States Bureau of Standards, under the title of "Some Determinations of the Stress Deformation Relations for Concrete Under Repeated and Continuous Loading." Special attention in the tests was paid to the question of wetness or dryness in concrete. The conclusions are as follows:

1. The true stress deformation relations for concrete under loads even exceeding designing loads and loads applied in practice and up to 50 or 75 per cent of the ultimate strength may be represented by a straight line.

2. For a few specimens, composed of lean mix or very wet consistency concrete just removed from damp sand storage, it was found that the increment of deformation per increment of load for the first application of load only could be represented by an equation of the exponential type, but second and additional applications of loads resulted in a straight-line relation.

3. For ordinary working loads and up to 50 to 70 per cent of the ultimate strength of the concrete, 95 per cent of the value for modulus of elasticity obtained by dividing the unit stress by the unit deformation for that load will represent the true modulus with sufficient accuracy.

4. The modulus of elasticity for normal concretes is the same for any given material in either the wet or dry condition.

5. The modulus of elasticity is apparently increased slightly for repeated or long continued single applications of loads. The modulus of elasticity of concrete in a structure subjected to loads within design limits is probably slightly greater than the value found from tests of cylindrical specimens of the same concrete. The stress-deformation relation under such conditions can be represented by a straight line.

6. With any given cement and grading of aggregate of the same maximum size, and for any given proportion of cement to aggregate, the ratio of modulus of elasticity to compressive strength of concrete is fairly constant regardless of consistency or flowability.

Stanton Walker, of the Structural Materials Research Laboratory Chicago, disagreed with the conclusion that the stress-deformation curve of concrete is linear below the elastic limit and defended the curvilinear relation as observed in the tests reported in the paper noted above. He further observed that he could find nothing in the tests to justify conclusion No. 3 noted above.

Surface Area Measured by Maximum Bulking of Sand

Tests Establish Value of Readily Obtained Factor for Use in Proportioning Concrete Mixtures

IN ONE of the several recent theories of rational concrete proportioning use is made of the surface area of the aggregate as a basis of cement measurement. Hitherto this area has been determined by a combination of mechanical analysis with a rather laborious grain counting. In a long series of tests in the laboratory of the Hydro-Electric Power Commission of Ontario it has been found that this area appears to be a function of the volume bulking of the sand under water additions, and this bulking is suggested as a ready measure of the surface areas of aggregates for use in proportioning concrete. The subject is discussed by Roderick B. Young and W. D. Walcott of the Hydro-Electric Power Commission in a paper before the recent meeting of the American Society for Testing Materials. An abstract of the paper follows:

When a sand increases in volume because of an increase in its moisture content, it may be said to "bulk." Bulking is expressed quantitatively as a percentage or ratio. "Sand" is used in its commonly accepted sense: namely, a fine aggregate derived from a natural source all of which will pass, when dry, a screen having circular openings ¼ in. in diameter. "Silt" as here used means that very fine material in a sand which will pass a No. 150 sieve. Mechanical analyses were made of each sand from carefully prepared samples taken by the method of quartering. The sieves used were a perforated plate having ¼-in.- diameter openings and Tyler's Nos. 6, 10, 20, 35, 65, and 150. Grain counts were carried out on each size of separation for a representative sand from each locality and from these counts and the specific gravity, the surface area was obtained using the formula

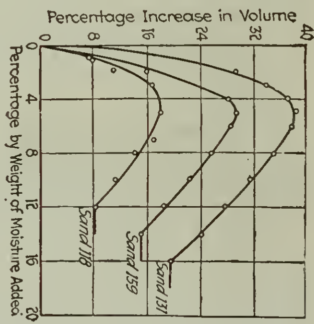


FIG. 1. RELATION BETWEEN MOISTURE CONTENT AND BULKING IN SAND

$$A = 236.1\sqrt[3]{\frac{n}{S^2}} \qquad (1)$$

where A = surface area in square feet per 100 lb., S = specific gravity of the sand, and n = number of grains per gram in any size of separation.

The increase in volume resulting from additions of moisture was obtained indirectly by determining the weight per cubic foot of the material first dry and then moist. Both ⅓ and ¼-cu.-ft.-capacity cubical measures were used at different times. The measure was filled by means of a cylindrical shell, open at both ends. This was placed in the measure, filled with the sand under test and slowly withdrawn. The capacity of the cylinder being slightly greater than that of the measure, an excess of material remained in the latter when the cylinder was removed. This excess was struck off with a straight edge. Several determinations were made on each sand and the results averaged. It was found that the method gave concordant results.

To obtain sands of different degrees of moisture a predetermined amount of water was added to the dry sand and thoroughly worked into it by kneading.

Knowing the weight per cubic foot of the sand both dry and moist, the percentage increase in volume due to the added moisture was calculated from:

$$P = \frac{W_1(1+r) - W_2}{W_2} \times 100 \qquad (2)$$

where P = per cent increase in volume, r = ratio of water added to weight of dry material, W_1 = weight per cubic foot of dry material, and W_2 = weight per cubic foot of moist material.

Fig. 1 shows the percentage increase in volume obtained in this manner for three sands: a fine, a medium and a coarse. The mechanical analyses of the same sands are shown in Fig. 2. These curves are representative.

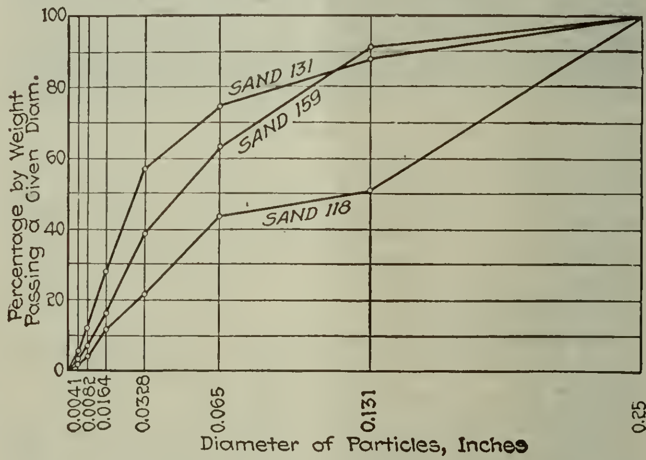


FIG. 2. MECHANICAL ANALYSES SHOWING RANGE OF SAND USED IN INVESTIGATION

A study of these tests revealed the interesting fact that the maximum percentage increase in volume, or bulking, is related to surface area. When plotted against surface area the points fall approximately on a straight line (Fig. 3). The equation of this straight line is

$$A = 40.6\,x + 180 \qquad (3)$$

in which A = surface area in square feet per 100 lb. and x = maximum increase in volume in per cent.

It may seem odd that the relation between bulking and surface area is independent of the percentage of water used to cause it. This would not be so were it not for the varying silt contents of the sands. Fig. 4 shows a relation between bulking and surface area for one, two and three per cent additions of water. However, to show this relationship it was necessary to plot only results from sands having approximately equal silt content. Other sands of different silt content would not conform to these curves.

Any silt contained in a sand will commence to absorb moisture as soon as water is added. This absorbed water takes little or no part in the bulking phenomenon. It is the moisture in excess of that absorbed by the silt that causes changes in volume. Sands of equal surface area but containing different percentages of silt will bulk differently for the same percentage of additions of water up to nearly the point of maximum bulking. At that point the variable effect of different silt contents is compensated for.

Experiments were also carried out upon sands having particles of uniform size. These sands were all prepared from one material by sieving it into its different sizes. Volume-moisture studies were then made

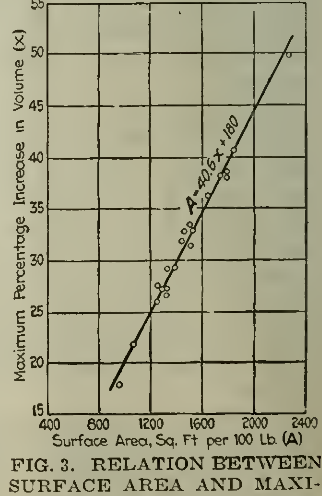


FIG. 3. RELATION BETWEEN SURFACE AREA AND MAXIMUM BULKING FOR GRADED SANDS

on each size. These experiments also showed maximum bulking to be related to surface area. But it was found that this relation did not follow the same law as with graded aggregates. It was found that sands coarser than that passing the No. 6 sieve did not increase in volume with additions of moisture. It is thought that the reason for this is that the weight of the particles of these large sizes is sufficient to overcome the separating effect of the film of water surrounding the moistened particle. This explanation has not as yet been tested out experimentally. A few experiments were made with mixtures of sand and gravel. Only one sand and one gravel were used but these were mixed in different proportions. Here also a relation between bulking and surface area was found. Successive additions of gravel decreased the percentage of maximum bulking in the same ratio as it decreased the surface area. Fig. 5 illustrates the results of these few tests. It is at once apparent that if the laws here indicated are general, the maximum bulking of sand or of a sand-gravel mixture could be determined if its surface area was known; conversely its surface area could be determined if its percentage of maximum bulking was known. It is evident, however, by the behavior of "one-size" materials that these relationships are not perfectly general since the large-size particles take no part in the bulking phenomenon.

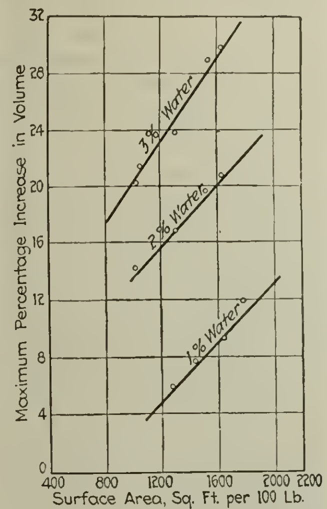


FIG. 4. RELATION BETWEEN SURFACE AREA AND BULKING FOR DIFFERENT MOISTURE CONTENT

An experimental study of the limitations within which the conclusions hold have shown that the following is approx'mately true:

1. Extremely coarse sands, sands in which over 60 per cent by weight will not pass the No. 10 sieve, give results higher than those obtained by mechanical analysis. Sands of these characteristics usually have surface areas less than 1,000 sq.ft. per 100 lb. They will usually be detected immediately by an experienced observer.

2. Extremely fine sands, sands in which 50 per cent passes the No. 65 s'eve, give results lower than those obtained by mechanical analysis. The sands are really "one-size" materials and usually contain a high percentage of silt. They have surface areas in excess of 2,000 sq.ft. per 100 lb. As in the case of the coarse sands they can usually be detected by examination

Silt, when present in excess of seven or eight per cent, affects the accuracy of the results to some extent. For percentages lower than this, the effect of the silt is compensated for by the adoption of the point of maximum bulking. Most sands acceptable for concreting purposes fall within the limits stated. This being so, the relationship between bulking and surface areas has two very valuable applications in the science of concrete proportioning:

1. Knowing the surface area and the moisture content the changes in volume in the aggregate can be determined and proportions corrected accordingly.

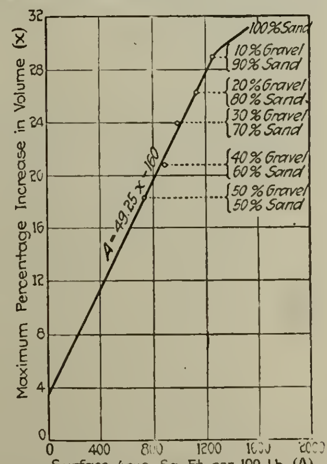


FIG. 5. SURFACE AREA—BULKING RELATION FOR MIXTURE OF SAND AND GRAVEL

2. Knowing the maximum increase in volume of a sand due to contained moisture, the surface area of that sand is at once obtainable.

While the first of these is impoitant, it is not the subject of this paper and will not be elaborated upon. The second will be taken up at some length.

A method of obtaining the surface area of an aggregate which is both simple and rapid can be based on this relat'onship between the maximum bulking and surface area.

The weight per cubic foot of the sand to be tested is first determined dry and again after the addition of different percentages of moisture. The additicns found to be best are four, five and six per cent of the dry weight of the aggregate; the maximum bulking usually occurring in this range, except for coarse sands free from silt when it may occur at as low as three per cent. The weight per cubic foot with the lowest percentage of moisture is first obtained; the last two percentages of moisture are then obtained by adding in each case the necessary extra water. The loss of moisture by this procedure has been found to be negligible. Applying successively Eqs. 2 and 3 to these results gives the surface area per 100 lb.

The equipment required is simple. That used by the writers consisted of a ⅓-cu.-ft. capacity cubical measure, a ¼-in. sieve to separate the fine and coarse aggregates, a small platform scale, and minor incidentals such as scoop, straight edge, glass graduate, etc. This apparatus may be varied somewhat to suit circumstances or the whims of the user without affecting the results.

Compared with the combined mechanical analysis and surface area calculations, the method is the acme of simplicity. It is rapid, inexpensive, requires a minimum of equipment and skill to carry out, and can be made to give accurate results.

The accompanying table shows results obtained by both methods. Here are tabulated concrete sands having, as is evident from their surface areas, a wide variation in grading. The maximum difference between their surface areas as determined by sieve analysis and grain counts and as determined by the bulking test is approximately 3.7 per cent while the average difference is only 1.77 per cent. This degree of accuracy is within the probable error of the sieve-analysis method.

COMPARISON OF RESULTS OBTAINED BY MECHANICAL ANALYSES AND BULKING METHODS OF DETERMINING SURFACE AREA OF SANDS

			Surface Area Sq.Ft.		Difference	
Sand No.	Source	Maximum Bulking, Per Cent	Mechanical Analyses	Maximum Bulking	Sq.Ft.	Per Cent
106-1	Niagara Falls, Ont.	33.1	1,515	1,524	+ 9	+ 0.59
106-2	Niagara Falls, Ont.	31.5	1,494	1,460	—34	— 2.28
106-5	Niagara Falls, Ont.	32.7	1,454	1,508	+54	+ 3.71
118	Buffalo, N. Y.	18.0	945	911	—34	— 3.60
128	Nipigon, Ont.	21.7	1,054	1,062	+ 8	+ 0.75
130	High Falls, Ont.	38.1	1,734	1,727	— 7	— 0.40
131	High Falls, Ont.	38.5	1,777	1,734	—43	— 2.42
136	Nipigon, Ont.	25.9	1,238	1,232	— 6	— 0.48
137	Nipigon, Ont.	29.2	1,324	1,366	+42	+ 3.17
141	Nipigon, Ont.	33.6	1,500	1,545	+45	+ 3.0J
143	Nipigon, Ont.	40.7	1,805	1,830	+25	+ 1.39
149	Niagara Falls, Ont.	31.9	1,436	1,476	+40	+ 2.79
150	Niagara Falls, Ont.	27.4	1,256	1,292	+36	+ 2.86
154	Niagara Falls, Ont.	26.7	1,299	1,264	—35	— 2.70
155	Niagaia Falls, Ont.	36.1	1,631	1,647	+!6	+ 0.98
159	Niagara Falls, Ont.	29.3	1,368	1,370	+ 2	+ 0.14
161	Nipigon, Ont.	27.2	1,273	1 285	+12	+ 0.94
178	Havelock, Ont.	33.5	1,513	!,540	+27	+ 1.78
183	York, Ont	27.3	1,304	1,289	—15	— 1.15
184	York, Ont	49.7	2,264	2,260	— 4	— 0.17
	Average					1.765
	Coarse Sands					
106-L1	Crushed Rock	21.6	717	1,057	+ 340	+47.40
107	Niagara Falls, Ont.	28.2	1,145	1,325	+ 180	+15.72
129	Nipigon, Ont.	24.6	1,003	1,179	+ 176	+17.55
151	Niagara Fal.s, Ont.	23.3	866	1,126	+ 260	+30.07
	Fine Sands					
106-4	Niagara Falls, Ont.	40.6	2,079	1,828	— 251	—12.05
134	Nipigon, Ont.	40.2	2,420	1,812	— 608	—25 12
144	Nipigon, Ont.	41.3	2,446	1,857	— 589	—24.05
157	Niagara Falls, Ont.	37.9	2,888	1,719	— 1,169	—40.04

The bulking test does not agree with the standard method for obtaining surface area with very coarse sands, very fine sands or with sands high in silt. This has already been touched upon. The table shows a number of such sands and the results obtained using both methods. It is thought by the authors to be extremely likely that the surface area determined by the bulking test may be a better measure of the concrete-making properties of the sand than the values obtained from the sieve analysis.

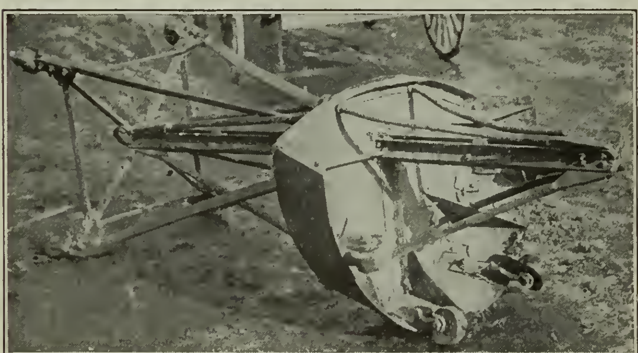
The bulking method has one weak point and that lies in its basic test—the one for the weight per cubic foot. This test is more subject to the personal equation of the operator than is the sieve analysis. It is believed that the rodding method of determining the weight per cubic foot—the method the Society is now considering for adoption as standard—would to a large extent overcome this drawback. Before the rodding test could be used it would be necessary to establish the proper equations linking surface area and maximum bulking; the equations given in this paper only hold for the methods described.

The presence of mica in a sand introduces an interesting problem. Any considerable quantity alters the specific gravity of the material (the number of grains per gram) and hence the unit areas for the different sizes of separation. These unit areas will depend to some extent on the quantity of mica present so that surface areas calculated from them do not give values comparable to similarly graded sands free from mica. The bulking test has been found to give the better value in such cases.

In conclusion, we should like to point out that the tests here presented seem to bear out the contentions of Edwards and ourselves that surface area must be taken into account in any method of proportioning concrete mixtures. It is the opinion of the authors that this bulking of particles occurs in concrete mixtures and that a study of the bulking phenomenon in concrete and its relation to grading of the aggregates as measured by their surface area will throw much light on some of our present difficulties in determining a satisfactory method of proportioning concrete.

Automatic Sewer Cleaning Outfit

Large sewers in Salt Lake City are cleaned by the machine shown in the photograph below. It is built of structural shapes and has wheels which keep the scoop from contact with the bottom of the sewer. Ropes are attached to both ends of the machine for recovery in case of any unusual obstruction. Ordinarily the sewage will carry the machine through from one manhole to the next without any pull on the rope.



SEWER CLEANING SCOOP IS PUSHED BY THE SEWAGE

The Salt Lake Sewer Department has three of these scrapers—for sewers ranging from 42 to 64 in. in diameter. They work best when the diameter of the disk is 1¼ in. less than that of the sewer thus restricting the flow past it to a ⅝-in. annular space. The maintenance of sewers is under L. H. Krebs, engineer of sewers who reports to S. Q. Cannon, city engineer.

Cost of Water for Public Purposes at Rochester, N. Y.

THE total "cost" of water supplied for public uses by the water-works of Rochester, N. Y., is $264,624 a year, according to figures compiled by Stephen B. Story, engineer Rochester Bureau of Municipal Research, in the course of a survey of the Water Bureau of that city. These figures were presented in some detail by Mr. Story before the convention of the American Water Works Association at Montreal, June 22 to 24, in the course of a paper on "The Revenue Chargeable to Public Uses of Water in Rochester."

As early as Jan. 1, 1877, or one year after the Rochester water-works were put into operation, J. Nelson Tubbs, chief engineer, recommended that the city pay for water the same as any private consumer would pay. Apparently it was not until 1917 that the city authorities recognized the justice of this principle and put it in partial application by crediting the Water Bureau $70,000 for water supplied to the Department of Public Works. Like credits have since been made for other city departments, but the total of the credits has reached only $126,000 thus far, compared with the $264,624 value of water actually supplied—assuming 10c. per 1,000 gal. to be a fair charge. The actual credits, Mr. Story says, are based on "guess work."

On the basis of 10c. per 1,000 gal. the water for public services passing through meters is worth $20,104.34. Unmetered water supplied for public uses, on the same basis, is worth $46,010. Rebates to charitable institutions total $15,000 and free water supplied to a school is valued at $3,000. The estimated value of the fire protection service, taking capital charges into account, is $180,510.

The accompanying table gives the estimated quantities of unmetered water supplied for public purposes, with the basis of the estimates:

ESTIMATES OF UNMETERED WATER FOR PUBLIC USE; CITY OF ROCHESTER, N. Y.

Item	Purpose	Quantity, Gal.	Cost at 10c. per 1,000 Gal.
A	Street flushing (by hand)	600,000	$60
B	Street flushing (by machine)	100,000,000	10,000
C	Street sweeping (by machine)	500,000	50
D	Street sprinkling	220,000,000	22,000
E	Sewer flushing (house laterals)	3,400,000	340
F	Sewer flushing (sewer laterals)	500,000	50
G	Sewer flushing (main sewers)	100,000	10
H	Snow removal flushing	3,000,000	300
I	Drinking Fountains	1,000,000	100
J	Horse troughs	110,000,000	11,000
K	Parks and playgrounds	20,000,000	2,000
L	Exposition park	1,000,000	100
		460,100,000	46,010

Item A. Street flushing (by hand).
Measurements of water used for hand-flushing using 2½ in. hose, 1 in. smooth nozzle. Hydrant pressure averaged 30 lb. 1,000 gal. per 1,000 sq. yd. Figures for area flushed from Street and Sewer Bureau.

Item B. Street flushing (by machine).
Six working days per week; 30 weeks per year.
Tank capacity flushed No. 1, 1,250 gal.; 29 fillings a day.
Tank capacity flushes No. 2, 1,500 gal.; 41 fillings.
Tank capacity flusher No. 3, 1,500 gal., 44 fillings.
Four wagon flushers with 60-gal. tanks, 56 fillings each per day.
Add margin for waste in filling.

Item C. Street sweeping (by machine).
Two Austin Machine Sweepers, 1,200 gal. per day, 200 working days.
Add margin for waste in filling.

Item D. Street sprinkling.
Six days per week; 30 weeks in season.
Forty tanks filled 40 times per day. Tank capacity, 750 gal. Allow margin for wastage in filling and temporary hydrant valves.

Item E. Sewer flushing (house laterals).
Sixteen hundred laterals flushed per year; 15 minutes per flushing is average time water is on. Hose and nozzle at 150 gal. per minute.

Item F. Sewer flushing (sewer laterals).
One hundred sewer laterals flushed per year· 30 minutes per flushing is average time water is on. Hose and nozzle at 150 gal. per minute.

Item G. Sewer flushing (main sewers).
Eleven sewers flushed per year. Sixty minutes per flushing is average time water is on. Hose and nozzle at 150 gal. per minute.

Item H. Snow removal flushing.
Varies yearly with amount of snow fall.
Estimate 30 days flushing at 100,000 gal. per day.

Item I. Drinking fountains.
Metered flow of fountain set up in meter shop was 25 gal. per hour. Run for five months per year. Twelve fountains of this type attached to fire hydrants around city.
Item J. Horse troughs.
Metered flow of one trough at 1,500,000 gal. per year. Seventy-five troughs operating all year in city.
Item K. Parks and playgrounds.
Estimate based on consideration of playgrounds and parks being about half metered.
Item L. Exposition Park.
Estimate well within the actual use.

Pay of Engineering Educators

Abstract of Paper by F. H. Newell, Professor, Civil Engineering, University of Illinois, Before Annual Meeting of Society for the Promotion of Engineering Education.

IN CONSIDERING adequate pay for teachers in engineering colleges it is necessary to have some base level of par value from which there may be a departure either above or below par to meet the varying conditions. This base level should be a plane of departure equivalent to the living wage upon which a man who devotes his entire time to the profession can find support for himself and his family. Reduction of the money wage below the base salary may be considered whenever, in addition to money wages, other valuable consideration is received. An increase above the base should be by stages or steps relatively small but taken at short intervals of one or two years and thereafter greater and the steps longer so as to clearly mark out the man of distinct ability.

Low rates of pay have resulted in a large proportion of instructors having to live beyond their means and necessarily going into debt. If engineering educators as a whole are underpaid the fact is due more to their lack of skill in bargaining than to the law of supply and demand. While the law of supply and demand is undoubtedly operative, its effect is largely concealed by other forces. The demand for engineering education as a commodity is reflected by the demand for graduates, since many graduates, new and untried men, are being offered more pay by prospective employers than their experienced instructors are receiving. A certain rate of pay having been acquiesced in during a long period now has an almost binding effect. The bargaining power of the individual educator must be increased and he must acquire the proper confidence in himself to drop the apologetic air of the under-valued man.

A salary schedule, embodying the base-level principle, similar to the schedule for engineering teachers reported by the committee of the American Association of Engineers at its annual meeting May 11, 1920, should be carefully considered and formally adopted by bodies representative of engineering educators and by societies of practising engineers. Such a standard is urgently needed in order that the public in general and particularly the governing boards of engineering colleges may have something by which to measure the kind of men they are getting and keeping. Without some such basis or common ground to start from all discussions of relative rates of pay become vague. By having such a standard, it may be possible to bring about a change in the attitude to the public, aided by publicity.

Engineering instructors, to be successful, must have a large measure of the spirit of self-sacrifice, and unselfish devotion for the good of their students, but they should not be compelled to seek outside employment or income from investments or depend upon the efforts of members of their families to enable them to secure a living. The public demands that the output of engineering colleges shall be of the highest possible quality, and there is not the proper confidence in the product turned out by cheap men. If there is agreement with the statement that the most critical problem in engineering today is to obtain a sufficient number of competent teachers, definite action should be taken in the matter of compensation. The promotion of engineering education becomes impossible unless these fundamentals are given proper attention. Individually, engineering educators can support the efforts of the American Association of Engineers in their behalf. Collectively, they can endorse the standards proposed by its committee. Unless definite steps are taken by engineering teachers to "speak for themselves" they cannot expect the support or sympathy of the public. By viewing the matter squarely and by taking action definitely the standard of engineering education may be raised and the object for which the Society for the Promotion of Engineering Education was formed can be carried out in the most definite manner.

Railway Water Service Organization

A COMPREHENSIVE organization for a railway water service department, proposed in a report by A. B. Pierce, engineer of water supply of the Southern Railway System, and designed as an aid in reducing water waste to a minimum, is shown in the accompanying chart. It is estimated that it would effect an annual saving of about $119,000 by checking water waste and securing more efficient operation of water stations. Special features of the plan are provisions for four inspectors and for daily reports by the pump men, these reports being compiled into monthly statements which are sent to the engineer of water supply. Stress is laid upon these two features by Mr. Pierce as he believes that few railways have such a complete system.

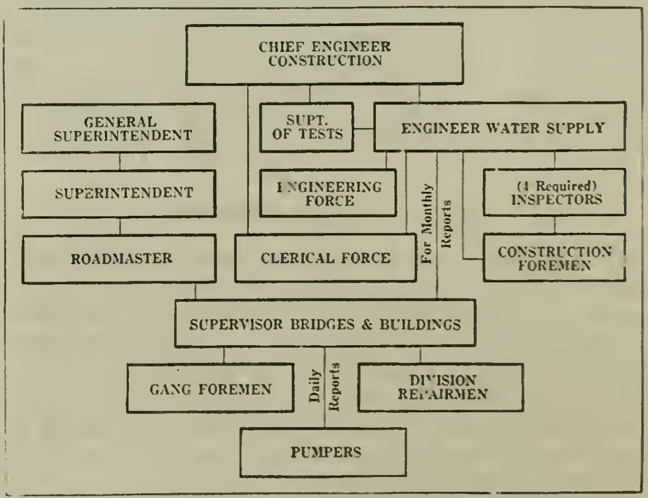


CHART OF A RAILWAY WATER DEPARTMENT

This plan differs somewhat from the one proposed by C. R. Knowles, superintendent of water service of the Illinois Central R.R., and shown in *Engineering News-Record* of April 1, 1920, p. 676. The Southern Ry. plan adds the inspectors and the daily reports but does not provide for a supervisor of water service, such a position being considered unnecessary with the proposed scheme of organization.

Notes from Foreign Fields

CONSTRUCTION METHODS IN ENGLAND

BY

E. J. Mehren

EDITOR ENGINEERING NEWS-RECORD

THUS far I have not been able to examine personally any construction jobs under way. I have, however, had the good fortune of talking to a number of British contractors and to salesmen of American construction machinery.

We are sometimes told in America that the British contractor uses antiquated methods and is not open to conviction regarding the labor-saving devices developed in the United States for construction work. What I have learned can be summed up in this sentence: Had the British contractor been faced ten or fifteen years ago with the high prices of labor that then prevailed in the United States (and that now prevail in Great Britain), he would have been using just as much machinery as the American contractor is using today.

In other words, the British contractor is wide awake. He knows how to figure a job closely. He knows that labor-saving machinery, competently operated, will reduce construction costs when wages are high. *When wages are high*—that is the crux of the situation, the reason for the difference between British and American construction methods. Before the war *good* construction labor could be secured in Great Britain for seven pence an hour (about fourteen cents of our money, under the pre-war rate of exchange) and with labor—good labor—at that figure we must admit that the use of expensive labor-saving machinery would not be justified. Today, conditions are quite different. Wages have more than trebled and the efficiency is only 50 per cent of what it was. Pick and shovel men now get 2s.1d., or about 50 cents an hour. The British contractor is, therefore, rapidly turning to labor-saving construction machinery.

American Plant Favored

It is apparent, too, that the wide-awake British contractor is very favorably impressed with the type of construction machinery we make in the States. Particularly did I hear favorable comment on the sturdiness with which we are building our construction plant. Such is the demand for it indeed, that an agent for American construction machinery assured me that if he had ten times the amount he is now receiving from the States he could dispose of it at once.

Another indication of what is coming in Great Britain is that English manufacturers are beginning to build types of plant developed in America but hitherto neither built nor used in the United Kingdom. Several firms are putting out their first light revolving steam shovel —on the order of the Thew and the Erie—while one company has completed its first trench digger. The designs are said to copy ours very closely.

One is safe in predicting, therefore, a new era in construction methods in Great Britain. Necessity is a great accelerator, and while so far only the larger contractors are using the American type of devices hitherto not used here, the smaller contractors are certain to follow rapidly.

Vehicular Tunnel Under Thames

Due to the interest now displayed at New York in the proposal to put a vehicular tunnel under the Hudson River, I was very much interested in walking through one of the vehicular tunnels under the Thames—the Rotherhithe Tunnel—a tube 30 ft. in external diameter, with a 16-ft. roadway and two footways, each about 4½ ft. wide. The roadway, under the stream itself, is some 70 ft. below the pavement level at the surface and the grades are less than 3 per cent. On the north side of the river, from which we entered, there are two ventilating shafts and in the tunnel as a whole the greater distance between shafts is about a quarter of a mile.

No restriction is placed upon the type of vehicle that may use the tunnel. We saw horse-drawn carts and wagons of many descriptions, both steam and gasoline-propelled motor trucks and one passenger automobile. The tunnel was not operated anywhere near capacity. There were long gaps in both lines of traffic, so that the speedier vehicles had no difficulty in passing the slower ones.

The roadway is paved with granite blocks, the edges of which are fairly well worn, so that owing to the large amount of horse-drawn steel-tired traffic it was extremely noisy. One had to shout to make himself understood. The atmosphere also was unpleasant, due probably both to the exhausts from the motor trucks and from the dust raised by the vehicles.

My guide said that the installation of a ventilating system had been frequently discussed, but so far no plans had been matured. The use of the tunnel would certainly be far more agreeable with an adequate ventilation system and this brief experience at Rotherhithe was indicative of the wisdom of the engineers of the proposed Hudson vehicular tunnel in laying such great emphasis on the ventilation problem. Here, with a distance of only about a quarter of a mile between shafts, the conditions in the tunnel were far from agreeable. More annoying than the smoke and dust was the noise. From the noise, I assume, we should be practically free at New York, because there would probably be a very small proportion of horse-drawn traffic. Certainly more than 50 per cent of the traffic through Rotherhithe, when we were there at 3 o'clock on a Thursday afternoon, was horse-drawn and steel-tired. As to the ventilation, though, the difficulties at New York would be much greater, both because of the greater distance and the expected constant streams of motor vehicles between shore shafts.

London, May 15, 1920.

Plan for Financing Milwaukee Water Filters

To finance the proposed new water filtration plant for Milwaukee—the city being up to its debt limit—Henry P. Bowman, superintendent, has recommended that the meter rates be increased by 40 per cent and that a $2 service charge be established, the latter to be continued after the filters are completed to meet operating costs. The present meter rates would be restored at the end of five years. The meter rates are now 6c. per 1,000 gal. in all consumers and there is neither service charge or minimum rate.

Education of the Highway Engineer

Extracts From Paper Read by Brig. Gen. C. H. Mitchell at Seventh Annual Canadian Good Roads Congress, Winnipeg, June 1-3.

WE naturally think of highway work as a branch of the broad subject of civil engineering, and so it is. But when one considers at length the various features involved not only in the actual road building but the closely related problems which accompany it, it is found that, as an engineering question the so called specialty embraces many features of other branches of engineering, such as mechanical, chemical and even electrical, with all of which the well informed and broadly trained highway engineer should have no small acquaintance.

It is not sufficient that the civil engineer engaged in highway construction should have a good experience and ability in land survey work, topography, cross sectioning or mapping, or skill in the location and the balancing and computation of quantities involved in excavations and embankments or in grades and drainage or in foundations or aptitude for the patient and laborious attention to office detail which goes with a well organized engineering staff. But he must also have a degree of experience in design and construction, perhaps even to the extent of being an expert in steel and concrete bridges and culverts, in retaining walls and those many concrete structures incidental to roads of all classes. To consider the subject broadly he must be also a student of meteorology and understand the climatic conditions and their effects and he must know something of geology and even of petrology where so concerned with the qualities of road metals. If he is concerned with paving roads and streets in closely settled areas he has a highly specialized field before him in the study of the sources, properties, preparation, construction, behavior and maintenance of all kinds of paving materials from gravel and stone to wood and asphalt. But that is not all for he must be prepared at all times, where building such roads and streets, to deal with the continuously occurring problems involved in taking care of water pipes and sewers, of street railway tracks, of railway crossings and their protection and operation and of the increasingly difficult electric line crossings whether telegraph, telephone or high tension electric power lines.

Must Have Large Professional Talents

But the engineer in this work, if he is to be really up to it, must be more than a civil engineer for, as pointed out he must have a knowledge of mechanical and electrical and chemical work as well to follow the present day progress. Not only must he be conversant with the underlying principles of traction but he must have a practical working knowledge of the mechanical and electrical machinery and equipment used in the processes of manufacture and preparation of materials and in the construction of roads. The varieties of such equipment, with the machinery for instance of handling materials in excavation, quarries, sand and gravel pits, and in the preparation of them by crushers and screens or the machinery used in construction, concrete mixers, road rollers, asphalt, tar and similar plants are in themselves such important factors in road building as to demand close attention and knowledge on the part of the engineers. But there is the other phase of the mechanical of which the road engineer of today must have more than a passing knowledge. He must know the various principles of operation and control of motor transport of all kinds from the touring motor car to the freight lorry and their effect upon his roads in all seasons and with the activities of the manufacturers of today he must also keep up with the rapidly changing types of steam, oil and electric vehicles.

The co-ordination necessary for electrical work in connection with streets and highways has already been indicated as to line crossings but it is no small matter in congested areas to deal with the complicated problems of electrical conduits in the road bed, overhead wires, electric lighting arrangements and the vexed questions of electric railway and their maintenance with regard to the road bed.

So with the chemical side of the work. There must be for the future a large proportion of these engineers engaged in or with a knowledge of the chemical properties of the various soils and materials of road construction and of the chemical processes involved in securing, preparing and applying in construction, the various special constituents of tar, asphalt and other materials.

Another feature, which in this new country is now very properly claiming attention in highway construction is that concerned with the strategical planning of routes either municipal or provincial and the work of general design related to the broad principles of town planning. Much is to be made and is being made of this feature and it is very desirable that the coming engineering generation should make it a part of their work of preparation. In doing this they should not lose sight of the artistic and æsthetic in their work of street arrangement and beautifying, in their boulevards and parkways and even in the long reaches of rural highways which are so attractive a feature in the roads of England and France, of which the soldiers in the war have pleasant memories.

Business Attainments Necessary

But engineering and technical knowledge and experience is not all that the successful highway engineer of today and tomorrow will require. That will be only a part of his professional equipment. He must be much more than a technical man. The nature of this work requires much other knowledge and many other qualifications. He must have administrative ability, he must have vision, judgment and tact and those most vital qualities which will enable him to deal with and co-operate with other men whether workmen or employers, foremen or contractors, sales-agents or walking delegates, business men, ratepayers or politicians. For after all the business of the building and maintaining of highways today is largely business, administrative work with engineering closely mixed with it and as we go on in our complex methods of doing things the business and the engineering will become more interconnected and inseparable. The highway engineer must therefore equally, be an administrator, an economist and a co-operator with the business man, the legislator and the ratepayer..

Now, how are we going to secure these engineers? It will be said we ask for a super-engineer.

The responsibility lies not so much on schools, colleges or universities as upon the municipalities and the governments who are building roads and highways. True, the colleges and universities must give the fundamental education, but it is quite evident that the further or later education must progress in successive stages in the field, on the actual construction or in the engineering or administrative offices of highway departments or commissions of the country.

Track Flangeways and Car Wheel Flanges

Increasing the section of flanges of cast-iron car wheels, as suggested by wheel manufacturers, is unnecessary in the opinion of the wheel committee of the mechanical section of the American Railroad Association. The track committee of the American Railway Engineering Association has expressed the opinion that the flanges can be increased without requiring any difference in width of flangeways at frogs and crossings and without changing the present method of track construction. On the other hand, the wheel committee considers that a change in section is inadvisable and that neither safety nor economy will be served by adding material to the flange in such location as will affect track clearances. In this respect the committee stands by its report of 1916. Some roads are using wheels with flanges thicker than the standard section, and others are using wheels in which the flanges are thicker at the base line, or at the tread, but track clearances are not affected.

Letters to the Editor

Is the Workman Responsible for the Present High Labor Costs?

Sir—In the article, "Is the Workman Responsible for High Labor Cost?" published on p. 876 of April 29, I find two corrections necessary:

1. In the tabulation on p. 877 under "masons," the per cent increase in wages should read 38.5 to 54 instead of 38.5 to 24. This is apparently a typographical error.

2. Just before the above mentioned table the index number for 1914 should be 99 instead of 132. The figure 132 was given to me in error, and the error was discovered when I made some additional studies from the original figures of the Department of Labor. The per cent increase in commodity prices should be 108 per cent instead of 56 per cent. This strengthens the argument and shows that the tradesman has been relatively falling behind in spite of high wage rates.

Dan Patch.
Boston, Mass. Aberthaw Construction Co.

Development of the Professional Spirit in Engineering Education

Sir—While methods of conducting large business enterprises have been developed along scientific lines, with few exceptions, educational methods are for the most part archaic and inefficient. Dr. Mann's article in *Engineering News-Record*, June 24, p. 1242, is inspirational and should materially assist in developing new ideas and ideals. The aim and the spirit of education should be service, and the development of the mind and the soul of the engineering student are equally important.

One difficulty in teaching engineering students is to obtain efficient and competent teachers. Young men are ever ready to follow a leader and the best method of developing the student is to have him come in intimate contact with teachers who are not only well educated and trained, but who are men with a heart and a soul; men who have the ability to develop in the student a desire to reach a position where he can be of service and to develop into a man of the highest type as well as an efficient engineer.

If the technical courses are developed along efficient lines, there will remain, even in the four-year engineering course, sufficient time to give courses in economics, business law, human relations and engineering administration. These courses should be conducted by men who have had a wide experience and who can impress themselves on the student. While researches such as outlined by Dr. Mann are valuable if they are directed by comeptent men, the results are very certain to be unsatisfactory if the teacher in charge is lacking in training and the ability to direct. The most important factor in engineering education is the teacher. It is at present very difficult to get well trained men to teach; and the call of business is taking away from the teaching profession many of our really efficient teachers of engineering. If the profession of engineering is to attain its right place, the position of the engineering teacher must be made more attractive. With able engineering teachers the details of instruction are not so material; with mediocre teachers, all methods will fail. Milo S. Ketchum,

Professor in Charge of Civil Engineering,
Philadelphia. University of Pennsylvania.

Sir—Replying to your letter of June 17 I endorse the point made by Dr. C. R. Mann, in his article in *Engineering News-Record*, June 24, p. 1242, that the spirit of service should be inculcated earnestly in all engineering students by all engineering schools. This is nothing new but has long been recognized by engineering schools, as was proved very conclusively by the way in which the engineers of the country responded when the United States entered the World War. If the writer of this letter had felt inclined to think that his own action in sacrificing $1500 per year salary and all certainty of future permanency of employment in the position he had held for twenty-six years to enter the Army was unusual in an engineering educator (which it was not) he certainly would have been disillusioned when he ran across so many other engineering educators in the service who had done practically the same without making any ado over such action whatsoever. The thousands upon thousands of practising engineers who thronged into the Army proved they had already been taught the true spirit of service at the engineering colleges by their deeds, not by words.

I realize that general pronouncements such as that of Dr. Mann on this subject are needed from time to time to keep our ideals ever before us. Just now, however, the most important thing in connection with teaching the spirit of public service is the devising and adoption of definite measures to instruct our engineering students in the great engineering and public movements of the day and the duty of engineers to participate therein effectively, personally and through strong local and national organizations, safeguarding the public and the engineering profession by the adoption of definite professional codes of ethics, by administering swift justice to those who violate professionl ethics, and by securing the passage of just and adequate engineers' license laws. Anson Marston,

Dean, Division of Engineering, Iowa State College.
Ames, Ia.

Engineering Foundation and An American Hydraulic Laboratory

Sir—Certainly there are many useful contributions to hydraulic engineering and the underlying science which can be made only by a well supported laboratory, as indicated in the statements of Clemens Herschel and the editorial in *Engineering News-Record*, June 24. Problems relating to power development, water supply, irrigation, sewerage and other practical applications of hydraulics, await solution in such a laboratory through the work of competent experimenters.

One element in the present situation in America, mentioned in your journal, should be brought much more prominently to the attention of engineers and the industries. There exists in Engineering Foundation, organized by four of the leading national engineering socities, on the basis of the generous gift of Ambrose Swasey as the nucleus of a large endowment fund "for the furtherance of research in science and engineering, or for the advancement in any other manner of the profession of engineering and the good of mankind," the instrumentality for bringing into existence such a laboratory as is suggested. Engineering Foundation supported Mr. Herschel in his experiments on weirs to the limit of its small resources. The Foundation is thoroughly competent to receive and administer endowment funds in any amount, including those especially designated for an American Hydraulic Laboratory. Furthermore, the Engineering Foundation Board could undertake the establishment and management of such a laboratory and could publish, through the journals of its supporting societies and its own bulletins, the results of the experimental work.

You were recently good enough to make known to your readers Engineering Foundation's endeavors to secure larger endowment. Will you not now bring to their attention this specific possibility in which the readiness-to-serve of the engineering societies through Engineering Foundation, the needs of the profession and the industry, and the far-sighted generosity of individuals and corporations can be brought together for the advancement of the profession and the good of mankind?

Alfred D. Flinn,
Secretary The Engineering Foundation.
New York City.

HINTS FOR THE CONTRACTOR

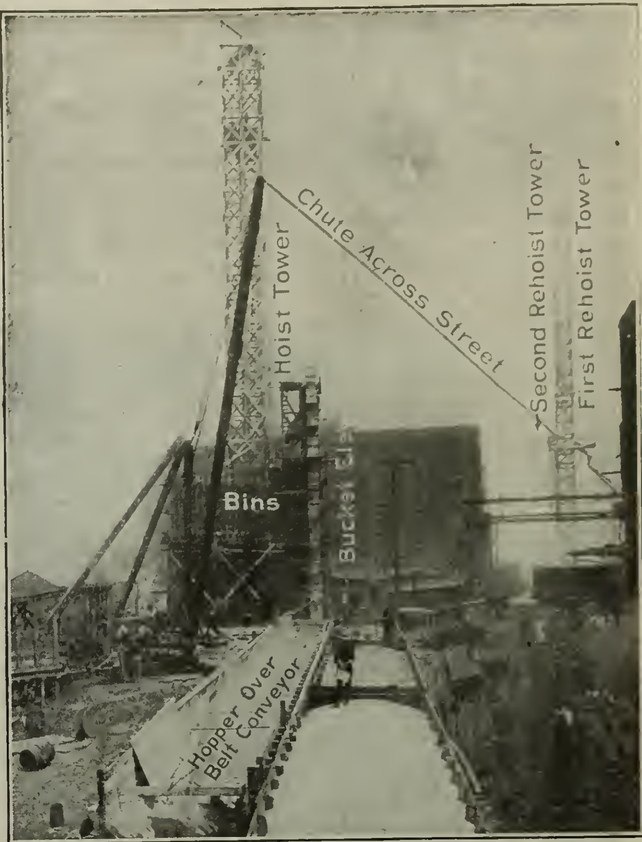
DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Concrete Building Plant Plans—I

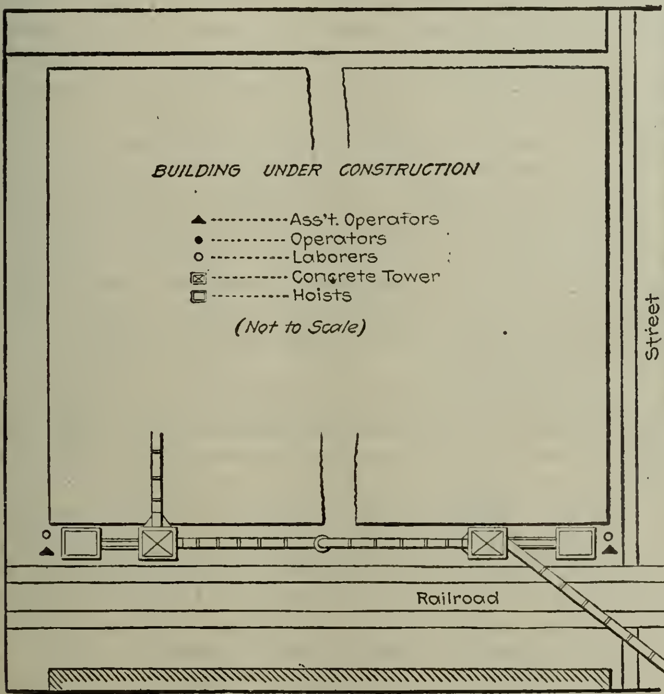
Across-Street Vacant Lot Keeps Plant Off Congested Street

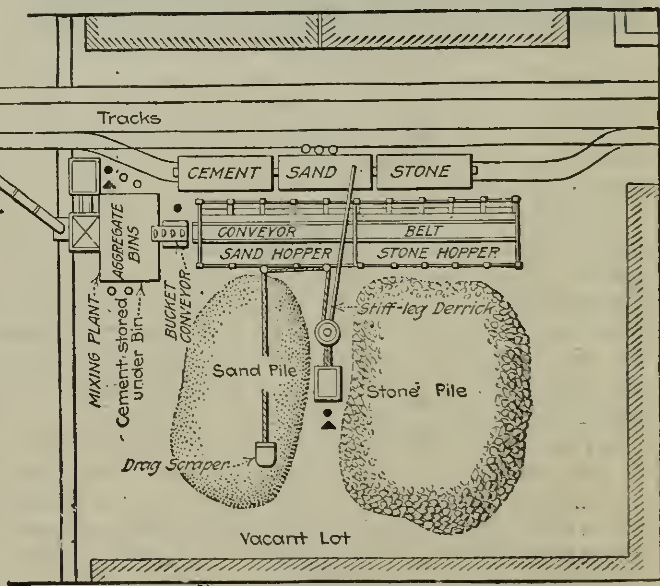
BY SPOUTING diagonally across intersecting streets and using two rehoist towers, it is possible, with a concrete plant located in an adjacent vacant lot, to distribute concrete for an eight-story building, 357 x 131 ft. and leave the streets unobstructed by equipment except for the sidewalk space on one side of the building. The illustrations show the plant layout and the distribution of the operating force.

All parts of the plant are balanced with respect to the 28 cu.ft. mixer. A ¾-cu.yd. clamshell meets the unloading requirements. The one special feature of the



VIEW OF PLANT FROM UNLOADING TRACK END





CONCRETE BUILDING PLANT LAYOUT IN CONGESTED DISTRICT

unloading outfit is the drag scraper arrangement for cleaning up the stock pile and heaping scattered material for the clamshell. A 16-in. conveyor keeps the mixer supplied. Mixed concrete is hoisted and chuted 500 ft. across the street to the first rehoist tower. There it is rehoisted and chuted direct to the forms for the south half of the building or is chuted to the second rehoist tower and there rehoisted and chuted to the forms for the north half of the building. For emphasis, attention is called again to the small street space occupied by construction plant.

The main concrete plant will place only the 18,000 cu.yd. of concrete in the main building superstructure. It was found more economical to put in footings and pedestals, in which the daily volume of concrete required was small and widely distributed, with a number of portable 7-cu.ft. mixers, instead of operating the central mixing plant. When the main building concrete is placed these small mixers will be again used to construct walks, curbs, platforms, etc.

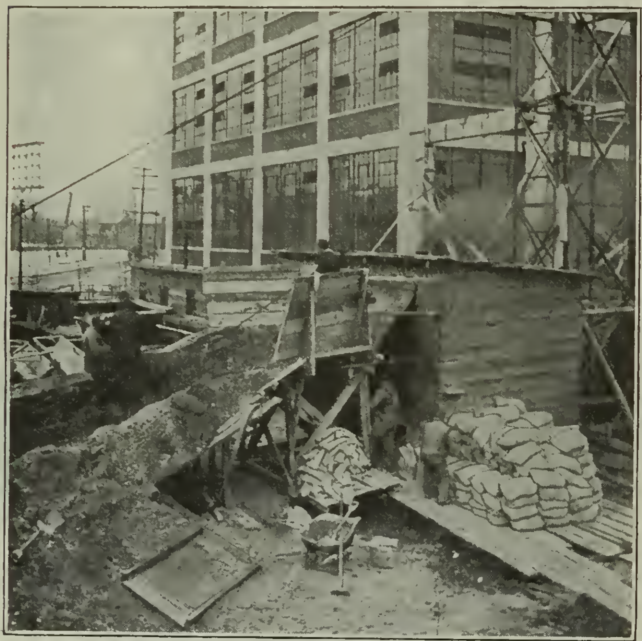
The building is being constructed in the stock yards district of Chicago for Morris & Co., by R. C. Wieboldt, general contractor, Chicago.

Handling Aggregate with a Drag Scraper

By Henry W. Walter
Niagara Falls, N. Y.

During the recent construction of a concrete factory building for the Shredded Wheat Co., at Niagara Falls, N. Y., lack of storage space near the concrete mixer led to the novel method of handling the coarse aggregate shown in the accompanying view.

The new addition to the plant occupied the entire remaining area of the plot with the exception of a small triangular strip at the front. After the concrete mixing and hoisting plants, cement storage sheds, etc., had been located on this strip, the remaining area was insufficient to insure a storage of gravel for more than one day's run. Gravel was delivered to the job by truck, and for various reasons could not be relied upon



to be continuous. Wheeling in barrows was impossible due to the scarcity and high cost of labor. Some method was necessary whereby a relatively high pile could be maintained and placed as close to the mixer hopper as possible.

A wooden bin with a gate and chute at its lower end was constructed immediately in front of the mixer hopper. The chute was hinged at the gate in order that it might be raised out of the way of the mixer hopper when the latter was being elevated to discharge into the mixer. Timber wing-walls were spiked to the sides and rear at the top of the bin, and the plank incline was built from the front down to the pile of gravel.

A snatch-block was fastened overhead to the frame of the concreting tower. A cable through this block and through one lower down on the tower was passed over a drum of the hoisting engine. The other end, out on the pile of gravel, was fastened to an ordinary drag scraper. Between operations of the bucket, the hoistman operated the scraper.

Incoming gravel was dumped at the foot of this incline, and spread out fan-shape from it to the street line. Two men were required at the scraper to guide it into the pile and to overhaul the cable when pulling it back. A third man, stationed at the hopper bin, signalled the hoistman and also helped with the overhauling. These three men, together with two others whose duty it was to level the pile in the mixer hopper and to carry cement, comprised the entire force operating at the raw material end.

No capital was tied up in this plant which was built out of materials at hand, and yet, supplying a 14 cu. ft. mixer, 125 cu. yd. of concrete have been placed during a ten-hour day. The men at the scraper worked steadily but were not crowded to accomplish this.

By means of the bin grate and a marked mixer hopper it was found that a more constant mix was obtained than possible with barrows and shovels.

The erection of the new addition is being done by the John W. Cowper Co. of Buffalo, N. Y. The work is under the direction of Walter McCulloh, consulting engineer for The Shredded Wheat Co. The solution of the aggregate handling problem is due to **J. P. Doyle**, superintendent for the contractor.

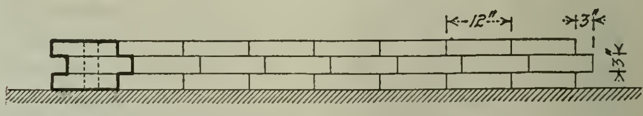
Large Cable "Trollied" Over Towers

USING $\frac{5}{8}$-in. wire ropes as trolley cables, two $1\frac{1}{8}$-in. chute-suspension cables, 1,000 ft. and 1,200 ft. long, respectively, were successfully installed on high towers at the Bunte factory under construction in Chicago by R. C. Wieboldt, general contractor. The suspension cables cross on an angle of about 60 deg. at a double hoist tower 230 ft. high. One cable spans the 230-ft. main tower and a 150-ft. auxiliary tower, between deadmen 1189 ft. apart. A low support tower at each end, where the cable slants down to the deadmen, holds the cable clear of crossing streets. The other cable spans the main tower, an auxiliary tower 180 ft. high and a rehoist tower 180 ft. high. At one end a support tower keeps the stretch from main tower to deadmen clear of railway tracks.

To erect each cable, a $\frac{3}{4}$-in. manila line was taken over the towers and was used to pull a $\frac{5}{8}$-in. steel cable from deadman to deadman over the towers. This cable was used to "trolley" over the $1\frac{1}{8}$-in. cable. When in place the main cable was tightened by $2\frac{1}{4}$-in. guy tighteners at each end. The trolley cable was left in place alongside the main cable to be used in taking it down. At the towers the main cable rides on a roller consisting of a 2-in. pin journaled in two steel angles about 1 ft. long attached to proper timber supports. When the main cable had been strung and pulled taut, the blocks used to support the chutes were spaced on a $\frac{3}{4}$-in. line and fed out on the main cable from the main tower to the auxiliary towers.

Sheeting Spiked Like Flooring

IN fabricating Wakefield sheet piles for Pier B of the Seattle, Wash., port works, large output was secured by laying the component 12- x 3-in. planks as indicated by the sketch and then spiking them in one operation as,



ordinarily, flooring is spiked. Wire spikes 9 x $\frac{5}{16}$ in. were driven staggered every 12 in. When driving was completed the piles were separated and turned over and the points of the spikes were clinched. The large platform necessary for the operation was provided by the pier deck.

News of the Week

New York, July 8, 1920

Duties of New Water-Power Commission Outlined

Personnel Partly Decided On and Prospective Work Abstracted From Bill As Signed

Proceeding on the assumption that the Water-Power Act, as signed subsequent to the adjournment of Congress, is now law, the President has designated the Secretary of War as chairman of the Federal Power Commission formed by the law.

The technical work which will be required of the Water Power Commission under the terms of the act is as follows:

Engineering:

- General investigation of electrical power industry.
- General investigation of water-power sites, and estimates of cost of development.
- Estimates of amount and value of power available at Government dams.
- Examinations, cost estimates and reports to Congress on projects recommended for construction by the United States.
- Examination, cost estimates and reports to Congress on projects for which it is recommended that the cost of navigation facilities be supplied in whole or in part by the United States.
- Preparation of comprehensive plans for development for all purposes of streams and stream systems upon which applications for licenses are made.
- Passing upon construction plans proposed by licensees.
- Physical valuation of properties in rate making proceedings.
- Determination of necessary repairs required for maintaining projects in effective operating condition.
- Determination of adequate depreciation reserves upon property.
- Determination of operating rules necessary for protection of life, health and property.
- Report on Great Falls power project near Washington.
- Report on District of Columbia water-supply.

Accounting and Statistical:

- Preparation of a system of uniform accounts.
- Preparation of forms of reports and inspections and checking of such reports.
- Examination of books and accounts of licensees.

(Continued on p. 92)

General Gorgas Dead

Major-General William C. Gorgas, former Surgeon-General, U. S. Army, died, July 4, in London, where he had gone a few weeks previously preparatory to a mission to West Africa in behalf of the British Government to investigate sanitary conditions. General Gorgas was born in Mobile, Ala., in 1854. He graduated, with the degree of A. B., from the University of the South, at Sewanee, Tenn., and studied medicine at Bellevue Medical College, New York City. In 1880 he was appointed Surgeon, U. S. Army, and was subsequently made Captain, Assistant Surgeon in 1885, Major, Brigade Surgeon and Major, Surgeon in 1898, and Colonel, Assistant Surgeon-General in 1903. During the Spanish-American War, while in charge of the yellow fever wards of the hospital in Havana, and in the years which immediately followed it, as chief sanitary officer of Havana, General Gorgas applied methods of combating yellow fever which eliminated that disease from the city.

In 1905 he was selected by the U. S. Government as chief sanitary engineer of the Panama Canal, and practically removed from the Isthmus the diseases of malaria and yellow fever, which had twice defeated the French canal builders, and made healthful the area surrounding the present canal. In five years' time he made a tremendous reduction in the yellow fever rate. General Gorgas was the author of "Sanitation in Panama," (reviewed in this journal Nov. 18, 1915), which deals with his conquest of yellow fever at Havana and Panama. In 1913 he went to South Africa for the British Government to investigate conditions in the Rand Mines, where epidemics of pneumonia raged. He received his appointment in 1914 as Surgeon-General, with the rank of Brigadier-General, and the next year was made Major-General, Surgeon General, U. S. Army. As a permanent director of the International Health Board of the Rockefeller Foundation, he also recently stamped out yellow fever at Guayaquil, Ecuador.

New Officers of Research Council

Election of officers of the National Research Council for the year beginning with July, 1920, resulted in the choice of the following: Chairman, H. A. Bumstead, Yale University; vice-chairman, C. D. Wolcott, Smithsonian Institution; Gano Dunn, New York, and R. A. Millikan, University of Chicago; Secretary, Vernon Kellogg, Stanford University; Treasurer, F. L. Ransome.

Engineering Educators Discuss Co-operation

Relations Between College and Industry Main Theme at Meeting of Society for Promotion of Engineering Education

Throughout the 28th annual meeting of the Society for the Promotion of Engineering Education at the University of Michigan, Ann Arbor, June 29 to July 2, ran the theme of the interdependence and co-operation of the engineering colleges with industry. Co-operation with engineering societies and engineering English also received much attention. The mechanical and electrical engineers intimately connected with industry were much in evidence at the meeting, while the civil engineers modestly put through a series of "principles which should be considered in planning and administering the structural courses of a curriculum in civil engineering." Results of intelligence tests for accelerating the early removal of the unqualified were given as a progress report only. One sensed the reassuring feeling that the engineering educators are distinctly aware of the great economic changes in the country's needs, due to the passing of pioneer development of natural resources to a more intensive industrialism. The professors, however, were more specific and practical than the above generality would indicate.

The sessions were opened by papers of decidedly practical import, "Co-operation Between Industry and Education," by R. D. Chapin, president, Hudson Motor Car Co., and S. P. Capen, director, American Council on Education. Mr. Chapin made a plea for more intensive training in the fundamentals, followed by specialization in direct connection with the industries. He indicated the excessive demands for highway engineers who particularly needed the broadening influences of the general courses.

What M. I. T. Is Doing

Examples of co-operative education were given by H. B. Shaw, Doherty Co.; C. S. Coler, Westinghouse Electric & Manufacturing Co., and Prof. W. H. Trimbie, Massachusetts Institute of Technology. The latter described the five-year electrical course given in connection with the General Electric Co. at Lynn, Mass. While the most striking difference between this course and other co-operative courses is in the length of periods, 13 weeks in the shop, 11 in school and 2 weeks' vacation, the main endeavor is to develop a student's mind, character and body, and at the same time inculcate in him a spirit of loyalty.

Ira N. Hollis, president, Worcester Polytechnic Institute and past-president, American Society of Mechanical Engineers, opened the discussion on co-operation with the engineering societies. He was of the opinion that the formation of chapters in the schools by the individual societies is too narrowing for the student. All national societies should join in forming single all-embracing undergraduate societies. He considers the societies as post-graduate organizations and he held that the founder societies must take their fair share in supplementing the education already given. Both Dr. Hollis and Dean M. E. Cooley, University of Michigan, instanced the success of the general student society and the subsequent failure of the specialized organization.

Dr. F. H. Newell, in discussing another paper, called attention to the numerous chapters being formed by the American Association of Engineers, an all-inclusive organization. Dean Cooley held that the co-operative endeavor of the national societies so far was largely selfish and designed to increase the future membership roll. In his opinion the national societies should concern themselves with uniform entrance and graduation requirements, with content of courses, particularly when longer than four years, with the difference between professional engineers and technicians and with financial and administrative problems of research.

Prof. J. H. Dunlap, State University of Iowa, gave some startling figures indicating the relative positions of the professions of medicine and engineering with reference to graduation requirements. Twenty years ago only 14 per cent of the medical schools required for admission more than a one-year high school course, as compared with the requirements of 33 per cent of the law schools and 80 per cent of the enginering schools. Moreover, 91 per cent of the medical schools had a four-year, 28-months, course, as compared with 98 per cent of the engineering schools having a 35-months course. The law course was much briefer than either of the other two professions. Today the medical schools are at the top, the law schools in a middle position and the engineering schools at the bottom of the list. Prof. Dunlap suggested that the society appoint a committee on a model or standard engineering curriculum to co-operate with a similar committee of Engineering Council.

Much pent-up animosity was evident during the discussion on experiment station legislation. Charles S. Howe, president, Case School of Applied Science, Cleveland, is head of a committee on the subject. He wanted light, wanted constructive criticism, but it was apparent that the fight between the land-grant colleges and the state universities for federal aid was not to be aired in this convention. President Howe wanted to know of some congressional bill to support. The factions are in an uncompromising attitude and the land grant adherents particularly preferred not to discuss the matter. Dean W. G. Raymond, State University of Iowa, presented a bill, now in the course of preparation, which will provide for apportionment by the executive committee of the National Research Council of federal funds for research to that institution, public or private, which has a problem worthy of solution. Dean F. L. Bishop, University of Pittsburgh, made a general plea for funds for research. He is now engaged on an investigation for a corporation costing $500,000. Much of the information developed should be public property but will necessarily be retained in the private files of the corporation. A resolution endorsing the principle of federal and state aid fathered by Prof. W. T. Magruder, Ohio State University, was endorsed. Later A. L. Williston, principal, Wentworth Institute, Boston, got endorsement of a resolution calling on the committee to harmonize the various plans and, if not able to do so, to bring in a bill of its own drafting.

No Action on Pay

"The Pay of Engineering Educators" was the title of a paper by Dr. F. H. Newell, University of Illinois, which received a surprisingly small amount of discussion and no action. Prof. C. J. Tilden, Yale University, chairman, American Association of Engineers' committee on salaries of engineering educators, indicated almost unanimous response from the heads of the engineering colleges to whom the preliminary report has been submitted with a request for comment and acceptance as corresponding member of the committee. Dean Bishop held that the revision of salaries proposed was based on a fallacy because it assumed that the salaries in 1912-14 were adequate and that the attempt was made to revise them in accordance with the comparative purchasing power of the dollar then and now. President Howe agreed with the schedule proposed but held that the existing scales were high for the instructors "we now have to take." Since the schedule is tentative no action was asked for.

The 1921 meeting of the society will be held at Yale University, New Haven, Conn., June 28, 29 and 30. The newly elected officers are as follows: President, Dean M. E. Cooley, University of Michigan; vice-presidents, Dean T. U. Taylor, University of Texas, and Dean H. S. Evans, University of Colorado; secretary, Dean F. L. Bishop, University of Pittsburgh; treasurer, W. O. Wiley, John Wiley & Sons.

Montreal Now Accepts Liberty Bonds from Contractors

Instead of the personal certified check of 10 per cent of the bid, Montreal contractors are now allowed to submit a victory bond or a City of Montreal bond, when they have been awarded contract for construction of municipal public works.

Highway Work in Southern States Faces Demoralization

Highway work in southern states has been severely affected by the recent ruling of the Interstate Commerce Commission giving the coal industry priority on open top cars, according to information received from several sources. As a result of the commission's ruling that railroads must distribute available coal cars for loading coal to a minimum of 50 per cent of actual requirements before using coal cars for loading other commodities, not a few southern contractors have had their material supplies cut off. So serious has the situation become that in Georgia, Virginia, and North Carolina highway work is threatened with almost complete discontinuance and highway commissions with disorganization.

Not only are state highway commissions affected, but city paving in many southern municipalities has slowed up. Immediately upon the publication of the commission's order, W. R. Neel, State Highway Engineer of Georgia, issued a circular letter to all contractors in which he requested information as to tonnage of materials necessary to complete contracts being executed with the state highway department and counties of Georgia. Contractors were asked to state points of origin of shipments and requested to send the information in as quickly as possible. Frank Page, chairman of North Carolina Highway Commission, requested the Interstate Commerce Commission to amend the embargo order so that coal cars entering the southern territory might be used for one trip between quarries and highways before shipping them back to the coal mines.

Although the Commission's order is effective only for thirty days, ending July 21, it is pointed out that those thirty days are ideal for highway construction, and also that if contractors and highway department organizations are disrupted in the embargo period it will be difficult to rebuild organization forces after the material shipments again pick up.

Water Power Commission

(Continued from p. 91)

- Accounting in connection with regulation of rates, service and securities.
- General technical statistical work.
- Annual report to Congress.

Legal:

- Preparation of rules and regulations.
- Passing upon legal phases of licensees.
- Legal questions in connection with regulation of rates, service and securities.
- Legal questions in connection with the Federal and State statutes applicable to the work of the commission.

Seek Change in Road Bond Interest Rate By Initiative Measure

Before July 14, 75,000 signatures must be obtained to place upon the ballot in California an initiative petition to change the interest rate on remaining state highway bonds to a rate which will make them salable, and also to relieve the counties of the payment of state highway bond interest after July 1, 1921. Under the initiative measure a board, composed of the governor and other state officers, and serving without compensation, is created to fix the interest to be paid from time to time to meet market conditions, but never in excess of 6 per cent.

This initiative measure is necessary if highway work is not to stop for an indefinite period, says a recent bulletin issued by the California Highway Commission, and if counties are to be relieved of the state highway bond interest burden.

The Committee of Twenty-one, which had charge of the campaign for the flotation of the $40,000,000 road bond issue, representing the recently held state-wide conference, which on June 19 unanimously proposed to back such a proposal for relieving the highway situation, met in San Francisco, June 29, and appointed a committee to direct the campaign for signatures. On this committee are Senator Johnson, chairman; Burton A. Towne, secretary; James O'Brien, of Marysville; A. S. Dudley, of Los Angeles, and Richard Welsh, of San Francisco. The committee, accepting the draft of the initiative as prepared by Attorney General Webb, will call upon chambers of commerce, boards of supervisors, farm bureaus and citizens interested in the continuation of state highway construction in California, to circulate the petition and secure the signatures necessary to place the initiative measure upon the ballot at the November election.

Salary Increase Authorized for New York Subway Engineers

The second $300 a year increase in salary for all engineers employed by the Transit Construction Commission of New York City who are receiving $3300 per annum or less was authorized on the 25th of June when the Board of Estimate approved the budget of the Transit Construction Commission, after the strong solicitation of the New York Chapter of the American Association of Engineers.

The same estimate carried an increase of 15 per cent for all inspectors.

The former increase of $300 per annum was granted at the end of 1919, when after considerable preliminary efforts, the representatives of the American Association of Engineers at the meeting of the Board of Estimate on December 3 prevailed upon the board members to not adjourn without adopting the budget to provide for salaries of all of the engineers employed by the commission and which carried with it a provision for a $300 increase.

Detroit Grade Crossing Program

As part of the general plan of eliminating grade crossings at Detroit, the Michigan Central R.R., New York Central R.R. and the Wabash R.R. will commence work on track elevation this season at Livernois Ave., Dix Ave. and Waterman Ave. In conjunction with this improvement, the city will open and extend Military Ave. across the right-of-way of these railways and will construct a subway under the tracks. The latter work will be done wholly at the expense of the city. Track depression is advocated by the city for the De Quindre St. line of the Grand Trunk Ry., but though the case was presented to the State Railroad Commission in 1917 no decision has been rendered. The scheme for complete elimination of grade crossings has been prepared under the Department of Public Works by the division of grade separation, of which John W. Reid is engineer. (See *Engineering News-Record,* March 13, 1919, p. 511). In a recent number of the *Detroit Motor News* Mr. Reed calls attention to industrial districts where costly plant investments are being made without provision for future removal of tracks from the street surface.

Federal Officials Organize

More than a hundred members of the government service who are in responsible administrative and technical positions met June 17 and perfected a tentative organization which is to be known as The Federal Club. Its purpose is to care for many of the problems of the service common to several departments by the interchange of views, and where appropriate, by joint action. Assistant Secretary of the Navy, Franklin D. Roosevelt, is the chairman of the temporary body and Dr. E. B. Rosa, chief physicist of the Bureau of Standards, is chairman of the committee on organization and constitution.

County Unit Road Bond Petitions Are Many in Indiana

Proposals by Indiana counties to build between $40,000,000 and $60,000,000 of roads under the county unit road law are either now before the state board of tax commissioners or will be laid before the board if it will indicate that it will approve any county unit road bond issue petitions, according to Fred A. Sims, chairman of the Indiana board of tax commissioners. This road building is exclusive of the road building program outlined by the state highway commission. Mr. Sims said the board will approve no county unit road law bond issues until after the special session of the legislature. He said if the legislature does not change the law, the board probably will not approve more than two or three of the scores of petitions now on file or about to be filed, because of the inflated bond issue market, the high cost of road building and other abnormal conditions.

New York Post Military Engineers Forms Permanent Organization

At a meeting held June 29, in the Army Building, 39 Whitehall St., New York City, a permanent organization of the New York post of the American Society of Military Engineers was formed. Preliminary organization had been effected two weeks prior to that meeting. Considerable interest is manifest in the formation of the New York post, both meetings being attended by approximately 100 former officers and enlisted men of the engineer establishment and officers of the Corps of Engineers.

In accepting the report of the organization and nominating committee the members of the New York post elected for the ensuing year the following officers: President, Col. F. A. Molitor; vice-president, Col. Geo. D. Snyder; secretary, Major P. E. Barbour; assistant secretary, Sergt. Allen E. Fitzgerald; treasurer, Major R. C. Coiner, Corps of Engineers, U. S. A. These officers, together with four directors-at-large, form the board of directors. The nominating committee presented seven names to ballot upon for directors-at-large, those elected being Col. R. D. Black, Major E. F. Robinson, Lieut. Col. A. S. Dwight, Col. Beverly Dunn.

A constitution at little variance with that of the parent organization was adopted. The formulation of by-laws governing the local society was by motion left to the board of directors, with the proviso that any changes in constitution or by-laws could be effected through a two-thirds vote of the membership.

The secretary read a communication from Major P. S. Bond, Corps of Engineers, U. S. A., in which it was stated that the membership cards in the parent organization had been received from the press and were now ready for distribution. Major Bond also reported through his letter the acceptance into the society of many new members.

The permanent organization of the New York post having been effected, its membership will now apply for a charter from the parent organization.

West Point Graduates Assigned To Engineer Corps

Those of the class recently graduated from the United States Military Academy who were assigned to the Corps of Engineers of the Army are: Francis E. Cox, Rhode Island; Thomas H. Stanley, Texas; Donald G. White, New Hampshire; Henry G. Lambert, Illinois; Charles G. Holle, Ohio; Charles S. Joslyn, U. S. Army; Arthur M. Andrews, Wisconsin; Edward C. Harwood, Massachusetts; John W. Moreland, Alabama; Wayne S. Moore, Illinois; Henry F. Hannis, West Virginia; Arthur L. McCullough, Wisconsin; Arthur V. L. James, Maryland; William W. Bessell, Jr., at large; James B. Cullum, Jr., at large.

Supplementary List of Delegates at Organizing Conference

In *Engineering News-Record* of June 10, p. 1138, was published a list of societies and delegates at the Organizing Conference held in Washington. D. C., June 3 and 4. Since the first list was compiled certain additions and corrections have been made. For the purposes of an accurate record, therefore, the following supplementary list is published:

Supplementary List of Organizations and Delegates in Attendance at Organizing Conference Washington, D. C., June 3-4, 1920. (*For Original List See Engineering News-Record, June 10, p. 1138.*)

American Association of Engineers,
A. B. McDaniel, Washington, D. C.
American Concrete Institute,
J. C. Pearson, Washington, D. C.
W. A. Slater, Washington, D. C.
American Society of Civil Engineers,
Richard L. Humphrey, Philadelphia, Pa.
American Society of Safety Engineers,
John A. Dickinson, Washington, D. C.
Associated Engineers of Spokane,
J. C. Stevens, Portland, Ore.
Connecticut Society of Civil Engineers,
T. A. Scott, Washington, D. C.
Engineers' Club of Columbus,
James R. Withrow, Columbus, Ohio
Engineers' Club of Minneapolis,
O. H. Dickerson, Duluth, Minn.
Engineers' Club of Philadelphia,
Joseph A. Steinmetz, chairman, Philadelphia, Pa.
Richard L. Humphrey, Philadelphia, Pa.
Paul Spencer, Philadelphia, Pa.
Louisiana Engineering Society,
William B. Gregory, New Orleans, La.
Mining and Metallurgical Society of America,
F. G. Cottrell, Washington, D. C.
Minnesota Surveyors' and Engineers' Society,
O. H. Dickerson, Duluth, Minn.
National Safety Council—Engineering Division,
S. J. Williams, Chicago, Ill.
New England Water Works Association,
Leonard Metcalf, Boston, Mass.
Oregon Technical Council,
J. C. Stevens, Portland, Ore.
Society for Promotion of Engineering Education,
F. L. Bishop, Pittsburgh, Pa.
Society of Automotive Engineers,
G. W. Coggeshall, Washington, D. C.
Joseph A. Steinmetz, Philadelphia.
Society of Naval Architects and Marine Engineers,
W. H. Capps, Washington, D. C.
Homer L. Ferguson, Newport News, Va.

Galveston Causeway Construction to Be Taken Over by County

On account of the rising costs of materials and labor the construction and repair of the Galveston causeway has been taken over by the Board of Managers of Galveston County under the provisions of the original contract, which has been held by Larkin & Sangster, Inc., Buffalo, N. Y. The contractors have notified the Board of Managers that the contract was forfeited as of date June 17, 1920. Under the contract entered into on Sept. 15, 1917, it was provided that if the total cost of the work should exceed $1,750,000 the county would take over the work. The contractors say this sum has been reached and that due to increasing costs of materials and labor and to increased cost of transportation it has been found impossible to complete the contract within the bid. Work will be continued under the direction of H. F. Jonas, who has been supervising engineer.

O. C. Merrill Named as Secretary of Federal Power Commission

Secretary of War Baker, who has been designated chairman of the newly created Federal Power Commission, has apointed Oscar C. Merrill, now chief engineer of the United States Forest Service, as executive secretary of the new commission at a salary of $5,000 per year.

Mr. Merrill was graduated from the Massachusetts Institute of Technology in 1905 and during his college course was connected with the city engineer's office of Augusta, Me. and the U. S. Geological Survey. After leaving college he taught for a while at the University of California and then was engaged on water-power surveys, sewer and sewage-disposal design and construction and water filteration projects in the Far West. In 1909 he became connected with the Forest Service and was assigned to the water-power investigations of that branch of the government. Since that time his major interest has been in Federal water-power administration and he has been one of the most important factors in the development of a Federal water-power policy. In his new capacity he will be the administrative head of the Government's water-power plans.

New Jersey Highway Commission Names Engineer

The newly appointed State Highway Commission of New Jersey was organized July 1. The new commission has named Thomas J. Wasser, county engineer of Hudson County, as state highway engineer to succeed William G. Thompson, resigned. George L. Burton of South River, was elected chairman of the commission and A. Lee Grover of Trenton, secretary.

Engineering Council Favors Single Quantity Estimate

The American Institute of Architects, Engineering Council and Associated General Contractors of America in October, 1919, appointed three conferees each, to discuss the matter of payment for estimating. These conferees agreed upon a report which was submitted to their respective organizations Feb. 17, 1920, and has since been under consideration by them. Engineering Council at its meeting, June 17, adopted the conclusion in a report of a special committee to which the report of the conferees had been referred, as follows:

"Whenever in the execution of work, competitive bids are asked for on detailed plans and specifications, those invited to bid should be provided with such an estimate of the quantities involved in the work as the surveys, plans and specifications permit to be made. The intent of this requirement is that a single estimate of quantities should be made by or for the engineer, architect, or other representative of the owner, so that each separate bidder will not be put to the expense of making up a separate schedule of estimates. This latter practice not only means a needless waste in the carrying on of contract work, but also discourages bidders and causes needless repeated handling of official plans and specifications in making up separate schedules of estimates."

Examination for Civilian Instructors, U. S. Naval Academy

An examination will be held in Isherwood Hall, U. S. Naval Academy, Annapolis, Md., at 9 a.m., Aug. 23, for the selection of two or more civilian instructors in the Department of Marine Engineering and Naval Construction. Candidates found qualified will be eligible, in the order of merit as determined by the board of examiners, for appointment to fill vacancies in that department, and others found qualified will be placed upon a reserve list. The annual salary of instructor in the department is $2,800. Candidates must be American citizens, and age limits are between 25 and 32 years, although the limits may be waived if candidates possess satisfactory courses.

The following qualifications will also be considered: Fitness to command the obedience and respect of students; degrees taken, post graduate work or other special studies; previous experience in teaching, and testimonials and references as to character and attainments. It is desired that applicants bring with them their references, which will be returned. Application must be filled out and returned to the Superintendent, U. S. Naval Academy, Annapolis, Md., without delay. The examination, which will be written, will require about three days.

A. A. E. Board of Directors Holds Quarterly Meeting

At the quarterly meeting of the board of directors of the American Association of Engineers, June 19, Dr. F. H. Newell, head of the department of civil engineering at the University of Illinois and past-president of the association, was appointed director of its field forces during the summer months. He will spend a large proportion of his time traveling and will assist the various chapters in solving their problems of organization and expansion. Dr. Newell was also elected a delegate to the Great Lakes-St. Lawrence-Tidewater Congress to be held in Detroit, July 22-24.

H. W. Clausen, general office manager of the C. D. Osborn Co., Chicago, was elected treasurer of the association, and the thanks of the association were ordered extended to John Ericson, retiring treasurer, for his useful services.

A motion was passed that each member of the Federated American Engineering Societies be invited to become a member of the association.

The board accepted the report of the building trustees, announcing that three types of buildings were under consideration; one type costing three million dollars, another one and a half million, and the third five hundred thousand, and recommending that subscription blanks be sent to members as a means of determining the amount of money which may be raised.

The national employment committee was instructed to formulate a person-

nel card and prepare plans for the expansion of employment service. The secretary was authorized to proceed also with the creation of an industrial department.

Ship Bursts British Dock Gates

With water level in the Alfred Dock at Birkenhead, opposite Liverpool, about 12 ft. above that in the Mersey River, on June 16 a small steamer in the entrance lock burst the gates open and plunged into the river. Several barges and small craft in the dock were carried out by the escaping water before the other gates of the lock could be closed. The steamer was not badly damaged, but barges were smashed and sunk and considerable quantities of coal and grain were lost. How the vessel got beyond control is not stated. A similar accident is reported to have occurred at the same place 22 years ago. At a still earlier date a coasting steamer approaching the entrance to one of the Liverpool docks from the river narrowly escaped striking the closed gates. In this case the indicator from the bridge to the engineroom broke down and the engine continued to turn ahead although the signal had been given to stop. The ship was steered so as to strike the masonry wall instead of the gate, the only damage being a slight denting of the bow.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Portland, Ore., Aug. 10-12.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Sept. 13-17.

The Technical Club of Dallas (Tex.) has made application for membership in the Federated American Engineering Societies. The club voted unanimously at last week's meeting to take this action.

The Ohio State Engineers, at their convention held recently in Columbus, elected the following officers for the coming year: President, John H. Matse, Cincinnati; vice-president, W. L. Shawkey, Youngstown; secretary, George P. Kalsgye, Lakewood; treasurer, T. S. Garret, Dayton.

The Buffalo (N. Y.) Chapter, Society of American Military Engineers has organized a new body, the charter of which, it is explained, will be open to all engineers with military service records. The first meeting was held recently, at which Colonel Clarke S. Smith was elected president and Captain A. B. Jones secretary and treasurer. A series of monthly meetings is being arranged.

Personal Notes

CHARLES E. DONNELLY, assistant city engineer of Kansas City, Mo., has been appointed office engineer for the city planning commission.

ERNEST R. SPRINGER has been appointed chief engineer of the Boston Transit Department, succeeding Edmund S. Davis, who has retired after 47 years in the service of the city, as noted in these columns May 27.

W. T. LEE, of the topographic branch, U. S. Geological Survey, is engaged in making studies of the coastal plain of the Carolinas and the eastern shore of Maryland, from an aëroplane.

FRED J. LEWIS, of Bethlehem, Pa., has been appointed assistant professor of civil engineering at Lehigh University. Prof. Lewis was formerly with the department of streets and engineering of Springfield, Mass., as an assistant engineer.

C. C. WILLIAMS, head of the Department of Civil Engineering, University of Kansas, sailed June 28 for Europe, to study transportation problems.

H. N. RODENBAUGH has been appointed chief engineer of the Florida East Coast Railway Co., succeeding E. Ben Carter, retired under pension. Mr. Rodenbaugh's headquarters will be St. Augustine.

ARTHUR E. LODER, general inspector, U. S. Bureau of Public Roads, with headquarters at Washington, D. C., has been appointed district engineer with headquarters at Montgomery, Ala. He will have charge of the southeastern district, comprising the States of South Carolina, Georgia, Florida, Alabama, Mississippi and Tennessee.

J. Y. MCCLINTOCK, formerly superintendent of highways for Monroe County, N. Y., has become associated with George R. Newell, civil engineer, with offices in the Newell Block, Rochester, N. Y. The new firm will handle general engineering work, including studies, surveys and reports and preparation of contracts.

MAJOR H. L. MCMILLAN, formerly with the sewage disposal division, Bureau of Surveys, Philadelphia, has joined the engineering statff of the Sanitary District of Chicago as assistant engineer.

THOMAS L. WILKINSON has resigned as manager of operations of the Intermountain Railway, Light & Power Co., and opened an office as consulting engineer in the Boston Building, Denver, Col.

JAMES THOMSON, city engineer and architect of Dundee, Scotland, has been elected president of the Institution of Municipal and County Engineers, Great Britain. He is a native of Edinburgh, where he received his engineering education. He was appointed city architect of Dundee in 1904 and city engineer in 1906. Mr. Thomson was one of the founders of the Concrete Institute and is a member of the Town Planning Institute of Great Britain.

H. S. ROGERS has been appointed division engineer of the Susquehanna Division, Delaware & Hudson R.R., with headquarters at Oneonta, N. Y. He succeeds J. M. Silliman, resigned.

FRANK D. NASH, formerly chief engineer of the Missouri & North Arkansas R.R., has been made assistant valuation engineer of the St. Louis-San Francisco R.R., with headquarters at St. Louis.

W. F. TURNER has been appointed division engineer of the Tucson Division, Southern Pacific Co., with headquarters at Tucson, Ariz.

W. M. SCOTT has been appointed chief commissioner of the Greater Winnipeg Water District, succeeding R. D. Waugh.

A. U. MAHON, state engineer of Montana, has resigned to become a member of the firm of the Western Construction Co., Helena, Mont. He is succeeded by C. S. Hidel, former assistant state engineer.

HARVEY DARTT, city manager of Mankato, Minn., has resigned to enter the employment of the Barrett Co., Minneapolis. Mr. Dartt was formerly city engineer of Owatonna, Minn. He will act as division engineer for the Barrett Co. in the promotion of Tarvia pavements.

SIDNEY D. STRONG has resigned as city engineer of Sault Ste Marie, Mich., to become city manager of Plymouth, Mich.

J. HERBERT FITHIAN, of Bridgeton, N. J., has been appointed supervisor of the New Jersey state highway system through Cumberland County, N. J., and parts of Salem and Gloucester Counties. Mr. Fithian is associated with Walter M. Sharp, engineer of Cumberland County.

JOHN S. SHERMAN, formerly with the Sanitation Corporation, has joined the sanitary engineering department of the Dorr Co., New York City.

P. M. BOWEN, who has been project engineer on Federal Aid road work, stationed at Roswell, N. M., has been appointed engineer of District No. 5, New Mexico State Highway Department.

J. WINTER SMITH, formerly engineer-appraiser for the Federal farm loan bureau, with the Montana Joint Stock Land Bank at Helena, has been engaged as irrigation engineer of the Montana Irrigation Commission.

ROY M. GREEN has resigned as professor of highway engineering at the Agricultural and Mechanical College of Texas to become president and

manager of the Western Laboratories at Lincoln, Neb. Western Laboratories will take over the consulting and testing practice of Clark E. Mickey, of Lincoln, and will specialize in the testing and inspection of all kinds of building materials and operations.

JEROME A. MOSS has resigned from the firm of Jos. E. Nelson & Sons, Chicago, and will engage in general railway contracting with offices in Chicago.

CAMPBELL SCOTT, WILLIAM D. ENNIS, GEORGE B. FRANKFORTER, ERNEST P. GOODRICH, CHARLES A. MARSHALL, FRED E. ROGERS, WALTER RAUTENSTRAUCH, FRANK B. MALTBY, ARTHUR W. HIXSON, and RUMSEY W. SCOTT, announce the organization of the Technical Advisory Corporation, 132 Nassau St., New York City, to act as consulting engineers and industrial economists and advisers. The officers of the new organization are: President, Campbell Scott; vice-president and treasurer, Ernest P. Goodrich, and vice-president and secretary, William D. Ennis.

JACK F. WITT, former engineer of Dallas County, Tex., has been named vice-president of the South-Central Division of the National Highway Traffic Association.

S. FRANK DOEBLER, construction engineer, Chicago, has gone to Austin, Tex., to take charge of the construction work on the Austin Dam across the Colorado River near that city. Work on the dam, which has been suspended since 1915, will be resumed at once.

OBITUARY

GEORGE W. VAUGHN, engineer maintenance of way, New York Central, exterior zone, lines east of Buffalo, with headquarters at New York City, died at Mount Vernon, N. Y., June 5, at 61 years of age. He was born at Paucutuck, Conn., and received his education in the Warner Polytechnic School, Providence, R. I. He began his career as rodman for the Pittsburgh, Cincinnati & St. Louis R.R., in 1881, subsequently serving as assistant to the engineer maintenance of way, supervisor of track, and assistant engineer maintenance of way, of that railroad. In 1887 he became assistant to the division engineer, Eastern Division, New York, Chicago & St. Louis R.R., later being promoted to division engineer and then to chief engineer in charge of property, reconstruction and maintenance of way. He entered the service of the New York Central & Hudson River R.R., in 1899, as supervisor of bridges and buildings, Eastern Division. The following year he was transferred to the Pennsylvania Division as division engineer and a year later to the Western Division. In 1905 he was appointed engineer maintenance of way.

JAMES M. EDWARDS, civil engineer and railroad operator, died at New York City, May 24, at 70 years of age. He was born in Oglethorpe County, Georgia, and graduated in civil engineering from the University of Georgia in 1869. Mr. Edwards was connected with the construction of the Louisville, New Orleans & Texas R.R., now the Yazoo & Mississippi Valley R.R., and was vice-president in charge of operations and general manager of that railroad until 1894. He was also connected with the Illinois Central R.R. In 1890 he moved to New York City, becoming associated with the R. T. Wilson Co., and had charge of the construction of the Yonkers street railway, of which he was president, and the Nashua electric line in Brooklyn. Later he re-organized and consolidated the street railways of Detroit into the present Detroit United Railways. Mr. Edwards was also president of the Matheison Alkali Works, Saltville, Va., and of its subsidiary, the Castned-Eltro Alkali Co., Niagara Falls.

BUSINESS NOTES

T. E. SPENCE has been appointed distict sales manager of the newly established New England office of the Reading Iron Co. located in the Compton Building, Boston. Previous to his connection with the above company, Mr. Spence for several years conducted a private engineering practice in Philadelphia, his clientele including a large group of industrial organizations. Later, he was associated with the Vacuum Oil Co., New York, in a special sales capacity, which position he resigned to join the sales staff of the Reading Iron Co.

THE BLAW-KNOX COMPANY, Pittsbugh, announces that the U. S. Senate has granted a petition to change the name of the town of Hoboken, Pa., where its plant is located, to "Blawnox." The company first established in Hoboken about five years ago, at the same time operating another plant at Wheatland, Pa. About two years ago the latter plant was removed and added to the Hoboken works. About 1,000 people are employed in the Blaw-Knox shops.

O. D. WEAVER, formerly with the Lidgerwood Manufacturing Co., is now associated with Robert B. Campbell Co., of Boston, New England agent for Ransome Concrete Machinery, Orr & Sembrow, Symons Clamp Co., and other manufacturers of contractors' equipment.

THE FREEMAN-RIFF CO. is completing its new plant at Terre Haute, Ind. This company manufactures conveying machinery, specializing in the design, manufacture and installation of installations for the handling of coal in boiler plants and retail coal pockets. J. B. Freeman, president, will be in direct charge of plant operation and production. Previous to his present position, Mr. Freeman was chief engineer of the De Pere Manufacturing Co., De Pere, Wis. D. M. Riff, secretary-treasurer, recently resigned from the American Steam Conveyor Corporation, as assistant manager of that concern's New York office.

THE PENNSYLVANIA PUMP & COMPRESSOR CO., Easton, Pa., has opened sales offices at 50 Church St., New York City; 2222 Chestnut St., Philadelphia; Fulton Building, Pittsburgh; Mutual Building, Richmond, Va.; Jefferson Bank Building, Birmingham; Newhouse Building, Salt Lake City, and First National Bank Building, Milwaukee.

Tractor Fresno Hitch and Control

A new mechanism, enabling the driver of a tractor to operate a fresno or grader attached to the tractor by means of a crescent shaped bar bolted solid at the center at the drawbar of the tractor, has been recently constructed, tested and is to be placed on the market. The points of the crescent extend outward and backward to clear the rear wheels of the tractor. The eye-bars of the fresno are shackled to the points of the crescent. This hitch brings the fresno close to the wheels, so the lateral swing on turns is reduced to a minimum.

TRACTOR-DRAWN FRESNO IS NEW GRADING DEVICE

The operation of the fresno is effected by a hand lever hinged to the body of the tractor, forward and below the seat. From there it passes upward and backward, where it is made convenient to the left hand of the tractor operator. To the upper end of this hand lever, just back of the operator, the front end of a "johnson" bar is connected and the rear of the "johnson" bar is connected to a bar attached firmly to the fresno. This attachment to the fresno is in line with the levers about 15 in. from the middle.

This new mechanism has been designed and built by O. S. Proctor of El Centro, Cal. Patents on the attachment and control are pending.

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—JAMES H. McGRAW, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN
Editor

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An Economic Study of Highway Design

JUST how far highway engineers have been able to go in spending money to reduce highway grades, and to what extent outlay of money to secure better locations are economical from the viewpoint of motor operation, have always been more or less indeterminate questions. Wilson G. Harger, former senior highway engineer, Bureau of Public Roads, begins in this issue the first of a series of three articles upon motor operation costs as affecting highway location and grade design. In these articles Mr. Harger presents definite data upon the capitalized value of saving in motor vehicle operation costs due to shortened distances and grade reductions. As the first or at least one of the first thorough economic studies of the kind the articles deserve attention.

New Partners in City Planning

CITY planning is being quickened and stabilized by the increasing interest in it shown by the realty operators—or "realtors" as they call themselves. A few years ago, representatives of realty organizations were given an important place on the program of the City Planning Congress. Since then these bodies have been featuring city planning on their own programs. At St. Louis, in June, the National Association of Real Estate Boards not only listened to an address by a city planning consultant but they also received a report from their own City Planning Committee. This report, according to a press summary, "urged greater activity in city planning" and condemned "the property owner who through short-sightedness, stands in the way of greater beauty and utility in city arrangement." No stronger allies for city planning could be found than realty operators once they were filled with sound ideas on the subject and gave it their hearty support. Heretofore many of them have been blinded to the ultimate interests of themselves and their clients through a desire for immediate profit regardless of the future welfare of themselves and their city. There have been notable exceptions as witness the volume entitled "Principles of City Land Values," by Richard M. Hurd, (see Engineering Literature Supplement to *Engineering News*, March 17, 1904). Municipal engineers should seize the opportunity to co-operate with local real estate men, as individuals and organizations, to further intelligent city planning.

Realtors Promote City Zoning

A FURTHER illustration of the growing interest of real estate organizations in city planning is afforded by the existence of a zoning committee of the Real Estate Exchange of Birmingham, Ala., which has collected data on zoning from other cities for presentation to the exchange. Since zoning places such restrictions on the use of land as may readily prevent the sale of plots, it might be supposed that real estate men would be against it. But the farsighted view is becoming more and more common and many realtors are helping instead of hindering the zoning movement that is now sweeping over the country. This is most encouraging.

Production and Transportation

THE fact that distribution is an important supplement of production and that the two are interdependent features of equal importance to commerce is not realized as generally as it should be, but it is being shown very forcibly by the present condition of railway transportation systems. Products badly needed in various sections of the country are either held because they cannot be shipped or are making snail-like progress to their destination. Under such conditions any marked increase in production serves mainly to increase the congestion of storage and transportation facilities. It has been urged, in fact, that the interests of the country demand immediate increase in transportation capacity rather than increased production, since products already have overwhelmed the railways with business. Inland waterways offer practically no relief. Highway and electric railway transport, important as they are in local and short-haul service, can effect only slight relief in the handling of the vast volume of freight. Distribution may be divided into long-haul service—or transportation—and local transportation. Along the same line of thought may be noted a recent paper on "Distribution and Warehousing" by Charles H. Moores, warehouse engineer, who states that the distributing branch of the warehouse business has been developed only in a few of the largest cities and that 60 per cent of the men operating merchandise warehouses are unaware of the great possibilities of organized distribution service. As an example he suggests that a number of warehouse firms operate a motor truck service and call the attention of shippers to its advantages as compared with reshipment by railway to local points. It is important, however, that railway men also should comprehend the possibilities of utilizing motor trucks for terminal transfers and the shorter hauls.

Simplifying Concrete Design

REINFORCED concrete is a variable material. Its physical properties are subject to all manner of change due to ingredients and methods, and actual placing is never accurate. Design, that is the prediction of stresses, must therefore always be approximate and dependent on the factor of safety. Lately, however, there has been a tendency to carry theory too far and to design much closer than the structure itself can be built. Were this careful designing and detailing not expensive in time and effort it might be defended, be-

cause, regardless of the variations in the materal, the closer theoretical stresses can be predicted the more dependable will be the factor of safety used. But there comes a point where economy and common sense demand simplification. Too many designers see the reinforced-concrete beam as a precise rectangle with clearly defined loads and nicely placed heavy lines indicating reinforcement. Such designers are too careful. They may go so far as one who has recently argued that the difference in stress in the upper and lower semi-circles of the tension rod section must be taken into account because obviously in bending such stress differences exist, or they may carry the theory of stirrup location to the point of the placing of the stirrups at the exact center of gravity of the successive trapezoids of the shear diagram. This latter offense results in about one diagram a week being submitted for publication to this journal. Stirrup design at best is a debatable subject, and stirrup location in the field highly elastic. So far as the safety of the structure is concerned some elementary calculations of size followed by location almost by eye will serve quite as well as elaborate computations or tedious following of tabulated or diagrammed data. Most designing offices follow some such scheme. Why should it not be recognized in the literature of the subject?

"France Will Rise Again"

FOR a number of weeks *Engineering News-Record* has been publishing, under the heading "Notes from Foreign Fields," a series of impressions by its editor, E. J. Mehren, who is making an extended trip in Europe. His comments, up to date, have dealt exclusively with things British—the highway problem, English engineering societies, construction methods and other subjects. Mr. Mehren crossed the Channel several weeks ago, and in this issue appears the first of his comments on conditions in France. He deals with that country's biggest question—the status of reconstruction—and his observations are based upon a tour of the devastated regions, including landmarks such as Ypres, St. Quentin, Amiens, Albert, Arras, Lens and Lille, which the World War has made famous for all time.

To engineers generally, and especially to those members of the profession who served with the American Expeditionary Forces and, under the stress of conflict, traversed much of the ground covered by Mr. Mehren only a few weeks ago, the story of France's progress in emerging from the ruins is of intense interest It is true that a comparatively small number of our overseas forces had the opportunity of seeing the devastation wrought by the enemy in these sectors of northern France. The greater part of the line in this region was held by the British, the Belgians or the French, our own operations centering principally in the east in the region of St. Mihiel and the Argonne. To certain of our troops, however, and among them several American engineer regiments attached to the British forces, the scenes depicted by Mr. Mehren bring back vivid memories. It was in the region of Ypres and, in fact, along the whole battle line extending south through the Somme Valley, that the greatest destruction to French towns was done. It is true that a vast amount of labor must be expended to repair the damage done in the Argonne region where our troops saw their greatest action, but as a general rule the havoc wrought by shell-fire in the Argonne, due to the comparative rapidity of our advance, does not approach in volume and in completeness that done in the Flanders region and throughout the north of France. It is here that France's greatest effort now is demanded.

Of the outcome there can be little doubt. Mr. Mehren's message of the progress being made to restore the devastated regions is truly inspiring. For some time after the armistice when, as was natural, everything was in a state of disorganization and France was seeking a well-earned breathing spell after her terrible struggle, progress in reconstruction took the form of words and plans rather than actual accomplishment on the ground. The reading of the article in this issue, dealing with the work at Lens, however, indicates clearly that conditions have changed and that actual results are replacing talk and "projects." The fact that on the first of May 43 per cent of the shell-torn farmlands had been cleared and put under cultivation is a fact of great significance to any one who saw that territory in 1918, for it tells the story of a supreme effort to restore conditions to their pre-war status.

From other figures cited in the article it is apparent, also, that the vital task of rebuilding the roads, of getting the railroads back into service, of clearing the land of shells and barbed-wire entanglements and of filling in the trenches is going on apace. Shattered houses in the towns and villages are being made habitable, but it is natural that this work should proceed slowly and it will be many years before the traces of the shelling to which they were subjected will be removed.

More important, perhaps, than the physical evidences of the fact that France is emerging from the ruins of war is the spirit in which the people are attacking the stupendous problem of bringing a semblance of order out of chaos. France is hard at work. Union hours, according to Mr. Mehren's observations, are practically unknown and the noise of the carpenters busy on the repair of buildings begins early in the morning and continues until nightfall. The fact, too, that in the ten devastated departments 3,967,000 people were residing on April 1 of this year, as against 1,944,000 at the time the armistice was signed, is an index of the spirit of determination with which the French nation is "carrying on." Seeing evidences of this courageous attitude throughout his travels, it is not strange that Mr. Mehren should write "France is rising—rising rapidly."

Transportation Development in Thinly Populated Countries

THE provision of transportation facilities needed to encourage the settlement and development of lightly settled but productive country is a difficult problem in view of the cost, the great distances, the demand for branches and cross-country connections as well as for main routes, and the light traffic that must be expected for several years. In encouraging the settlement and development which has been interrupted seriously by the World War the government of the Union of South Africa and its protectorates is encountering this problem, as outlined in a report which is abstracted on p. 103. In this case there is the further condition that the matter is in the hands of the government, which must balance the needs and desires of the country against the problems of taxation and finance.

Roads as auxiliary to railways are discussed in the

report, but highway development in South Africa is in its earliest stages, with no definite plan or policy yet formulated. One result of government ownership of the railways is a public argument that in districts not yet supplied with communication the railway department should build highways. It is not difficult to answer this argument. For one thing, there is the essential difference that a direct charge is made for the use of railway facilities and the returns are expected to approximate the expenses, even if they do not show a profit. But highways, on the other hand, are provided for the free use of the public, except so far as taxes may indirectly bring some return to provide for maintenance and extension. There is the possibility of adopting the turnpike system, but this appears to be practically obsolete.

Light railways as an auxiliary means of developing the transportation system at low cost in sparsely settled districts are not touched upon in the report. This seems to be a rather strange omission, especially as such lines would logically be handled by the Railway Department independently of the highway problem. It is probable, however, that they would be a drain upon the resources of the Railway Department rather than productive of revenue, and that the benefits accruing to the districts served and to the country at large would not appear in the financial reports of the Department. In what relative degrees the railway system is to be regarded as a source of revenue and as a means of development is a question for the government. Much has been done in the construction of light pioneer railways in countries having conditions comparable with those of South Africa. In this connection reference may be made to recent Canadian projects for light narrow-gage temporary railways to open up communication in advance of permanent railway construction.

To sum up the transportation problem of South Africa, so far as it can be determined from the report mentioned above, it appears that there is need for the prompt initiation of a definite and vigorous policy of highway construction as a matter of public benefit. Further, the development of both road and railway systems offers opportunities for promoting the growth and prosperity of the country. It may be that this indicates a new field for the American engineer, contractor and manufacturer.

The Chicago Drainage Canal Decision

NAVIGATION rights and the power of the War Department to protect them are held to be supreme by Judge Landis, of the U. S. District Court, in his Chicago Drainage Canal decision (see p. 107). Under the law, the judge holds, Chicago's plea for protection to its water supply has no standing. He does not pass on the strength of the plea. He rules out any such plea, as not within the cognizance of the law governing the case.

The decision settles nothing. It is merely another step in a controversy so long drawn out that only those specially interested remember its origin or are even aware of its existence. If the United States is as long over the case on appeal as was the lower court, any one of many things may have happened before a final decision is reached. One of these will probably be a compromise of some kind under which the Chicago Sanitary District will build or pay for lake regulating works and be permitted to use its drainage canal to its full capacity. Another will almost certainly be the construction of sewage-works to lessen the increasing burden on the canal due to the rapid growth of Chicago. A remoter possibility is that Chicago will win Congress to its way of thinking that sanitation should be superior to navigation in this case. Most remote and unlikely, a Secretary of War may come into office who will depart from the rulings of a long line of predecessors.

The Chicago Drainage Canal has raised many broad and serious questions of sanitation, navigation and power, besides governmental questions—local, state, national and international. All center in the one primary question: The right in law and equity of diverting water and sewage from one natural drainage system into another and thus changing the order of nature and impairing whatever rights in law or equity may be involved. Such a main question, with its many subsidiaries, cannot be left to the decision of any one city. It becomes a state, or a national, or an international question, according to the circumstances of each case.

Unfortunately for Chicago, it does not seem to have foreseen the necessity of going beyond its State legislature for authority when it launched an unprecedented drainage canal project with interstate and international reactions. When Chicago came up against the United States in the injunction suit brought by St. Louis on sanitary grounds, it won a Scotch verdict, but it fared differently with the War Department which has persistently and consistently refused to grant Chicago all the water it wants to divert from Lake Michigan.

Without presuming to pronounce on the magnitude of the effect of the drainage canal upon the levels of the Great Lakes, and thus upon navigation, we have no hesitancy in saying that petty and in some cases almost imaginary navigation interests have always been and still are made paramount to other and far greater interests because of the rigid interpretation and enforcement of laws and rules established when navigation was of importance and highway and railway transportation were in their infancy. Traffic changes and perhaps changes in sanitary conceptions and needs demand a reconsideration of some of the ancient rules to protect navigation. But obviously there must be some limit set on the uses of water for other than navigation purposes. Otherwise Chicago might claim a continuing right to water for sewage dilution proportioned to its increasing population. Other cities, too, might put in claims for the use of water for one purpose or another.

Finally, whatever engineers of today, possessed of the existing body of sewage dsposal data and confronted with the millions of population soon to be served, might decide if they were to attack de novo the Chicago sewage problem, we cannot but have admiration for the conception, design and construction of the Chicago drainage canal. It is based on the sound principle and practice of disposal by dilution. It has worked sanitary marvels for Chicago, including a probable very large part in the reduction of Chicago's long-time high death rate. That it has injured either navigation on the one hand or, on the other, the health of the people in the Mississippi Valley, has not yet been proved. What injury in both directions, and to power on the Niagara and St. Lawrence Rivers, might be wrought if Chicago could take all the water for the canal it might take if under no check, is another matter. Ample checks exist, so there need be no fear on that score.



CLEANING UP DEBRIS AT YPRES AND TYPES OF CONCRETE SLABS AND CORRUGATED IRON HUTS BUILT

Notes from Foreign Fields—"Lens Will Rise Again"

BY E. J. Mehren
EDITOR, ENGINEERING NEWS-RECORD

EDITOR'S NOTE—*This contribution of Mr. Mehren's series is published out of its regular order because of the intense interest attaching to the reconstruction in France. It was written in Paris, June 25, immediately after Mr. Mehren had completed a tour of the devastated regions.*

On top of a heap of brick and stone that was the Hôtel de Ville (the town hall) at Lens I saw three days ago this sign in French: "Lens Will Rise Again." Round about was the most hopeless ruin I have seen in the devastated regions. Scarcely a wall of arms-length height can be found. Destruction—utter destruction!

CATHEDRAL AT YPRES

Yet on the highest heap of debris stands the sign of courage and confidence and dogged determination—"Lens Will Rise Again."

And that is written across the whole of the north of France—*France Will Rise Again,* not by words, but by deeds.

France is rising from her ruin. France's scars of war are disappearing. France is repeating the days when her recuperative power astounded the world. She is making another record—a record that will eclipse that of the seventies.

Strange words, these, in view of the tales we heard of a nation exhausted, unable to rise unless helped by other lands, and particularly by the United States.

Yet this evidence is here and none can dispute it.

I have covered the ground north of Paris—St. Quentin, Chauny, Noyon, Amiens, Albert, Arras, Lens, Lille, and up into Belgium, around Ypres. I have talked to engineers and contractors who have covered every mile of ground from Verdun on the southeast to Ostende and Zeebrugge on the Channel, among them Charles A. Stone, of Stone & Webster and the American International Corporation. Their testimony bears out that which I have seen. France is rising from her ruins; she is earning again the admiration which she won in her recovery in the seventies and in her stubborn resistance in the four years of war.

True, the signs of battle are not wiped out; they will not be wiped out for many a year. True, also, that one can conceive of the work going faster; but unaided, using only her own resources, short of men and materials and transportation facilities, she has restored life in the devastated regions, she has cleared 85 per cent of the farms of projectiles, and this season (up to May 1) had put under cultivation 43 per cent of all the devastated lands.

Let me repeat that and write it in italics—*In less than two years after the cessation of hostilities, 43 per cent of the churned-up, desolated farming land is producing crops.* The additional land put under cultivation since May 1 has probably raised the percentage to 60 or 65.

Let me make it stronger still and hammer it home: At this very hour—I take the statement from an official document issued June 20—the ten devastated departments are producing enough cereals for their own needs and may, in fact, be able this year to send cereals to the rest of France.

France Is at Work

The villages, of course, are still in ruins; the industries are barely getting started; the peasants are living in all sorts of improvised shelters, from tar-paper-covered shacks to old army barracks and corrugated-iron-roofed huts with low sidewalks of concrete. For many a year they will live in these temporary dwellings; but they are at work, they are producing wealth, they know no union hours, they are not complaining—they are just doggedly at work, pulling their destroyed territory out of the chaos in which it was engulfed.

I hope I will not be mistaken. Northern France today is not a country in which one would freely choose to live—unless to help pull in the yoke with these courageous French peasants. The cities are still liberally strewed with ruins; Lens and Albert and Bapaume and other cities are still flat; the villages are brick heaps, save for the temporary huts—but the region that was dead has been reborn, the life that was gone has returned, the upheaved soil is coming under the plow and producing crops, the villages are rising again, the less damaged buildings in the cities are being *rapidly* restored (yawning gaps in street-rows will be there for years), and the hum of industry is heard.

A few figures will help to carry the tale to those who cannot come to see:

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ONE OF THE FIRST TEMPORARY SHELTERS BUILT AT LENS

The population of the ten destroyed departments, reduced on Nov. 1, 1918, to 1,944,000 has risen (as of April 1, 1920) to 3,967,000.

Life has been resumed in 4,000 *communes* where it was extinct, or practically so. Of 6,445 schools before the war, 5,345 have resumed their duties, generally in temporary buildings.

Nearly 1,700 co-operative reconstruction societies have been organized and 141,000 persons are engaged in reconstruction operations.

Out of 3,950,000 hectares of land to be restored, 3,339,000 had, on May 1, 1920, been freed of projectiles, 2,780,000 had been cleared of barbed-wire entanglements and 1,680,000 had been ploughed for the first time. The progress in the seven weeks since these figures were compiled has probably brought the ploughed percentage to 60 or 65.

Of 265,000,000 cubic meters of trenches 156,000,000 had been filled, and of 300,000,000 meters of barbed wire entanglements, 203,000,000 had been taken up. A total of 15,350,000 cubic meters of débris had been disposed of, out of a total of 41,000,000 cubic meters.

In all, 297,000 houses had been totally destroyed, and 277,000 more damaged. Of the latter, 185,000 had been put in livable condition. Moreover, 28,500 wooden huts, 28,200 temporary wooden houses of fair construction, and 16,800 temporary houses of brick, concrete slabs, etc., had been erected.

Of 51,547 km. of highway needing repair at the time of armistice, 17,789 had been put in temporary condition, and 2,265 had been completely restored. Seventeen hundred culverts and bridges out of 3,168 had been replaced, most of them with temporary structures.

The main-line railroads, whose length I have been unable to secure, had been completely restored, as had also the canals. The branch railway lines to the extent of about 60 per cent had been put in condition to permit operation and some 391 km. out of 2,386 had been completed. Of industrial establishments, 2,627 out of 3,508 had resumed operation by May 1. Production is not at pre-war capacity, but the wheels of industry are again moving.

All this France has done by herself—practically unaided. She has done it because of the energy and devotion and courage of the people of the devastated regions, backed by the whole of France.

I was awakened by carpenters at 7 in the morning; I saw them rebuilding industrial plants as I went in to dinner at 7 in the evening.

The peasants stop only at nightfall.

Yes, "Lens Will Rise Again." *France* is rising—rising rapidly.

PARIS, June 25.

Machine for Forest Products Laboratory

Tensile, compressive, and bending tests up to 1,000,000-lb. load can be carried out on a new vertical screw-power testing machine just built for the Forest Products Laboratory, Madison, Wis. One or two earlier machines of the same general type and of the same capacity has been built, but the present machine is of somewhat wider range of use. Its overall height is 45 ft., of which 37 ft. is above the level of the table, and its floor plan is 15 ft. x 10 ft. 8 in. It will take columns up to 30 ft. long; when arranged for tension tests the pulling head has a maximum travel of 29 ft. In transverse testing it can take beam specimens up to 10 ft. long. The upper or weighing head can be fixed at several different elevations, to adapt the machine conveniently to different lengths of specimens; two keys passing through openings in the weighing column hold the head. The weighing mechanism is independent of the power mechanism. Readings on the beam are by 10,000-lb. increments to 1,000,000 lb., a micrometer dial giving the readings from 100 to 10,000 lb.

Cold Weather Troubles Encountered in Water-Works Operation

Slightly Condensed from Report of Committee on Cold Weather Troubles, Charles R. Bettes, Far Rockaway, N. Y., Chairman; presented at June Convention of American Water Works Association.

THE Committee received 85 replies in response to its questionnaire regarding the cold weather troubles of 1917-18. The information has been tabulated and is filed with the editor of the *Journal* of the association. The data is interesting and valuable but lack the uniformity necessary to make a comprehensive comparison, and the Committee did not feel that the data were such as to warrant the expense of printing.

Temperature — Extreme low temperatures prevailed throughout the country during the winter of 1917-18. Unfortunately, the replies to the questionnaire seldom gave temperature where trouble was experienced and did not indicate the close relation between trouble and temperature that one might expect. Trouble was experienced in comparatively high temperatures in some localities and none reported at low temperatures in others, without any explanation of this unusual condition. In few cases was the depth of snow mentioned. Nearly all reported an increase in consumption during the cold period.

Depth of Pipe Cover—The data on depth of piper covering were interesting but not conclusive except in emphasizing the need of giving special study to local conditions. Pipe having a covering of 54 in. of coarse gravel froze while pipe having only 24 in. of cover, but laid in wet ground, escaped. The size of the pipe and circulation being the same, it is reasonable to suppose that the nature of the covering material accounted for the difference.

Thawing Methods—The data on thawing were more complete. Forty-six replies reported in more or less detail the use of electrical current in thawing; 22 reported as to other means, etc. Important details, however, were lacking in many cases. In 53 of the cases the information was not comparable. Steam was used successfully in a number of cases. The majority of replies clearly favored the use of electrical thawing and indicated that this method afforded advantages both as to cost and efficiency. The cost data were incomplete, a few replies only giving details as to length or size of pipe, time, etc. The cost for services ranged from $1.90 to $139 per service; and the time from thirty minutes to two days. In general, it may be said that the expense of thawing a service was under $9 and the time required less than one hour. In the majority of the cases reported the current was taken from the local lighting company; 14 water companies did their own thawing; and in five cases the work was done by plumbers. The current used ranged from 5 volts and 150 amperes to 125 volts and 600 amperes. Storage batteries were used to some extent. There is a possibility that the use of electrical current may damage the pipe and connections. We recommend that those using this method carefully note the effect with a view of subsequent report to the association. Many automobiles were converted into effective thawing outfits; and there are undoubtedly possibilities in this line.

The committee endeavored to obtain from manufacturers specifications for an outfit, low in first cost, light in weight, simple and effective, that could be easily transported by sleigh or auto and operated by gas engine or the auto engine itself. We believe there is a market for such an outfit and hope that the manufacturers will give the matter earnest consideration. The committee recommends a generator operated by a gas or oil engine, set on an iron frame, equipped with rheostat, automatic circuit breaker, voltmeter, ammeter, cable, etc., all to be mounted on a trailer or sleigh, and further suggests the use of a current of from 30 to 50 volts and 130 to 400 amperes. There should be a rheostat control to permit increase or decrease in the voltage without interfering with the proper operation of the outfit. By proper manipulation such an outfit should do both for services and for reasonably sized pipes and if properly and carefully handled, would be safe and effective. It was suggested that where high voltage current was available, an A. C. transformer be held in reserve so that if more convenient, current could be taken from the power company. The manipulation in this case should be entirely under the control of the power company. It must be borne in mind that in the use of any electrical current for thawing there is definite risk and that care and common sense must be exercised.

Services Need More Covering—The greatest cold weather trouble probably comes from frozen services, at least the greatest "kick" comes from this source. The service pipes are seldom laid as deep as the mains and often with much less covering—exactly the reverse of what it should be. Not infrequently the tap is made near the top of the main and the goose-neck is perhaps 4 to 8 in. above the main. Services should have more covering than the mains and should be carefully inspected, especially if laid by plumbers. A main or service that has once given trouble should be lowered to prevent a repetition.

Fire Hydrants—A frozen service is more or less inconvenient but a hydrant out of commission creates a serious risk. Hydrants should receive special attention and every hydrant on the system should be inspected late in the fall. The drip should be open, if the hydrants are set so they can drain. If set in water, the drip should be plugged and the hydrants pumped out. Those on dead ends should be packed. Where it is necessary to take these precautions, hydrants should be inspected frequently. There should be a rigid rule to prevent unskilled or curious people opening hydrants during cold weather "to see if water will run"—a not infrequent cause of trouble.

Frozen hydrants were reported successfully cleared by steam, hot brine, calcium carbide, alcohol or by building a fire about them. No information was given as to the effect of salt or carbide on the valves. Alcohol was reported as giving satisfactory results but it is rather expensive and since the prohibition amendment might be considered unsafe; not, however, as unsafe as the practice of building fires. Ordinary hot brine will do good work. If the trouble is in the branch, salt and carbide are said to be effective.

A Local Problem—The operating man must study the conditions in his locality and solve them as a local problem and not be governed too much by what may be good practice in other localities. This refers not especially to cold weather troubles (which after all are of comparatively small moment) but to the operation of the entire plant. The actual number of services, hydrants and mains frozen is a very small per cent of the whole, and indicates that water. works in general are as efficiently managed as other businesses.

Floating Jib Crane of 200 Tons Capacity

In building a steam-power floating crane for very heavy lifts for the Cammel, Laird & Co. shipyard, at Birkenhead, England, the builders, Cowan, Sheldon & Co., Ltd., of Carlisle, adopted the luffing-jib type but without rotation, the jib being hinged directly to the tower fixed to the deck of the scow. The crane has a lifting capacity of 200 tons at 65-ft. clear reach beyond the end of the scow, and with capacity for 30 tons lift on an auxiliary block at a reach of 97½ ft. clear. The forward post of the tower, carrying at its top the end pin of the jib, is set 35 ft. inward of the forward edge of the scow. The main hoist consists of two separate 100-ton blocks, which for joint lifting are coupled by a crosshead. The rate of lift at maximum capacity is 8 ft. per minute, while the 30-ton auxiliary hoist has a lifting speed of 40 ft. per minute. Luffing for hoisting the jib is done at a rate requring 20 min. for the full range of about 50 deg. vertical angle, under maximum load. Outline drawings of the crane and a brief description are given in *Engineering* of June 25, 1920.

Road and Railway Transportation in South Africa

Relation of Government Owned Railways, Roads and Motor Service in Developing New Lands for Settlement and Farming

INCREASE in transportation facilities to promote the development of the country is a problem before the government of South Africa. In addition to the continual demand for railway extension there is a growing demand for a system of public roads to supplement the railway system. These two factors of the transportation problem, together with the relations between them, are discussed in a report by Sir William W. Hoy, general manager of the Department of Railways and Harbors.

Highway development appears from the report to have been left to local authorities, which have not been able to make much progress. It is pointed out by Sir William Hoy, however, that highways constitute a national rather than a local consideration, because the prosperity of the country depends upon the development of its material resources, which in turn depend largely upon the provision of transportation facilities. Owing to the long distances with consequent heavy expenditures for both construction and maintenance in relation to a thin and scattered population it is considered that proper development of the highway system is beyond the financial limitations of local authorities and that therefore the government should provide at least main roads sufficient to develop the resources and increase the prosperity of districts upon which road taxation must be levied.

It has been suggested that road construction in country districts not served by railways should be undertaken by the Railways and Harbors Department, as other government departments are not in financial position to assume the responsibilities, while both roads and railways are factors in land transportation. Sir William Hoy dissents from this view. He states that road construction and control are not properly functions of a railway system and that users of the railways would object to paying largely increased rates and fares in order to provide money for highway work. Furthermore, he points out that though there may be advantages in grouping roads and railways in one department, the financing of the two systems must be kept separate. He is not prepared to say that co-ordinated control of roads and railways is necessary in South Africa, but he considers that a present and absolute necessity is a progressive road policy controlled by an authority having sufficient financial resources for a general program of development.

On the other hand he argues that no railway system, however complete, will suffice to meet the transportation needs of a country, whether thinly or thickly populated. Even allowing for an extensive and continuous program of construction, many districts of South Africa will have to wait several years before they have railway communication, to say nothing of the branches and feeders needed to promote and assist development. Railways cannot serve directly all the farms and it will be many years before all farms are even within such close reach of a railway as to make intensive cultivation profitable, to secure economic transportation and to admit of produce being delivered to competitive markets.

That some alternative and auxiliary means of transport is necessary, therefore, it is stated in the report, which discusses motor transport on highways as a possible auxiliary or feeder system, reference being made to the practice of several English railways in operating road motor service in agricultural districts. Flexibility is the great advantage of a service of this kind for collecting products, distributing supplies and handling local traffic in such a way as to meet the needs and develop the resources of outlying districts. But motor transportation requires good roads and in South Africa these exist only in the neighborhood of large cities. Heavy wear and consequent heavy maintenance and repair work on the roads will attend the development of motor traffic and must be considered in any highway program.

A thorough investigation to determine the best means of solving the transportation problem is an urgent necessity, according to the report, which points out that future prosperity depends upon the opening up of internal resources and that the full development of the country cannot be obtained until something is done to improve the transportation facilities.

Light Creosote Oils in Wood Preservation

Light creosote oils properly injected into wood apparently will prevent decay until the wood wears out or until it checks so badly that the untreated portions are exposed. Such is the indication of service records collected by the U. S. Forest Products Laboratory on railway ties and telegraph poles preserved with low boiling creosotes.

Creosotes used in ties from 25 to 50 years ago were for the most part oils having 50 per cent or more distilling below 235 deg. C., with a residue not to exceed 25 per cent at 315 deg. C. The ties so treated lasted from 15 to 20 years, and failure was traceable in most cases to mechanical wear, such as rail cutting and spike killing. In no case was failure found to be the fault of the preservative.

Of 1558 telegraph poles in the Montgomery-New Orleans line, which were pressure-treated with a light creosote oil, 1049 poles were still sound after 16 years. In 91 per cent of the cases of decay the fungi had entered the wood through checks and shakes. Representative sections in the Norfolk-Washington line showed that after 17 years service, of the 1614 poles inspected, 1469 were sound, 92 decayed at the top, and 105 decayed at the ground line. The decay at the top was caused chiefly by cutting off the poles. In those decayed at the ground line, the causes of failure, as determined in 88 per cent of the cases, were checks or shakes. Here again as in the ties, the preservative outlasted the mechanical life of the wood.

The following conclusions are from the Forest Products Laboratory "Technical Notes," recently issued:

"Unless some other factor than protection from decay is considered important therefore, there is apparently no need to specify high boiling oils. The important point is that any coal tar creosote which is not extremely low boiling or extremely high boiling will satisfactorily prevent decay, and in the selection of an oil, factors such as price, penetrability, and convenience in handling should receive greater consideration than moderate diffierences in volatility."

Motor Operation Costs as Affected By Highway Location and Grade Design—Part I

"Mileage Service" Prime Consideration of General Policy — Extreme Refinements of Location Impracticable—Economic Grade Limits Defined and Recommended Practice Enunciated

By Wilson G. Harger
Former Senior Highway Engineer U. S. Office of Public Roads

MANY engineers, particularly men with railroad training, seem to feel that highway location and grade design should be based strictly upon a ton-mile cost analysis. Very few roads are designed strictly upon this basis, and the writer believes that the reasons why they are not, are sound, except for unusual cases. It is the intention of this article to outline the desirable features of locating from the standpoint of motor operation, and, at the same time, indicate the practical limitations in applying them. Certain general principles can be derived from the laws of mechanics modified by judgment. The data given have been used by the writer for some time as a basis for comparison of routes and alternate locations. The relative operating costs on different grades are, at present, entirely a matter of personal judgment and must be used as such.

Railroads have spent large sums to reduce the ton-mile cost, and in their locations careful comparative estimates are made of construction cost and operating cost. Why is this not done more in highway location, considering the increase in mechanical transport? One of the evident reasons is that railroads get a direct tangible money return in dividends for their expenditure, and the returns to a community on a public road investment are too intangible. It is undoubtedly true that to get the full value of an improved road system the engineering location should be made for the most efficient use of motor vehicles, but there is no possibility of obtaining, nor any justification for expending, extremely large sums to reduce the ton-mile cost below that obtained by the usual modern highway design.

If we had unlimited funds a careful analysis might be carried out on special roads, but we must consider the following fact: The locations of roads in well settled districts are practically confined to existing rights-of-way, except for minor relocations to avoid extreme grades or for reasons of safety. This is necessary, for the community has grown along these well set routes and the principle of direct contact holds. These rights-of-way were not necessarily laid out with regard to economic road location. In fact, they are often arbitrarily fixed by land section lines, or locations where a poor road could be constructed originally without much labor or cost. The cost of new rights-of-way for entire new locations and the difficulties of acquiring them are prohibitive at this stage of development in road building, except in unusual cases. The improved roads of today are only a progressive stage in the development of highway transport. The demand for them and the satisfaction in their use lie mainly in the fact that they provide a firm surface and can be used the year round; that they cheapen somewhat the cost of hauling, that they make the use of light automobiles feasible for long and fast trips. The community is willing to pay a certain amount for the improvement in road conditions which the usual practice in modern road construction gives, but it is not willing to pay large additional sums for further reduction in ton-mile hauling costs. Only a comparatively few men would get a direct benefit from such expenditure. The indirect returns to the community are too intangible. Much of the road traffic is pleasure traffic and a few more gallons of gas mean nothing. If the owner did not spend his surplus for gas he would spend it for ice cream, soda, or the movies. There seems to be no way of making the few road users who would be benefited by a further reduction in hauling cost pay the price of the necessary construction. It may be that for certain toll roads, some time in the future we can use a ton-mile location analysis, but we are not yet up to such a standard.

Mileage Service First Principle

This does not mean that the engineer should not make an effort to get the best possible location, but he should bear in mind that the first principle of general policy considering any comprehensive road improvement program is "mileage service," and he should aim to get the greatest mileage of road that will serve the great majority of road users. Poor grades or poor alignment should never be used on high grade improvements as they are the fundamental elements of design, but there is a limit to expenditures that would further reduce the ton-mile hauling cost.

Saving in distance is valuable; saving in total rise and fall is valuable; and the elimination of sharp curves is desirable. Every effort is made to accomplish these results, utilizing the existing roads where we have to; making minor relocations to avoid extreme grade or danger, because the sentiment of the community approves of these measures, but always bearing in mind that today and for a long time to come mileage is the prime requisite of the programs. It is possible in sparsely settled communities to make reasonable engineering locations but in these districts shortage of funds often plays havoc with our intentions.

It is well to bear in mind what distance saving is worth, and what a saving in total rise and fall is worth. The data given are, of course, of general value only, as the fluctuating cost of motor operation, the types of hauling, and special conditions of all sorts affect the figures. They, however, show in a general way that it is well worth while to reduce traffic losses arising from these elements of needlessly poor location or design. A. R. Hirst gives the above conservative figures on the value of saving distance:

If the very conservative sum of 10c. per mile is allowed for each mile of travel save , the saving of a mile in dis-

VALUE OF A MILE IN HIGHWAY DISTANCE SAVED

Average Number of Vehicles per Day	Saving to Owners per Year	Saving Capitalized at 5 per Cent Equals
100	$3,650	$73,000
250	9,125	182,500
500	18,250	365,000
750	27,375	547,500
1,000	36,500	730,000
2,000	73,000	1,460,000
5,000	182,500	3,650,000
10,000	365,000	7,300,000

tance on highways carrying the foregoing average number of vehicles per day, will save the traveling public the given amount per year, which is the interest at 5 per cent on the amount given in the third column.

The value of eliminating rise and fall cannot be figured with any degree of accuracy, as there are too many indeterminate and variable factors, but in the writer's opinion it is not likely that the capitalized value of saving one foot of rise and fall, per 100 vehicles per day on long routes, will exceed $60 on light grades or $400 on heavy grades. For small grading reductions on short hills the time factor is of no consequence, and the practical value of saving a foot rise or fall is not, probably, more than ⅓ of these figures. (See Part II of this article.)

It is very evident that considerable expenditure is justified to reduce distance and rise, but it is also evident that it would be impractical to carry this method of location to its logical conclusion by expenditures in any way approximating the figures given. The location of a free public road with no direct revenue return cannot be analyzed from the same point of view as a trunk line railroad. Before large expenditures are made for unusual refinements in location it is just as well to get a reasonably complete mileage of good, usable, firm-surfaced roads, as 100 mi. of the usual modern improved road are more valuable to the community as a whole than 50 mi. of more scientifically located highways. *Needlessly short mileage is the most serious criticism that can be made of any general policy.*

Summary of Motor Traffic Considerations

The design of a highway should, however, comply, as nearly as possible, with the theoretical demands of cheap operation. The principles used in this connection may be stated as follows:

1. The selection of maximum grade within the bounds of standard practice is not affected by the ability of single-unit motor vehicles to climb. Long trailer trains would modify the maximum grade.

2. The selection of maximum grade within the bounds of standard practice does not affect the factor of safe descent.

3. For a fixed rise and fall and distance, a combination of different rates of grade have no effect on fuel consumption. However, the total cost of motor operation, including the time factor, is, probably, slightly less for a uniform grade. This effect is not, however, noticeable enough to reduce the steepest grade below a reasonable maximum, and has no practical effect whatever on the use of rolling grades—as the value of smoothing out a rolling grade becomes less as the rate of grade is reduced.

4. For a fixed rise and variable distance depending upon the rate of grade, the lower the rate of grade the higher the fuel consumption and operating cost. Under these conditions the grade should be kept to the steepest reasonable rate.

5. In the matter of convenience in driving, it is desirable to avoid shifting gears. The grade at which gears are shifted for the ordinary car on improved roads is about 6 per cent—10 per cent for pleasure cars and 5 per cent to 8 per cent for standard trucks. This, however, is subject to constant change and not of much importance.

6. The value of distance saved can be closely approximated.

7. The value of rise and fall saved cannot be closely figured, but it is certain that it has more money value on steep grades than on light grades.

8. In locating roads, distance can be balanced against rise but it is not possible to analyze this closely. As a rule, distance should rarely be increased, particularly if good alignment is lost, unless it is necessary to get a reasonable maximum grade, or unless a noticeable rise and fall can be eliminated by a short additional distance.

9. Ruling grades need not be consistent in rate, so far as ordinary motor traffic is concerned, as they do not limit the load of single-unit motors.

From the standpoint of motor traffic the two most important considerations are short distance and the elimination of needless rise and fall on steep grades. Rate of grade or the elimination of rise and fall on light grades has very little effect.

Effect of Grade Selection

With the data at hand it is not possible to analyze the cost of motor operation closely for different rates of grade, but certain fundamental principles of road location can be established, by the principles of mechanics modified by judgment. Reduction in distance, time of travel and needless rise and fall are desirable, but it is very difficult to put a money value on such savings, particularly the elements of time and rise.

Practically, a little extra gas means nothing to a large proportion of road traffic, and a little extra time means less, for we all waste much of our time in spite of the teachings of efficiency. Therefore, to attempt to place a construction value on the saving of a little fuel and time hardly looks reasonable for most conditions. Under some circumstances, however, such as long distance main roads, particularly where regular, systematic truck freighting occurs, the time element is a real factor and should be considered. The writer has been in the habit of eliminating the time factor in considering motor traffic on local service roads, but includes it for special service commercial roads. This as a general rule means about twice as much expenditure is justified for saving distance and about three times as much for saving rise on special service roads as upon local service roads.

The discussion is only of general value and will first develop certain principles of location, and then a rough approximation of operating costs on different grades.

Light and heavy trucks are commonly operated on firm surfaced roads up and down 15 per cent grades. Light passenger cars have no difficulty in climbing 15 per cent grades even on fairly poor natural soil roads. The safety of descent depends largely on the condition of the road surface and the brakes, but it is not a noticeable factor in design up to 12 per cent which is beyond the reasonable bounds of modern practice in grade selection. *That is, the factors of climbing power of single-unit motor vehicles, and safe descent, do not affect the selection of grade from the standpoint of motor transport.*

Drivers dislike to be forced into second or low gear. If it is possible to determine approximately the rate of grade at which most cars or trucks shift gear, some information is had on grade selection. It is, of course, difficult to figure this closely, for as motor design improves gear ratios vary. Then cars run on varying degrees of efficiency, gasoline varies in quality, etc., but as a matter of interest the author's experience indi-

cates that the average light pleasure car of the year 1919 shifts into second gear at about 7 per cent and that very little gear shifting is necessary on long 6 per cent grades. W. C. Slayton, a truck fleet manager, says that his 5-ton standard gear ratio trucks generally drop into second at about 5 per cent and that very little shifting would be required on long 4 per cent grades. Passenger automobiles drop into low at about 10 per cent and the 5-ton trucks into low at about 8 per cent.

From the standpoint of convenience in driving pleasure cars these premises, if they apply, indicate that if for any reason a 6 per cent grade can not be obtained you might just as well use a 10 per cent and that heavy expenditure to get a 7 per cent or an 8 per cent has no bearing on the convenience of the road. This applies only to scenic routes. In the same way for truck hauling, if you can't get a 4 per cent there is no object from the standpoint of convenience in using less than an 8 per cent. Other factors, however, apply to reduce this extreme jump as discussed later. It should however be borne in mind that if trucks are operating regularly over a stated route special gear ratios can be and are used to meet the existing grades. Convenience therefore plays a minor part in grade selection.

Fuel Consumption

For an equal distance between terminals and an equal rise and fall the fuel consumption does not theoretically depend on the rates of grade. If, however, the selection of rate of grade affects the distance, but not the rise and fall, the lower rate of grade will increase the fuel consumption. To illustrate: Suppose a tractor is hauling a train of farm wagon trailers on a hard surfaced road; and suppose there are two villages *A* and *B* (see Fig. 1) 10,000 ft. apart and 100 ft. different in elevation. The theoretical energy in foot pounds per ton of load required to haul between these points is for all practical purposes the same for any ordinary maximum grade as shown in Table No. 1.

TABLE I.

Rate of Grade, per Cent	Resistance per Ton of Load (Lb.)	Length of Grade to Rise 100 Ft., Feet	Ft.-Lb. of Energy Used to Rise 100 Ft. on Grade Shown	Remaining Distance on Level, Feet	Ft. Lb. to Haul on Level for Remaining Distance	Total Ft. Lb. Energy to Haul from A to B
2½	90	4,000	360.000	6,000	240,000	600,000
4	120	2,500	300,000	7,500	300,000	600,000
5	140	2,000	280,000	8,000	320,000	600,000
6	160	1,666	266,640	8,334	333,360	600,000
8	200	1,250	250,000	8,750	350,000	600,000
10	240	1,000	240,000	9,000	360,000	600,000
Vertical	2,000	100	200,000	10,000	400,000	600,000

Resistance per ton of load on level 40 lb.

If we assume that the fuel consumption is proportional to the energy expended, Table 1 indicates that under these conditions no appreciable saving in fuel consumption results from the use of a low maximum grade. It is probable, however, that the time factor makes the lower grade somewhat cheaper on which to operate. This adds considerable strength to the contention that very little practical advantage results from reducing grades on local service roads below a reasonable maximum where the rise remains fixed and also indicates that long uniform low rates of grade have no particular added value over a series of grades of different rates provided the rise and fall and distance remain the same.

Now suppose *A* and *B* were only 1,000 ft. apart in distance and 100 ft. different in elevation. A road between them on a 10 per cent grade would be only 1,000 ft. and would take only 240,000 ft.-lb. of energy per ton of load on the trailer. A road on a 2½ per cent grade would have to develop additional distance to rise 100 ft. It would be 4,000 ft. long and would require 360,000 ft.-lb. of energy to haul 1 ton of load. From this it is possible to see that *where the selection of a low rate of grade increases the distance for a fixed rise it increases the fuel consumption.* Under these conditions it is desirable to use the highest rate of grade that will satisfy the other requirements of traffic and construction cost, such as reasonable limiting loads for teams or trailer trains, convenience in the matter of gear shifts and the cheapest construction location and maintenance cost.

Recommended Practice

From the standpoint of horse traffic, single unit motor traffic or trucks with one trailer, safe footing, and economy of construction and maintenance, the rates of maximum grade mentioned below seem reasonable for the great majority of improved roads. In unusual cases the possibility of the extensive use of long trailer trains would tend to reduce these rates. However, the author wishes to emphasize the opinion that it is not likely that the long trailer train will develop as a popular general utility mode of hauling, and while there undoubtedly will be cases where this method should modify the design, it will be the exception rather than the rule. The following rates are satisfactory for usual motor equipment and additional expenditure would not be warrented for the benefit of a few users unless they paid the additional cost of construction—

Main Commercial Roads in Flat Country—Long 2½ per cent maximum grades are desirable but do not justify much additional construction cost. Any long grade up to 5 per cent is satisfactory. Short 6 per cent grades are not consistent.

Main Commercial Roads in Hilly Country (Well Settled districts)—Long 5 per cent maximum grades are allowable and warrant considerable expenditure provided they do not increase the total distance. Seven per cent grades are probably justified to prevent increase in distance. Long 6 per cent grades are fairly satisfactory, but if a 5 per cent cannot be obtained it is just as well to jump to the 7 per cent rate. Short 7 per cent grades are not inconsistent with long 5 per cent rates provided the element of safe team footing is considered.

Main Roads (Pioneer districts)—Long 5 per cent maximum grades are very desirable, provided they do not increase the total distance, particularly if the road is a natural soil road and considerable horse traffic prevails. Any long grade up to 7 per cent is satisfactory. Short 7 per cent and 10 per cent grades in connection with 5 per cent and 7 per cent long grades are justified from the standpoint of all classes of traffic except trailer trains. Grades heavier than 7 per cent are not, however, in much favor on account of danger and high maintenance costs.

Side Agricultural Roads—Anv long grade up to 7 per cent is satisfactory.

Scenic Pleasure Roads—Six per cent is convenient; but any grade up to 10 per cent is suitable, provided the alignment is safe.

Consistent Maximum Grades—Considerable expenditure is justified to obtain consistent maximum grades for the benefit of team or trailer-train hauling.

(To Be Continued.)

Six-Track Coal and Water Station for Through Trains

Quick Service for Heavy Traffic on P. & L. E. R.R. With Minimum of Manual Labor—Water Supply Requires Treatment

A LOCOMOTIVE coaling and water station on a six-track line, capable of serving trains at 10-minute intervals in both directions, with a 20-minute stop for each train, has been built on the Pittsburgh & Lake Erie R.R. at Brightwood, Pa., where there are four running tracks and two freight train sidings of 100 cars capacity.

The use of mechanical equipment has made it possible to reduce operating labor to a minimum. Traffic averages 20 to 35 freight trains daily in each direction.

The plant is seven miles west of Pittsburgh and supplants an old one at Groveton, two miles farther west. Coal, water and sand can be supplied to trains on all six tracks, while the four inner or freight tracks also have ashpits where engine fires are cleaned. Three stops are made, one to take water and drop ashes and the others to take coal and sand. Freight trains are frequently operated on the two outside or passenger tracks. A view of the plant is shown in Fig. 1, and Fig. 2 is a general layout plan. A 750-ton reinforced-concrete coal bin spans the two middle tracks and is cantilevered out over the adjacent tracks, the chutes for the two outer tracks being carried by a steel bridge. The coal elevator tower, conveyor bridge and conveyor house above the bin are of steel construction, sheathed with asbestos-covered corrugated iron. Coal is delivered in hopper bottom cars set out on a stub having capacity for ten loaded cars above the track hoppers and ten empties below them. As this track has a grade of 1 per cent descending to the main line, the cars can be fed to the hoppers by gravity. A derailing switch set normally for a diversion track protects the main line against runaway cars.

Two track hoppers serve two coal elevators, each of which has a 2½-ton skip and individual hoisting machinery. In general one elevator is kept for reserve. The elevators operate automatically when started and each has a capacity of 75 tons of run-of-mine coal per hour, while the machinery is designed to handle lumps as large as 2-ft. cubes. Both skips discharge into a single hopper at the top of the tower, from which the coal is fed to an inclined rubber belt conveyor discharging above the center of the bin, so that the coal is self trimming. The belt has a handling capacity equal to the total of both ships. With this equipment a 24-hour supply of coal can be delivered to the bin during one 8-hour day shift.

Sand is dumped from hopper cars into a track hopper on the down grade side of the coal hoppers and is raised by a bucket-belt elevator to a belt conveyor which delivers it to a bin having capacity for forty carloads, or 2,000 tons. From the bin the sand is delivered manually to a bucket-belt elevator for delivery to hoppers which feed the drying stoves. The dry sand passes by gravity over inclined screens to a hopper-bottom bin and thence to the boot of another belt-bucket elevator, which in turn feeds a belt conveyor running to two storage bins in the top of the coal bin. Each bin has a capacity of 225 cu.ft. and from it there is a gravity feed through 6- and 4-in. pipes to 4-in. swinging chutes which serve three tracks.

Water is taken from the Ohio River, which flows

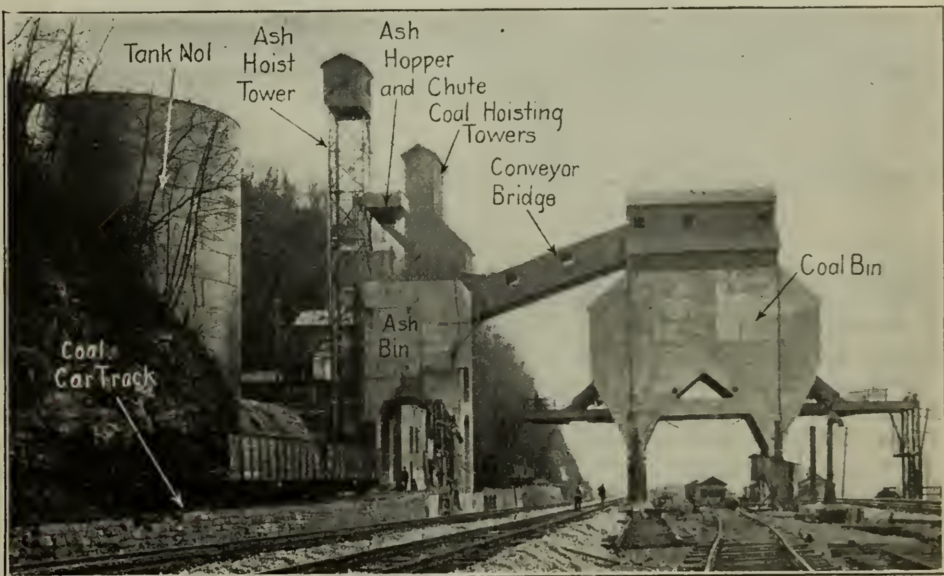


FIG. 1. COAL AND WATER STATION SERVES TRAINS ON SIX TRACKS

beside the railway. It requires treatment to make it fit for use in boilers, as it is very hard in dry seasons, and in flood time carries a large amount of matter in suspension. An attempt was made to get a supply by sinking wells to a gravel stratum below the river bed, but the water contains too much salt.

Intermittent treatment was adopted, as continuous plant supplying one storage tank would not give sufficient time for sedimentation. Two steel tanks or standpipes, of 400,000 gals. capacity each, are used alternately. As the raw water enters the tank it is dosed at the inlet pipe with a soda-ash and lime solution. To determine the quality of both raw and treated water, a few simple titration tests are made daily by the pumper, using standard solutions of soap, of soda and of acid. The amount of soda and lime required for each tank is determined by the tests of the raw water and by standard tables supplied to the pumper

by the railway company's chemist. Tests of the treated water indicate the efficiency of the treatment.

With this size of tank and an 8-hour pumping period about 16 hours are allowed for chemical reaction and subsequent sedimentation before the water is required for use. At the beginning of the next pumping period, the operator changes six valves, diverting the raw water and solution to the empty tank and connecting the full tank to the 16-in. supply main to the 12-in. water columns. Quick-acting gate valves are operated by levers attached to the stems. As the sets of valves are in proper position when the three levers for one tank are up and the other three are down, there is little chance for mistake or confusion on the part of the pumper. Inlet and outlet pipes are 10-in. and 16-in. in diameter respectively while the solution is fed through a 1½ in pipe.

Four water columns are installed, one for each outside or passenger track and one for each pair of freight tracks. As the ashpits are short, all engines are spotted in the same position, in order that the water columns can be so located that the firemen can fill the tender tanks while the hostlers are cleaning the ashes from the fireboxes.

Investigation showed the economy of a large pumping plant with which one pumper working 8 hr. could pump and treat water sufficient for a day's supply, as compared with a smaller plant requiring three men for three hour shifts. Two triplex pumps were available and together could deliver 42,000 gals. per hour, so that one man on an 8-hour shift could easily supply 300,000 gals, which is in excess of the present maximum daily consumption. At the present wage scale, the annual salary of a pumper exceeds the interest on $25,000 at 5 per cent, so that the use of a plant requiring one man instead of three was equivalent to saving $50,000 in capital expense.

Locomotives on the four freight tracks drop ashes into hoppers having bottom gates over a transverse tunnel in which an electric car runs. When this car is loaded it is run to the end of the tunnel and dumps the ashes into the bucket of a hoisting tower near the coal elevator. From the tower the ashes are spouted to a concrete bin over the coal car track, so that empty coal cars can be loaded with ashes. Each round trip of the ash hoist is started by pressing a button in the tunnel, the car and skip mechanism being interlocked to prevent interference. One man for each shift can handle the removal of ashes even with twelve locomotives per hour. Other ash plants on this road require two men per shift. With the present wage scale capitalized as explained above in regard to the pumpers there is a capital saving of $75,000 by eliminating three men.

At the river end of the ash tunnel is a pump room for the water supply plant, containing two electrically driven pumps with a capacity of 350 gal. per minute. Although this room has been submerged during high-water periods, the operation of the plant has not been affected, as the tunnel concrete was made waterproof in order to provide against this contingency. A 1 : 2½ : 4½ gravel concrete was used, the cement having lime paste added in the proportion of 8 per cent of its volume. A coating of coal tar pitch was applied to the exterior of the walls and roof.

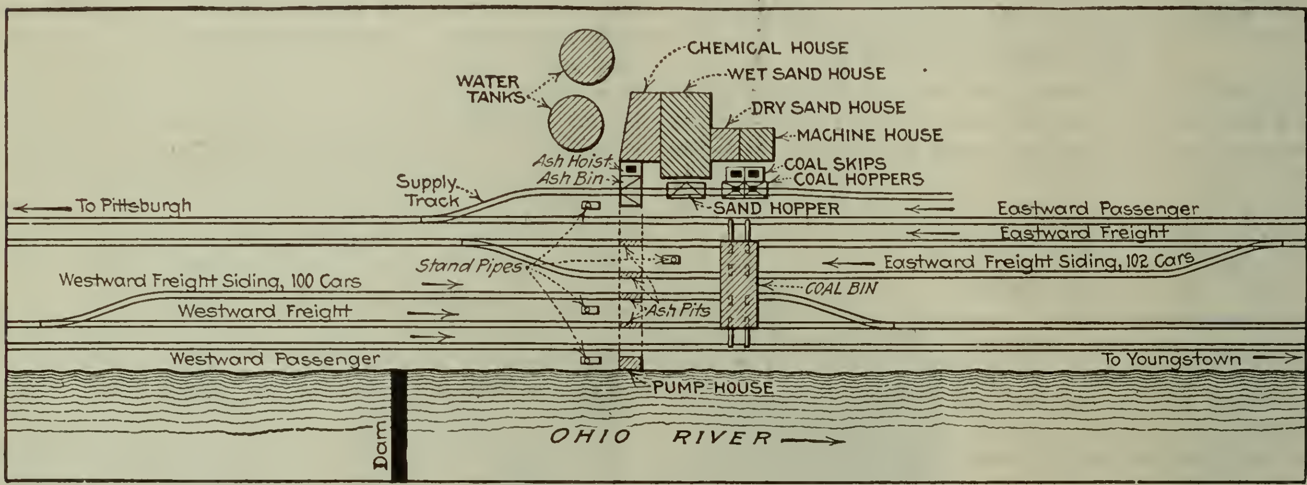


FIG. 2. LAYOUT OF BRIGHTWOOD COAL AND WATER STATION, P. & L. E. R.R.

Electric current for power and light is furnished from the railway company's power plant at McKees Rocks, four miles distant, the combined load representing about 200 hp. Negotiations were opened with a local electric company, but as no allowance could be secured for the short working periods of the motors the minimum change was prohibitive. An alternating current line for signal purposes was being constructed at that time by the railway and three additional wires were installed to carry the 6,600-volt current for the coaling station. It is estimated that the saving over the charge for outside supply will pay in three years for the 4-mile power lines and the transformers, while there will be equal reliability of service.

Comfort and safety of the men have been given attention. Clearances are ample, stairs and walks have guard railings and protection is afforded against falling counterweights at the chutes in case of breakage of their chains or cables.

The design and construction of the plant were under the direction of the late J. A. Atwood and his successor, A. R. Raymer, chief engineer of the Pittsburgh & Lake Erie R.R. The general contractors were Pihl & Miller, Pittsburgh, Pa., and R. H. Beaumont & Co., Philadelphia, Pa., had the contract for the machinery equipment.

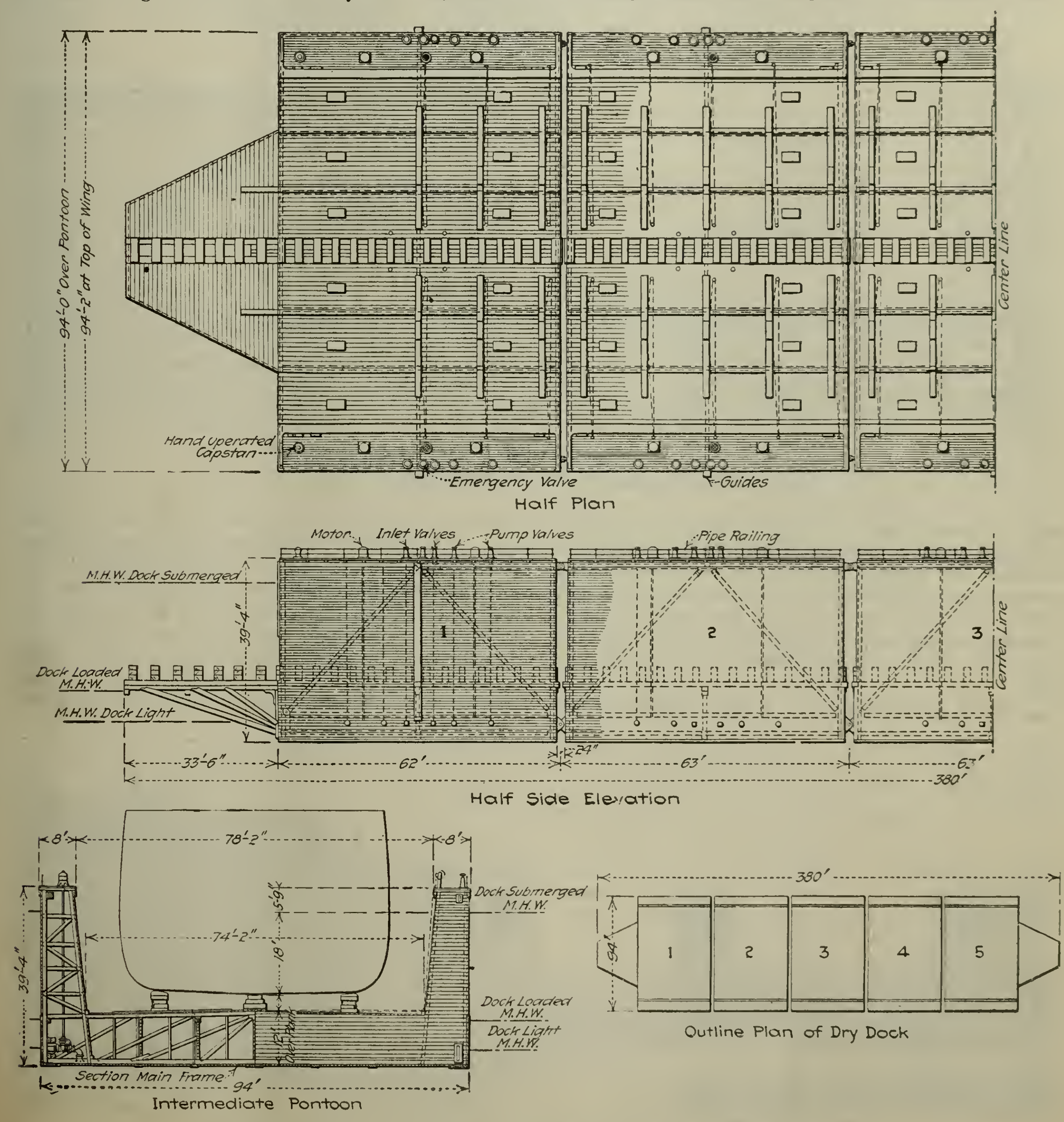
Sectional Floating Drydock Made Continuous by Interlocks

Timber Structure at Pensacola Has Longitudinal Truss System in Wing Walls of Each of Five Sections

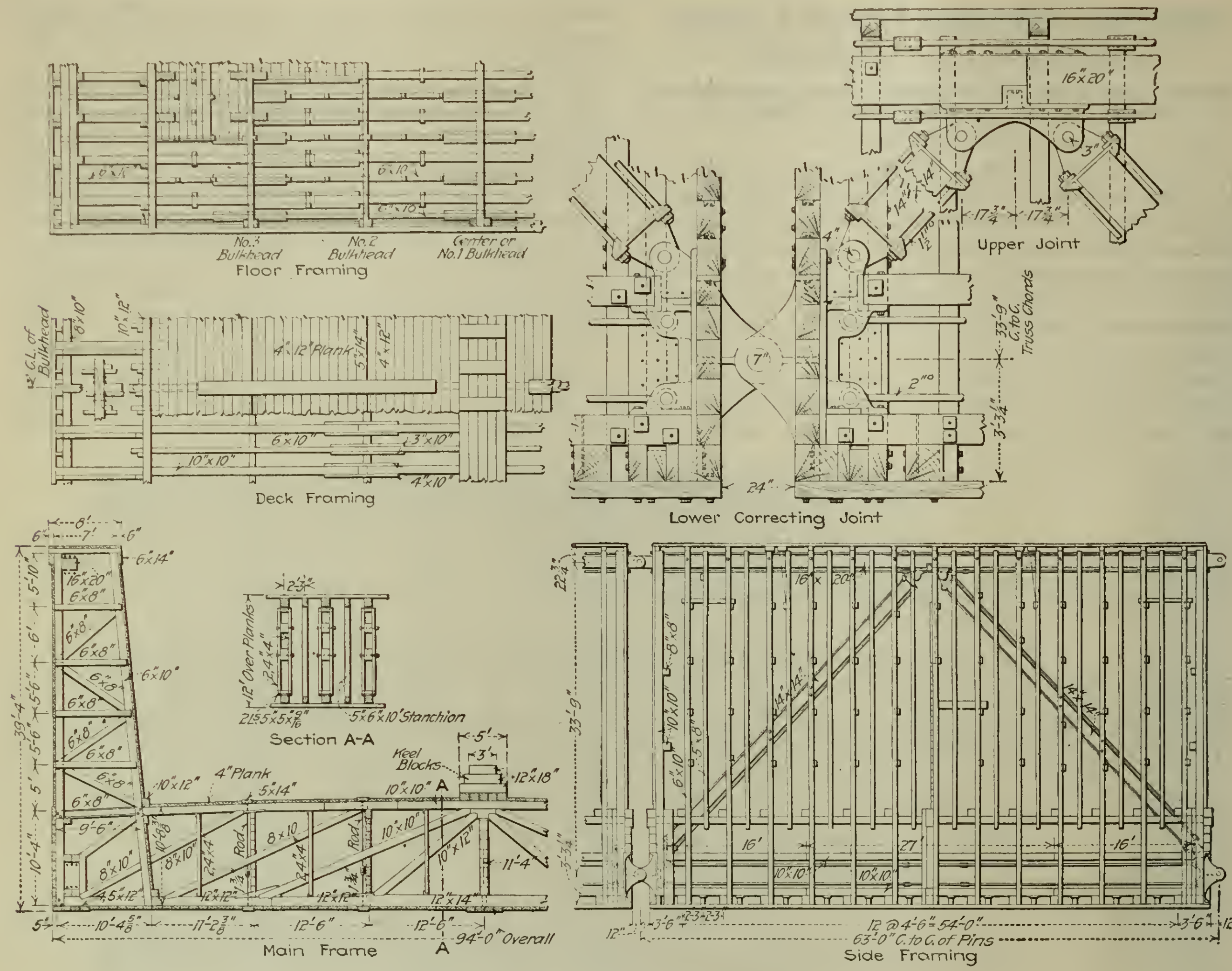
FLOATING dry docks, mostly of from 5,000- to 10,000-ton capacity have been built in a number of ports in this country since the war increase in shipping has made repair facilities imperative. Among them is the recently completed dock for the Bruce Dry Dock Co., at Pensacola, Fla., which was built by the Aberthaw Construction Co. of Boston, Mass., after designs by the Crandall Engineering Co. of East Boston, Mass. Some of the details of the structural designs of this dock are worthy matters for record. Of particular interest are the interlocking connections whereby the longitudinal trusses of the wing walls of each of the five timber sections are made continuous for the length of the structure.

The dock is built of timber throughout and is designed for a normal lifting capacity of 5,000 tons. It is, however, capable of handling a maximum load up to 6,000 tons, for each of the five sections has a reserve buoyancy of 1,200 tons, with the deck practically awash. It has a length overall of 380 ft., an extreme width of 94 ft., with a width of 78 ft. 2 in. between the wings at top and 74 ft. 2 in. at deck level. The pontoons are 12 ft. deep, and can be submerged to give 18 ft. of water over the top of the 42 in. keel blocks.

For the handling of large ships floating drydocks are generally of the sectional type, in which any one section, by turning through 90° can be docked in the remaining sections and thus painted or repaired. There



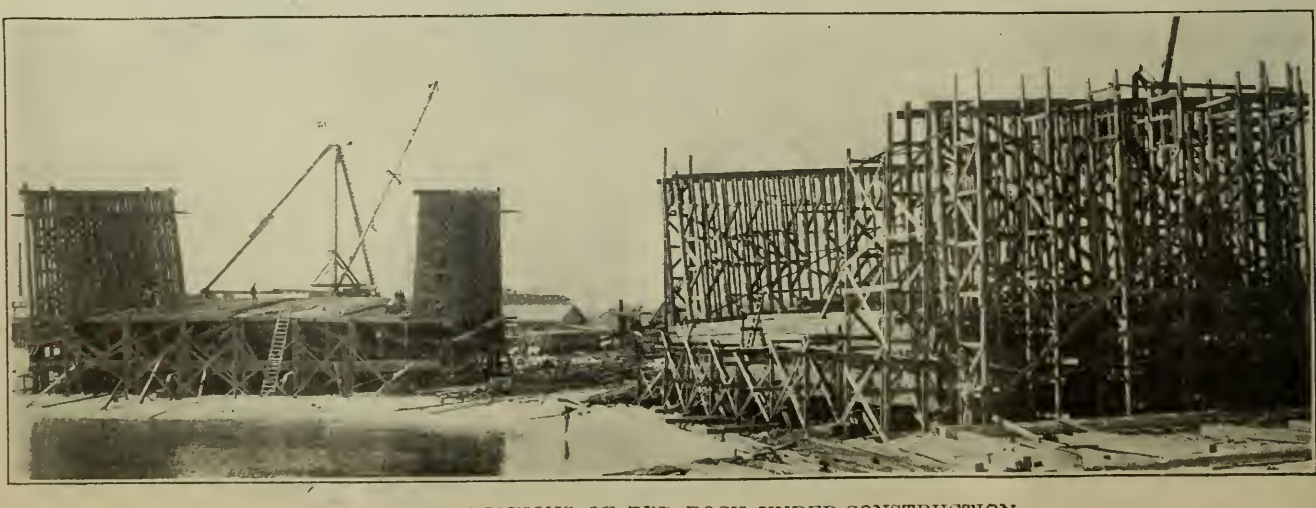
GENERAL LAYOUT OF FLOATING 5,000-TON DRY DOCK AT PENSACOLA, FLA.



DETAILS OF FRAMING OF PENSACOLA DRY DOCK

are three types of such docks, those consisting of several independent units, those with continuous side wings and those built as a sectional dock but with longitudinal trusses as a means of connecting the sections at top and bottom. The Pensacola dock is of the last type, and is of all timber design, though in some docks of this type the side or wing walls are of structural steel framework.

In raising a ship, the work is done by the upward pressure of buoyancy of the water, on the bottom of the dock. This pressure is uniformly distributed all over the bottom, while the bulk of the ship's weight is concentrated along the center line on the keel blocks. In order to distribute this concentrated load evenly over the bottom of the dock, a special form of transverse truss developed by the Crandall Engineering Co. is used on all docks designed by that company. These transverse trusses are located every few feet along the



TWO OF THE SECTIONS OF DRY DOCK UNDER CONSTRUCTION

ONE OF THE SECTIONS JUST AFTER LAUNCHING

length of the dock. This truss design is a simple, statically determinate type of such form that the stresses in the various members may be accurately calculated.

The design of the dock is such that when the U-shaped sections are connected together they form a rigid unit which will support the weight of the ship without distortion either of the ship or the dock. This is accomplished by the system of longitudinal trusses. In each wing wall of a section there is incorporated the panel of a longitudinal truss. When the sections are joined, by means of the steel castings, these panels are formed into one truss extending along each wing wall of the dock. A set of continuous timbers runs along the upper outer edge of each wing wall. At the center, where the two 31-ft. timbers are spliced, is a cast-steel member with bearings for two 4-in. steel pins. These are the connecting points for the diagonals running from the center top to the two lower corners of the section. These diagonals, 39 ft. long, are attached at the lower end, also by means of a 4-in. steel pin, to a large steel casting forming the point of junction between the one section of the dock and the next. Between the castings at the ends are steel tie rods, consisting of eyebars, fitted with turnbuckles, for taking tensile stress, and timbers to take the compression load.

The connections between sections are made by means of 7 in. steel pins, top and bottom, let into the heavy cast-steel members, as shown in the drawings herewith. The casting at the bottom corner measures more than 6 ft. vertically and more than 4 ft. in the direction of length of the dock wall. Its width in the other direction is almost 4 ft. This casting transmits the tension or compression from the bottom chord and diagonals and the shear from the diagonals. The casting at the upper part of the dock is much more simple, having only the function of transmitting the tension or compression of the top chord.

As the waters where this dock is to be used are heavily infested with teredos, protection against damage is necessary. Consequently each section will be sheathed over the entire bottom and each of the sides to above the load water line, with two complete layers of sheathing. Each layer consists of felt put on with a coating of tar and covered with a double thickness of creosoted boards, fastened with galvanized nails. This sheathing will cover the timber construction of the dock, which consists mainly of long-leaf yellow pine.

Control of the flotation of the dock is accomplished by means of vertical centrifugal pumps placed in the bottom of the several sections. There is one pump to each of the four transverse compartments in each section. Each pump is driven by its own electric motor, located at the top of the side wall, and connected with the pump by a long shaft. The center of suction opening is 40 in. above the bottom of the dock. The pump and motor capacity have been made sufficient to raise the dock, with load of five thousand tons in 45 min. of continuous pumping.

The twenty motors operating the pumps are each of 20 hp. operating on three-phase, sixty-cycle current at 850 r.p.m. They are direct connected to the pump shafts, and take current at 220 volts. The twenty pumps are 10 in. centrifugal single suction pumps of the closed impeller type. The operation of the dock will be controlled by a dockmaster stationed at the pier at the head of the dock. The pump motors will be controlled from a single switch house near the dockmaster's station.

Road Oils and Carpet Coats

Abstract of a Paper Read by J. A. Duchastel Before the Canadian Good Roads Congress at Winnipeg, Manitoba

THAT the scarcity and inefficiency of labor and the general high cost of materials used in road construction, as well as the difficulty encountered in securing them, have so affected road construction programs that the highway engineer is face to face with a problem that demands not only the strictest economy, but the employment of every resource in preserving existing mileage, was the gist of a paper read by J. A. Duchastel, city engineer and manager, Outremont, Quebec, before the recent annual good roads congress given under the joint auspices of the Manitoba Good Roads Association and the Canadian Good Roads Association at Winnipeg.

Mr. Duchastel asserted that "the greatest of all problems in road construction today, after drainage, is road maintenance." He said that road maintenance should begin the day a new surface has been completed and that only through the most careful study of maintenance requirements could existing mileage be preserved. Following are some of the most pertinent of the points in Mr. Duchastel's paper:

While it is admitted that a surface treatment with bituminous material is a ready means of salvaging many types of pavement, on the other hand, it must be remembered that the road to be treated must have a foundation of sufficient strength to sustain the traffic that it is going to have; that the drainage must be good; and that the road surface must be in good condition. No surface coat will last if these conditions are lacking.

The surface treatment must be considered as a preservative in the same way as a carpet over a hardwood floor; the carpet coat has to be renewed from time to time in the same manner as the carpet over a wooden floor.

Dust-laying oils of asphaltic or tar origin do not, as a general rule, form a protective coat as the heavier oils used in connection with carpet coating. In many cases, far from protecting the surface of the road, these light oils have introduced an element of lubrication in the upper layers of the road surface with the result that disintegration often sets in faster than it would normally.

A sure indication of wear on a road is the presence of dust, and a bituminous carpet coat properly laid will stop the appearance of dust and will preserve the road both from wear and from disintegration due to the presence of water. It will render the road practically impervious. Bituminous materials used for a carpet coat should be asphaltic oil containing from 60 to 80 per cent asphalt or refined tars containing few or no constituents distilling at a temperature of

300 deg. F. Care should be taken to avoid building too thick a carpet, results of which are a rolling or waving in the surface.

In determining whether an old macadam or gravel road should receive a surface treatment, a traffic census should be taken and if it is found that more than 200 automobiles travel over this road per day treatment with a bituminous coat becomes imperative. If the road is in good shape and the coating properly applied, this road can stand up to 2,000 or 3,000 automobiles per day during the summer season.

Before determining whether it is wise to apply a bituminous carpet coat to a macadam or gravel road, it is necessary to investigate the following points:

1. The nature and volume of the traffic over the road.
2. The thickness of the metal composing the roadway itself.
3. The nature of the subsoil and its drainage.

If any of these items require attention it would be a waste of money to treat a surface without remedying any of these faults.

In laying a carpet it is necessary that the road surface be swept clean, so that it resembles a mosaic after the sweeping is done, all stones being exposed over the entire area.

No road oiling should be undertaken unless the roadway is absolutely dry. A couple of hours after the application of the bitumen the surface should be covered with sufficient coarse sand or screenings to absorb all the excess bitumen.

In the case of bleeding of finished surface an application of coarse sand or screening should be made without delay.

Tests of Metal Struts and Beams for Airplanes

STRUCTURAL engineers accustomed to working with metal ⅜-in. thick as a minimum may have cause for mental readjustment before dipping into a field where the thickness of strut and beam webs is measured in terms of one or two hundredths of an inch. And yet analysis of the strength of the built-up members of the all-metal airplane, through study of the significance of tests to failure of a multitude of successive patterns for the struts and frames of the wing framework, throws light on the fundamentals of efficient structural design. Data for such study are given by Major J. S. Nicholson, in the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland for February, 1920, traces the "Development of Metal Construction in Aircraft" in England during and after the war.

Aside from the greater durability and reliability of metal wing framework over the standard designs in spruce, the complete wings developed greater strength under test, though held to the dimensions and weight limits of the wooden types. The two metals utilized were duralumin and cold-rolled alloy steel or plain carbon steel of the following typical properties:

Material	Specific Gravity	Modulus of Elasticity	Yield Point Tension	Ult. Str Tension	Elong.
Duralumin..........	2.8	10,750,000	32,500*	58,000*	Not given
Alloy strip..........	7 8	29,000,000	135,000*	156,000*	15 0%
Carbon strip........	7.8	29,000,000	106,400	120,000	4 0%
Spruce..............	0.45	1,600,000	Max. fibre stress 5,500		

*Heat treated.

The plain carbon steel contained 0.30 per cent carbon and 0.85 per cent manganese and had been annealed when 0.064 in. thick, being then cold rolled to 0.024 in., normalised by heating to 350 deg. C. and cold rolled to 0.018 in. The alloy steel analysed 0.20 per cent carbon, 1.0 per cent chromium, 3.5 per cent nickel, 0.10 per cent vanadium, and had been quenched at 800 deg. C. and drawn at 400 deg. C. after cold rolling. The duralumin analysis is not given (Copper 3.5 to 5.5 per cent, magnesium 0.5 per cent, manganese 0.5 to 0.8 per cent, aluminum balance, is given in Bureau of Standards Circular 76) but as for treatment the material was normalized by heating to 500 deg. C. and quenching in water. An interesting characteristic of this metal is that immediately following this treatment the ultimate strength is 50,000 lbs. per sq.in. with yield point of 20,000 lbs. per sq.in., both of which properties undergo an increase during the next ten days to an ultimate strength of 60,000 lbs. and a yield point of 34,000 lbs.

As most of these airplane members are subjected to combined compressive and bending stresses, the differing properties of steel and duralumin offset each other strikingly. The modulus of elasticity of duralumin is only 0.37 that of steel, but for a design of the same weight and overall dimensions, the moment of inertia is 2.78 that of steel—hence the *EI* factor for duralumin will be $0.37 \times 2.78 = 1.03$ that of steel. The beams or struts of the two materials should therefore be equally strong, but the duralumin has the important advantage of superior rigidity against secondary failure, in that its individual components will have 2.78 times the thickness of the corresponding steel components. Most of the strut and beam designs suggested for test broke down by such secondary failure at low fiber stresses.

The tests of the members give ample proof of the importance of makeup and detailing in reaching high efficiencies in these tiny members. The best designs executed in steel attained unit fiber strengths as high as 112,000 lb. per sq.in. in combined compression and bending. One design that reached 123,000 lbs. fiber stress was further increased to develop 175,000 lb. by special heat treatment after construction. The duralumin spars showed strengths of about 40,000 lb. per sq.in.

Comparison of Results of Water Analyses and Surveys

In checking over the results of a recent survey of railroad water supplies in Iowa the following figures were obtained as to the agreement between the examination made in accordance with the United States Treasury Department method and the sanitary survey made by an experienced officer of the United States Public Health Service.

WATER SUPPLIES IN IOWA

Supplies Satisfactory	Supplies Unsatisfactory		
By Both Survey and Examination	By Both Survey and Analysis	By Survey, Analysis Satisfactory	By Analysis, Survey Satisfactory
67%	18%	9%	6%

More significant than this has been the work by the Division of Sanitation, Minnesota State Board of Health, since the Minnesota work covers a longer period and includes the results upon a much larger number of supplies. The results given in the following table of unsatisfactory supplies were based on the investigation of 1,119 water supplies of which 730 were found to be unsatisfactory in their existing condition.

UNSATISFACTORY WATER SUPPLIES IN MINNESOTA, 1912-18

	Shown Unsatisfactory by		
Unsatisfactory Water Supplies	Field Survey and Analysis	Field Survey	Analytical Results
Number 730	354	338	38
Per cent, 100	49	46	5

From 1920 report of Committee on Official Standards of Water Analysis, American Water Works Association, Jack Hinman, Jr., Chairman, Iowa City, Iowa.

Developments in Railway Water-Supply Service

Electric Motors and Oil Engines for Centrifugal Pumps—Storage Capacity and Tanks—Treatment of Water

INCREASED use of electric pumping plants for railway service has resulted from the increasing number of points at which current is available and from the economy of electric operation, especially when the motors are under automatic control or remote control (as by a push button in the station agent's office) so as to eliminate the expense of continual attendance. This statement was made by C. R. Knowles, superintendent of water service of the Illinois Central R.R., in a paper read recently before the Western Society of Engineers. On this railway there have been installed duplicate electric units, each half of the unit having a daily capacity of 1,000,000 gal. and the operation being controlled entirely by the height of water in the tanks. The cost for current is about the same as the former cost of coal, but the electric plant requires only one man as against three men for the steam plant, so that there is a net saving of $1,500 per year for labor.

Oil engines of the semi-diesel type are being used extensively for railway pumping stations and are proving economical, besides being practically as reliable as steam plants. They are especially adapted for driving centrifugal pumps but are not as flexible as steam engines when used with positive displacement pumps. Mr. Knowles states that failure to recognize this latter point has resulted in some unsatisfactory installations. The substitution of two oil engines for a steam plant eliminated two pump men, with an annual saving of $1,800 for labor besides a reduction in cost of fuel. Increased use of centrifugal pumps has resulted from the introduction of oil engines and electric motors. Gasoline engines were never serious competitors of steam, says Mr. Knowles, except at the smaller pumping stations and at other points where the cost of coal was excessive.

Water Storage and Tanks

Greater storage capacity at water stations has become an economic necessity under present conditions of shorter hours, higher wages and overtime pay. With constant delivery from a city supply and with a fairly uniform demand, the size of tank is not important. But where the delivery and demand are irregular, the tank should be of sufficient capacity to take care of maximum consumption during the period when water is not being delivered. If the tank is too small to carry a night supply the cost of water service may be increased materially by the necessity of employing additional pump men. In a number of cases reservoirs have been established to insure an adequate supply for water stations.

Steel tanks had been largely superseding wood tanks until a few years ago, but the high cost and restricted supply of steel during the war necessitated a return to wood. Creosoted wood tanks have proved a profitable investment" says Mr. Knowles, as their first cost is less than that of tanks of steel or untreated wood, their maintenance cost is less and their life is expected to be as long as that of tanks of the best untreated wood. An advantage of steel tanks with conical or hemispherical bottoms is the opportunity for sedimentation. Mr. Knowles suggests the need of a simple settling basin or filter for use with flat-bottom tanks, as the removal of suspended matter from the work will effect material economy in repairing and washing locomotive boilers.

Treatment of Water

Treatment of water for locomotives, generally by a softening process, and the removal of suspended matter and scale-producing elements has received increased attention within the past few years owing to the increasing cost of boiler repairs and fuel and the urgent necessity of keeping locomotives in service. On the Great Northern Ry., 77 water softening plants have been installed under a program carried out by C. H. Koyl, who is now engineer of water service of the Chicago, Milwaukee & St. Paul Ry., and is planning to establish water treating plants in the bad water districts. The Missouri Pacific Ry. in 1918 had 52 water treating plants, mainly in the hard-water district of the plains west of Kansas City. According to a report by R. C. Bardwell, chief chemist, these plants in 1918 treated 1,368,305,000 gal. and removed 1795 tons of scale forming matter at a cost of $89,873, including labor, chemicals, maintenance and 10 per cent for depreciation on an investment of $154,300. The saving for one year in boiler repairs and kindred expenses was nearly double the total investment.

Mr. Knowles states that there are now about 600 railway water treatment plants, treating an average of 36,000,000 gal. each, or a total of 21,600,000,000 gal. annually. Assuming that 8 per cent of the total railway water consumption, or 72,000,000,000 gal., is used by locomotives and power plants and that 50 per cent of this is of such quality that treatment would be economical, the existing plants furnish less than 6 per cent of the amount of treated water needed. That a larger proportion of the water is not treated is thought by Mr. Knowles to be due in part to lack of centralized responsibility for the quality of the water on many roads. In his opinion, few investments in railway improvements will show quicker or larger returns than a properly designed and operated water treating plant. The experience of the Missouri Pacific Ry., noted above, supports this opinion.

New Studies of High Chromium Steel

Experiments on high chromium steel have recently been carried out by the Bureau of Standards to determine the influence of various kinds of heat treatment. Advance notes of the general trend of the results indicate that the maximum hardness is obtained by quenching at about 1,066 deg. C. (1,950 deg. F.), but that quenching from 955 deg. C. (1,750 deg. F.) gives the best combination of strength and ductility. Steel quenched at temperatures above 1,010 deg. C. (1,850 deg. F.) shows a very low elongation and reduction of area. Such brittleness can be decreased by short-time tempering, up to about 427 deg. C. (800 deg. F.), while tempering above this heat decreases the strength and hardness rapidly, the most rapid change being produced in tempering between about 800 and 1,000 deg. F. The material studied had the composition C 0.29 per cent, Mn 0.38 per cent, Si 0.70 per cent, Cr 13.2 per cent. All quenching was done in oil.

First Modern Grain Elevator In Australia

American Equipment and American Engineer Control Construction—Bin Walls Poured to Full Height in Sections—Concrete Chuting System Unique

BUILT entirely with American equipment and under the direction of the American superintendent for an Australian contractor, the first modern terminal grain elevator in Australia is being completed on Glebe Island, Sydney. The structure, with complementary construction, is being built for the New South Wales Government and will provide for the storage of approximately 6,000,000 bu. of wheat. Construction includes the circular storage bins, the working house, a track shed, three cargo sheds, a power control station, a boiler and dryer house, a dust condenser, a dust incinerator, towers and conveyor galleries and miscellaneous construction.

The elevator is being constructed upon the site of an old stone quarry formerly operated by the New South Wales Government. About 250,000 cu.yd. of material were removed from the site prior to the time it was decided upon as the location for the elevator. Excavation of an additional 50,000 cu.yd. was necessary to bring the site to the proper track grade.

Storage is provided in 72 circular bins with inside diameters of 31 ft. 2 in., and 71 interspace bins, affording storage for 5,600,000 bu. The overall width of the bins is 267 ft. 6 in.; their overall length 302 ft. 6 in.; and their height above slab 108 ft. Bin walls are concrete 8 in. thick, of a 1:2½:4 mix, reinforced by steel bars ⅜ x 1¼ in. so as to form a continuous spiral. The usual moving form construction was followed in pouring the bin walls, and the 1⅛-in. jack-rods, by means of which the forms were raised, were used as vertical reinforcement. Horizontal reinforcing bars were fastened to these jack-rods by means of a special wire clip made of No. 12 standard-gage steel wire. The details of the wire clip, showing the method of fastening to jack-rods and splicing horizontal bars are shown in accompanying sketches. In splicing horizontal reinforcement bars an overlap of 2½ ft. was allowed. The specifications required the ends of the bars to be hooked where splicing was

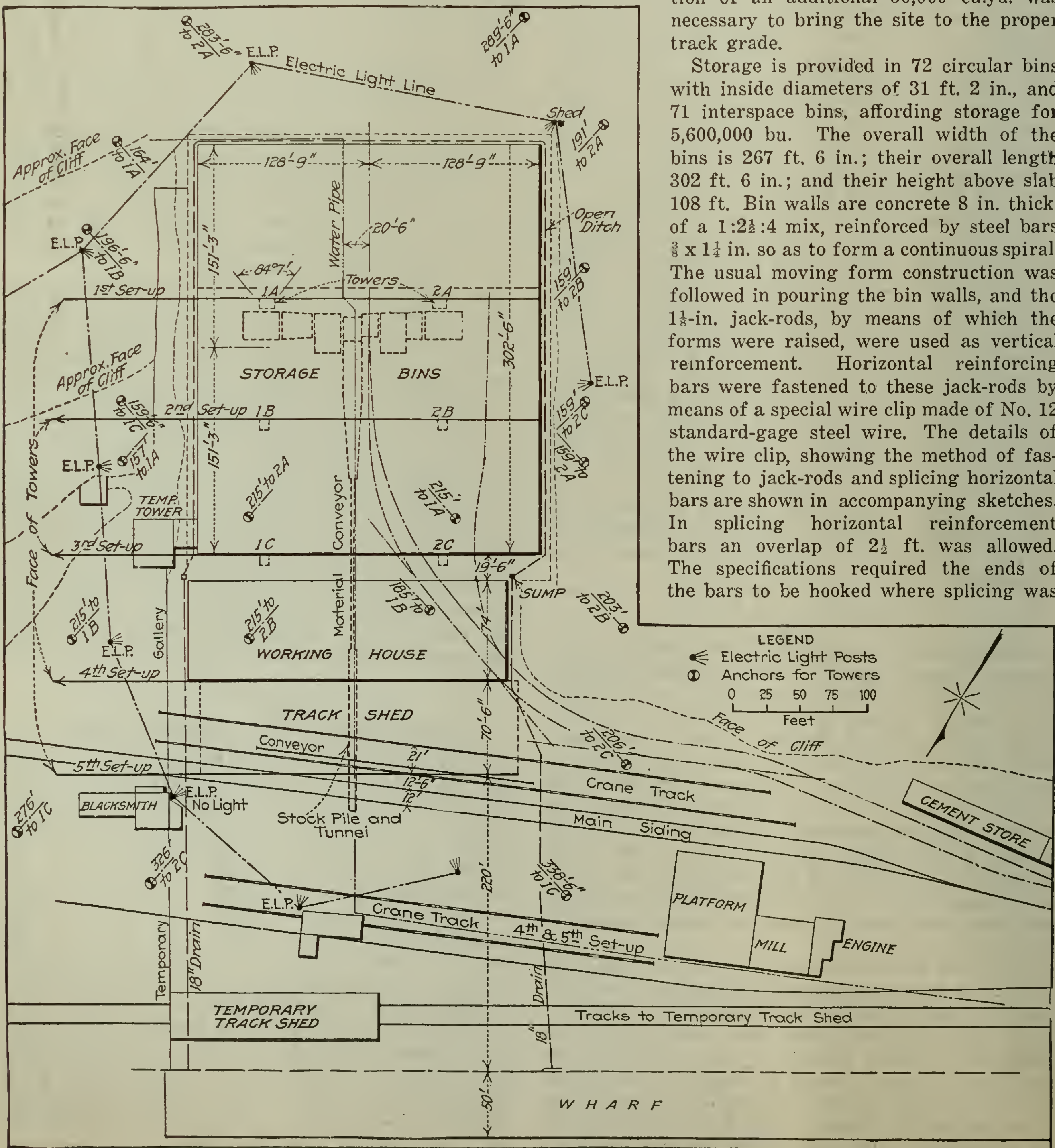


FIG. 1. CONTRACTOR'S LAYOUT INDICATING TOWER ANCHORAGE POINTS AND TOWER SET-UPS

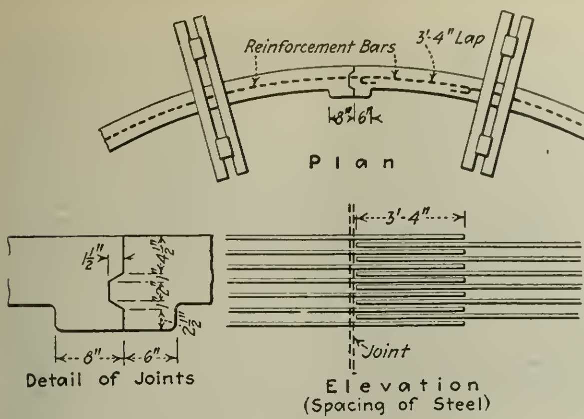


FIG. 4. CONSTRUCTION CUT IN BIN WALLS SHOWS DETAIL OF JOINING SECTIONS

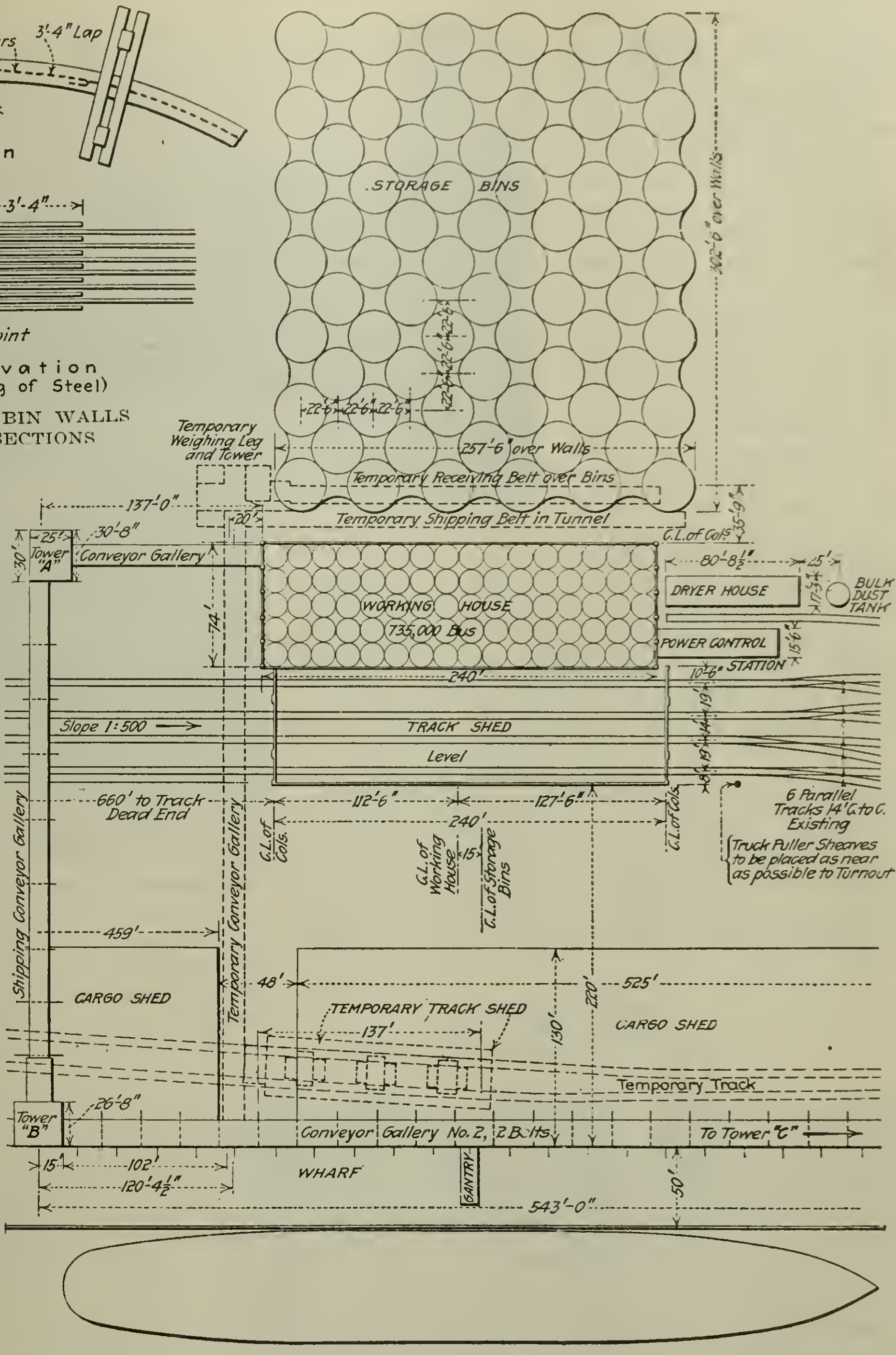


FIG. 2. GENERAL PLAN OF STORAGE BINS, WORKING HOUSE STORAGE SHEDS, TERMINAL FACILITIES

done. The forms were fastened to iron-bark wood pieces 5 x 7 in., generally 7½ ft. in length. They were yoked together with lumber of the same material and width and thickness and bolted with ¾-in. bolts. The form yokes supporting the joists upon which rested the chuting trestles were longer than 7½ ft., elevated to give ample clearance between chuting trestle and decking floor. Sheeting for the forms were of jarrah, an Australian hardwood, 1¼ x 4¼ in., 4½ ft. long. All other lumber used on the job was Oregon fir.

The first work on the elevator was done in November, 1918, when a temporary siding for the storage of materials was laid. Rock excavation began about the same time and early in March, 1919, part of the contractor's plant—all of it American — was installed. Work on the construction of the twin concreting towers began in April, 1919. Both of the towers were built upon the ground and raised by a fleet of donkey engines, additional pulling power being furnished by two railroad freight engines located at the waterfront several hundred feet distant. Concreting towers were held in place by ⅝-in. steel cables fastened to eye-bars concreted in rock. A predetermined set of anchorage points was indicated upon the contractor's layout for each tower for each set-up. In raising the towers considerable advantage was had in the fact that the foot of the tower rested against the base of a cliff, and the difficulty in erection was modified because of the position of the main supporting lines on the cliff's top. In anchoring the towers four lines of ⅝-in. steel cable were set at vertical intervals of 42 ft., making four sets of four lines each for each tower. Towers were of a six-leg type, the front posts of the main bay being of 6 x 8-in. material, the back posts 6 x 6-in. pieces and the outside posts 5 in. square. Posts were braced horizontally with 2 x 10-in. planks and diagonally with 2 x 6-in. pieces. One of the towers was equipped with a passenger elevator to carry workmen to and from bin wall tops.

Because of the high cost of lumber necessary in the construction of forms it was found impossible to proceed with the erection of all bins simultaneously. Concrete was therefore poured on but one section at a time —each of three sections containing an area about 100 ft. wide and having for length the full width of the bins

or 267½ ft. Such a construction method necessitated making a vertical joint through piers, slab and bin walls. The joint was made through the centers of the circular bins. Horizontal reinforcement was made to project beyond the joint so that when a bond had been effected with the adjacent section an overlap of horizontal reinforcement of 3 ft. 4 in. was had. Reinforcement on the second section was spaced midway between bars in the first section and that in the first and third section were therefore in the same plane. A 3-in. off-set was given to the bin wall extending 7 in. each side of the joint and on the inside of the circular wall, giving a thickness of 11 in. A groove, 1½ in. deep, 2 in. wide and with 1-in. shoulders, was made in the section first poured and ran the entire height of bin walls 4½ in. from the convex surface.

FIG. 1a. PIER FORMS AND FOOTING EXCAVATION, FIRST SECTION OF BIN WALLS

The elevator site being a former stone quarry a solid rock foundation was had upon which to support the loading of 25 tons per square foot for the storage bins and 30 tons per square foot for the working house. This loading was distributed by a reinforced-concrete slab 12 in. thick under interspace bins and 14 in. thick under circular bins. Piers and slab were so constructed to make each bin self emptying. Concreting on the piers of the first section began the latter part of May, 1919, and on the bin walls July 21. By August 9—or a total elapsed time of 38.83 ten-hour shifts—the first section had been poured to its full height of 108 ft.

In order to begin work on the second section of the bin walls, it was necessary to move both material bins and concreting towers back from the face of the completed section approximately 100 ft. Material conveyors, bins and sheds were moved in a day and the first tower was moved its approximate 100 ft. in three hours. Hoists, used in handling concreting materials on the job, also were used in moving the material bins and the concrete towers and in conveying machinery. Material bins and the concreting tower were lashed and bolted together, set upon rollers and with the four sets of supporting cables held taut moved back to new sets of anchorage points. Three such set-ups were necessary to complete the bin walls. By the end of January, 1920, all work had been completed on the storage bin walls with the exception of the roof and the conveyor galleries and work had commenced on the circular bin forms for the working house.

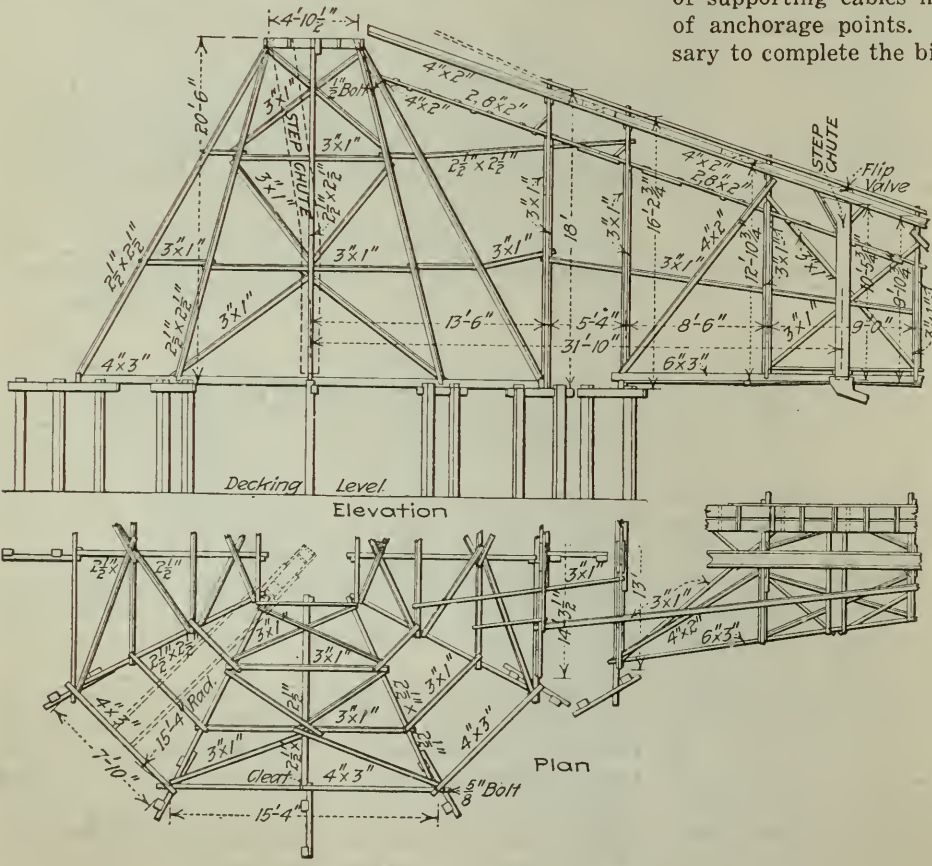


FIG. 3. PLAN AND ELEVATION OF FIXED TOWER TRESTLE USED IN CONCRETE DISTRIBUTION

One of the features of the construction was the type of chuting, designed and erected by the contractor, used in handling concrete from towers to bin walls. Two octagonal timber trestle towers were built, resting upon the moving form yokes. These towers were so set that each served the same number of bins, and in the approximate centers of each half section being poured. The construction of each half section was, therefore, a complete job, as each tower was served by its own mixer and concreting tower. The circular towers had a top diameter of 5 ft., bottom diameter of 29 ft. and a height of 20½ ft. Legs were

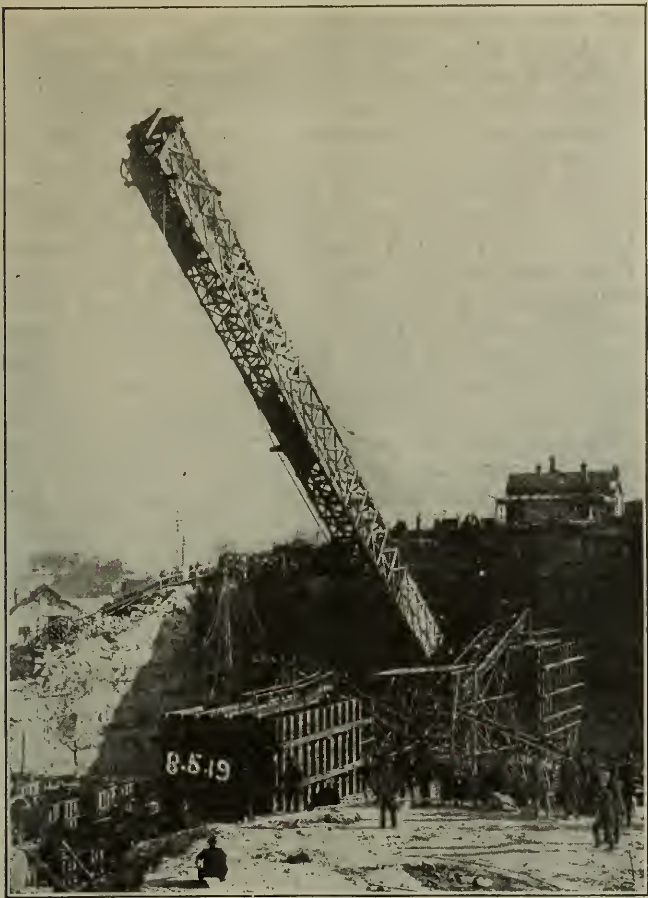


FIG. 2a. FIRST OF TWIN 210-FT. CONCRETING TOWERS RAISED IN 50 MINUTES

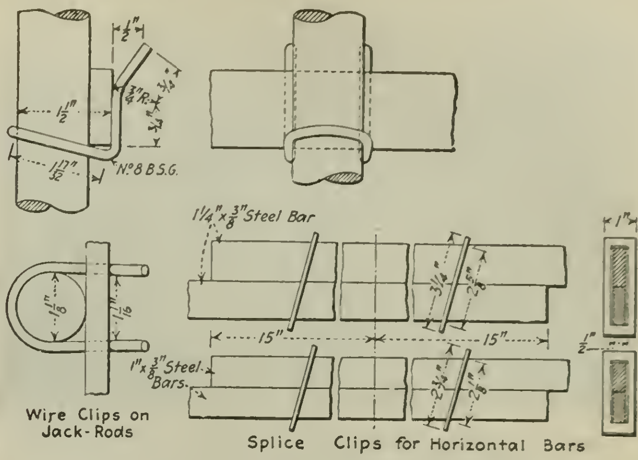


FIG. 6. CLIPS USED FOR SPLICING BIN-WALL REINFORCEMENT

built of 2½ x 2½-in. lumber, fastened together by cleats of the same dimensions and braced with 1 x 3-in. braces. The bottom timbers were of 3 x 4-in. material and the top timbers of 2 x 6-in. material. The top was decked with 1 x 6-in. flooring laid upon 2 x 4-in. joists. It was surrounded by a handrail and built up in the center was a frame supporting a turnhead of 12-gage sheet iron, 2 ft. inside diameter. The turnhead at its mouth tapered to a diameter of 9 in., and, fitted with an elbow, delivered concrete to the series of chutes extending radially from it to the centers of all bins whose walls the turnhead served. For pouring concrete on bin walls immediately beneath the circular trestle tower step chutes, fitted with flipvalves, were used. Despite the apparent fragility of these trestle towers they were found entirely adequate to handle all concrete. Only 6,000 ft., b.m., were used in the construction of each tower. Chuting used, with the exception of that in the terminal spouts, was of No. 12 standard-gage sheet-iron and of the deep cross-section shown in an accompanying sketch. Chuting in the terminal spouts was No. 22 gage. All chuting, however, was of the same deep cross-section.

In pouring the concrete on the bin walls some rather unusual work was done. Progress reports and bin-wall alignment records were kept on each of the three sections and the data secured showed that, during the pouring of the first section an average of 5.4 ft. every two 10-hr. shifts was maintained. On the first section the hoppers were installed at the same time but it was found to be dangerous, so was discontinued during the pouring of the other two sections. On the second section workmen averaged a total lift of 9.8 ft. per day of two 10-hr. shifts, and on the third section 12 ft. per day was attained. Considerable rain fell during the pouring of the second and third sections, particularly during the pouring of the third section when as much as 1.43 in. was recorded during 24 hr.

The working house will supply temporary storage for 785,000 bu. provided in 80 circular bins of a diameter of 14 ft. 5 in. Bin walls are of 6-in. concrete reinforced with steel bars ⅜ x 1 in., and set 25 ft. above the slab level of the main storage bins. The working house is 77 ft. wide and 242 ft. long, as measured by the slab under the bin walls. Bin walls are spaced in general 15 ft., c. to c. and are 74 ft. in height. The total height of the working house is 185 ft. 9 in. above the base of rail in the track shed. It is joined to the storage bins 19½ ft. distant, by conveyor galleries. Ship-

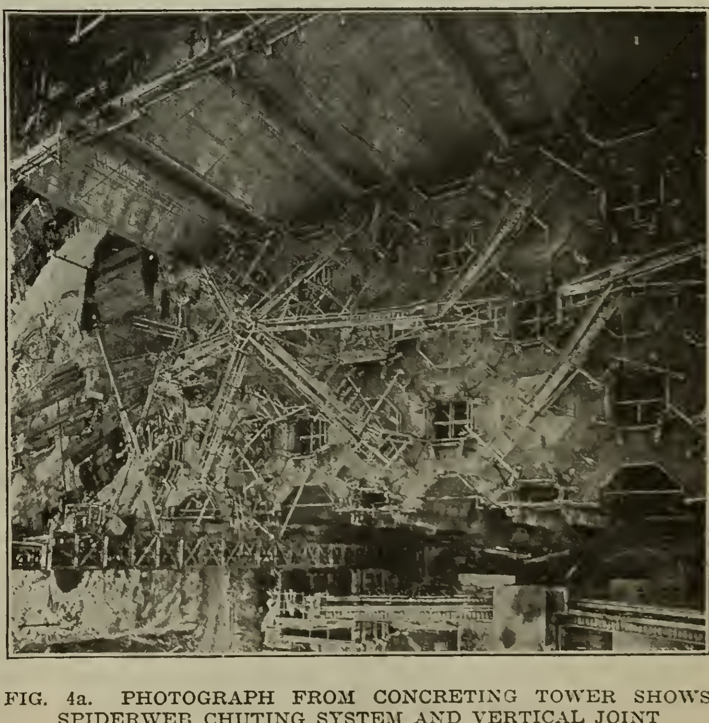


FIG. 4a. PHOTOGRAPH FROM CONCRETING TOWER SHOWS SPIDERWEB CHUTING SYSTEM AND VERTICAL JOINT THROUGH BINS

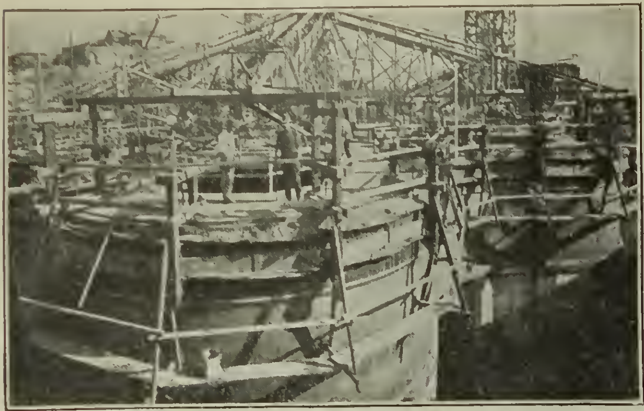


FIG. 5a. LONG FORM YOKES SUPPORT FINISHING SCAFFOLD AND TRUSSED BEAMS OF CHUTING SYSTEM

ping and receiving legs are placed beneath the slab level in the working house and above the bin slab are the conveyor floor, scale floor, weighing floor and the top floor.

When finished, the track shed, where the grain will be received, is to be 240 ft. long and 70½ ft. wide, on center lines of columns, and will extend over four parallel tracks. The track shed is to contain 20 track hoppers, each hopper having a capacity of 2,500 bu. and placed below the base of rail. This part of the plant will be able to care for 30 cars an hour. Grain will be conveyed from the track hoppers to five receiving legs in the working house and then elevated to the top of the structure to garners of 2,500-bu. capacity. Below each garner is to be placed a scale hopper capable of weighing 1,600 bu. of grain at a time. From the scales grain will be distributed by rubber conveyor belts to any part of the working or storage houses.

Initial installation also includes the construction of three cargo sheds, 381 ft., 525 ft., and 459 ft. in length, respectively, and approximately 132 ft. wide. Space is allowed for an increase in this covered storage if necessary. Construction also covers the building of a series of wharves, one of which, 2,600 ft. in length, is practically complete.

Grain to be shipped is withdrawn from any part of the plant to the five shipping legs in the working house whence it will be elevated to the 1,000-bu. garners above automatic shipping scales having a capacity of 4 tons per draft and an easy working limit of 16,000 bu. of wheat per hour. From working house to storage bins grain will be handled by six conveyor belts running out over the tops of the bins. From bins to working house 11 conveyors in the basement of the storage house will deliver to shipping legs in the working house.

A. W. Menkins, general superintendent for H. Teesdale Smith, contractor in charge of the construction, is the American who is superintending the construction. When work was first begun it was found that not one workman in the entire force of 500 men had any knowledge of moving form grain elevator construction. Some consideration was given the plan of importing from the United States enough workmen to form a skeleton organization of skilled elevator constructors, but the plan was soon condemned as too expensive. It was therefore necessary for Mr. Menkins to educate all the workmen in the respective tasks assigned them. Only the highest praise is given by him to the working force which surrounded him and which not only proved efficient but which evinced unusual pride in its work—the construction of the first grain elevator south of the equator.

All of the machinery and equipment used on the job was of American manufacture. The elevator was designed by the John S. Metcalfe Co., a firm which has designed many like structures in the United States and Canada. W. H. Merry is the chief engineer for H. Teesdale Smith. Engineering superintendence and inspection was furnished by Robert Kendall, chief engineer, Railroad and Wheat Silos, New South Wales Government. Detailed plans were furnished by the contractor, approved by the engineer.

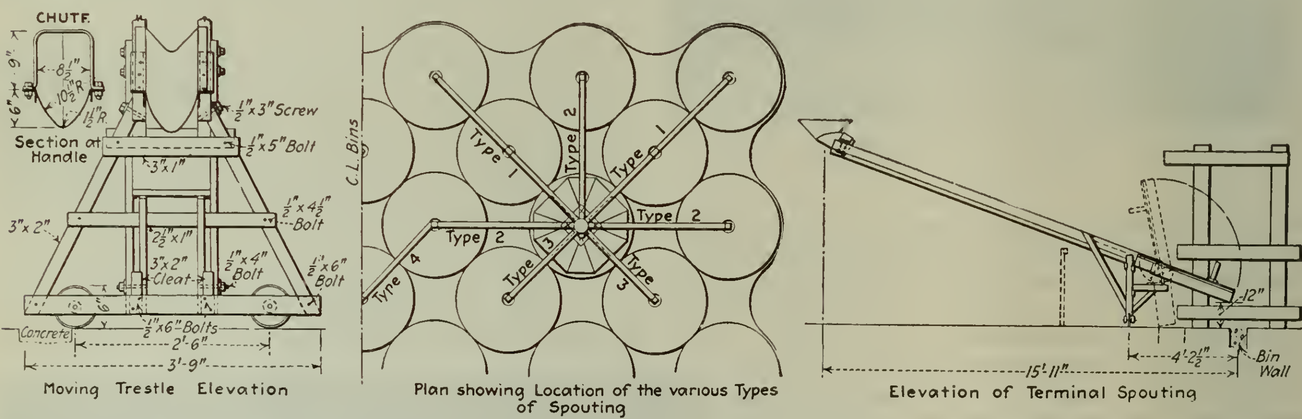


FIG. 5. TERMINAL TIMBER TRESTLE IS OF BICYCLE TYPE—TRUSSED BEAMS OF VARIOUS TYPES IN CONCRETE HANDLING—CHUTE DETAIL SHOWS DEEP CROSS-SECTION

Water Works Association Has Seven Sections

With the completion of the organization of the Canadian Section of the American Water Works Association at Montreal in June, the association now has seven geographical sections. The other six are: New York (including northern New Jersey); Four-State (southern New Jersey, eastern Pennsylvania, Maryland, Delaware, and District of Columbia); Central State (western Pennsylvania, Ohio, Indiana, and Michigan); Illinois; Iowa; Minnesota. Each section has its own chairman, vice-chairman, treasurer, secretary and trustees, and its own constitution.

Distinctive Features of a Co-operative Course in Engineering

Abstract of paper by W. H. Timbie, Associate Professor in Electrical Engineering, Massachusetts Institute of Technology, before Annual Meeting of Society for the Promotion of Engineering Education.

DIFFERENCES in several important respects from similar courses in other institutions are to be found in the co-operative course in electrical engineering conducted by Massachusetts Institute of Technology and the General Electric Co. The course was established primarily to produce men with an intimate knowledge of the best manufacturing processes and a thorough training in modern research methods and, where possible, ability for creative design. The principal distinction of the course is the fact that the single co-operating company recognizes that for three years the students are placed in a plant for the particular purpose of being educated and trained as engineers of a particularly high grade.

The course covers a period of five years, the first two being identical with the regular course in electrical engineering at the Institute and the last three being divided between instruction in theory at the Institute and training in manufacturing methods at the Lynn plant of the General Electric Co. While at the works the students are given a fixed payment per week as employees of the company. Each group of students spends alternately thirteen weeks at the plant and eleven weeks at the Institute, with a vacation period of two weeks at the end of the period at the Institute. The period of thirteen weeks at the shop was determined as the minimum time required for the uninterrupted study necessary for the students to familiarize themselves with all phases of the work in a single department, and the period of eleven weeks at the Institute was determined to fit the standard length of theoretical courses—the shortest being ten weeks and the longest some multiple of ten weeks.

Full recognition by the single co-operating company of the purposes of the course leads to the use of these students not for the purpose of getting out greater immediate production in some departments, but to placing them in the shops and offices to learn and to learn thoroughly manufacturing methods and the best relations of labor, mechanism, and materials in high-grade production. The length of time spent in each department is regulated not by the needs of that department but by the value of the experience to the student. The officials of the company believe that by this method they can produce the future engineers who will be so badly needed by the company and by other industrial concerns in the near future.

Other distinctive features of the course are the continuity of the theoretical studies and humanistic subjects; liberalizing of the engineering student's education by means of collateral reading; the inculcation of an intense spirit of loyalty to the Institute and to the co-operating company; the unusual amount of theoretical work included, and the fact that a Master's Degree is awarded by the Institute upon the completion of the five years' work.

In the study of English a plan is used to promote interest by the reading of letters from successful graduates, bringing out the fact that the higher the engineer rises in his profession, the greater is his need to be able to speak well and to write well. Classes are also formed into committees for the practical presentation of engineering reports. Ready access to books on all subjects and in all fields of literature is afforded and the program of the student is laid out with the definite purpose of giving him an opportunity for reading outside of the prescribed courses.

As an example of the unusual amount of theoretical work included in the course, a student pursues one course after another in mathematical physics from the beginning of his freshman year to the end of his post-graduate year. In the middle of his sophomore year he begins the study of electrical engineering and continues it without a break four terms a year for the remaining three and one-half years. During the last year the work at the institute is composed of advanced research and creative design.

Handling and Sorting New and Old Rails

MORE GENERAL use of mechanical means of handling heavy rails and old rails at railway store yards, together with greater care in sorting old rails for further use, were among the suggestions made by the rail-handling committee at the recent annual meeting of the purchases and stores section of the American Railroad Association. It was considered that economy can be effected by the use of locomotive cranes, rail loaders, ditching machines and steam derrick cars. The committee stated that it is more economical to distribute new rails along the track than to unload them into stockpiles.

Inspection of old rails should be performed by stores department men whose qualifications are satisfactory to the engineering department. They should be classified for main track, for branch lines and for yards and sidings, those of each class being further classified into four divisions according to height measured to $\frac{1}{32}$-in. To distinguish the rails, the committee proposed painting the ends green, white and red for the three main classifications and marking the ends with numbers 1 to 4 in white paint for the four secondary classifications. At the rail docks, each class and subdivision would be piled separately, the rails being in opposite directions in alternate layers, with one end of each layer carefully lined to facilitate counting and measurement. These piles should be as high as they can be built with the machine, and it is suggested that many railways incur considerable unnecessary expense through lack of apparatus for handling rails.

Instead of leaving the disposal of scrap rail to track supervisors it is thought likely that much of this scrap could be resold by the purchasers as second-hand rails. For this reason the committee considers that all rail classed as scrap should be sent to the division or general stores department for inspection and classification.

Paving Stone Production Increases

Manufacturers of granite paving block in the eastern part of the United States, according to the U. S. Geological Survey, report an increase of nearly 40 per cent in quantity, those in Minnesota and Wisconsin report an increase of more than 50 per cent, and those in Missouri report a decrease of 25 per cent during 1919. The entire paving block industry made an estimated increase of 36 per cent in quantity and about \$6 an average price per thousand during 1919.

Concrete Elevated-Railway Floor With Precast Form Slabs

Cost of Wood Forms Leads to Devising New Method of Constructing Slab Floor—Results of Tests Show Thorough Bond

A NEW type of solid-floor construction is being applied to a portion of the Webster Ave. extension of the Third Avenue elevated railway in New York City, by the Interborough Rapid Transit Co., which is building the new line. It comprises precast reinforced-concrete "planks" which are laid across the stringers and serve as form or centering, and a cast-in-place top course of concrete, making the total thickness of concrete 6½ in., as shown in Fig. 1. The cast-in-place portion of the slab bonds with the form unit so thoroughly that integral action of the entire slab results. The construction was submitted to careful test before its use for the elevated-railway floor was approved, and these tests gave remarkably satisfactory results.

The Webster Ave. extension leaves the Third Ave. line just north of Fordham Road; it runs along Webster Ave. to Gun Hill Road and through Gun Hill Road to White Plains Road, where it connects with an elevated extension of the subway system. On Webster Ave. the railroad crosses Mosholu Parkway, a broad boulevard which connects Van Cortlandt Park with Bronx Park and is also a link of the main thoroughfare leading out of New York in a northeasterly direction.

On account of the importance of this thoroughfare it was required by the certificate authorizing the construction of the railroad that the portion of the structure crossing Mosholu Parkway should be of an ornamental character. This was interpreted as including that the structure should be provided with a solid deck to carry a ballasted track. As the roadway of Mosholu Parkway is carried on a bridge across Webster Ave., and as the elevated railroad structure is built above the bridge, the structure is considerably above the level of Webster Ave. line at this point, the maximum distance from the street level to base of rail being 43.4 ft. (Fig. 2).

FIG. 2. WEBSTER AVENUE ELEVATED RAILWAY NEAR MOSHOLU PARKWAY CROSSING, WHERE PRECAST FORM SLAB CONSTRUCTION IS BEING APPLIED

The solid deck was designed as a concrete slab of minimum thickness 6½ in., laid on the top of the longitudinal track stringers and trusses. In estimating the cost of placing the concrete slab it soon became apparent that the cost of formwork would become an unreasonable proportion of the total cost of the slab, in fact would amount to more than 50 per cent of the total cost.

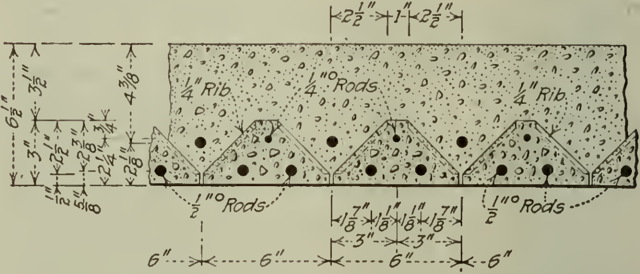


FIG. 1. CONCRETE SLAB RAILWAY FLOOR CONSTRUCTION WITH PRECAST FORM SLABS

This is partly due to the structure not being uniform, so that the forms would have to be reconstructed each time they are used, partly to the difficulty of removing the forms, and partly to the high cost of lumber. It was therefore attempted to find some material which could be left in place, whereby the cost of removing the form would be saved.

The material that suggested itself as most suitable for this work was concrete cast in advance and placed on the top of the structure. It was further conceived that by making this precast form of a general triangular shape and of a maximum width no larger than the spacing distance of the reinforcing rods a precast concrete form might be made deep enough to be sufficiently strong to carry the construction load without losing any appreciable construction height, because the reinforcing rods could be placed near the bottom of the triangular space between two adjacent form slabs. Upon investigating the stresses it was found that the horizontal shear along the plane betwen the form slabs and the deck concrete would be so small that there was no reason to believe that when in place the form slabs would not act as a part of the complete slab, at least if the contact surface were properly corrugated.

For the purpose of proving the truth of this, a number of sample form slabs were made for test. They are shown in Fig. 3. They were made 7 ft. long, 6 in. wide and 3 in. deep, reinforced with two ½-in. square bars at the bottom and one ¼-in. round bar at the top. This last bar was put in only for the purpose of securing the slabs against breaking while being handled. Some of the slabs were provided with a crosswise corrugation on the upper faces, 1½ in. wide and ¼ in. deep. Other test slabs were provided with recesses 6 in. from the end, 6 in. long and ¼ in. deep. The purpose of these corrugations and recesses was to provide mechanical bond. Some weeks after

these form slabs were made testpieces, as also shown in Fig. 3, were cast. The composite testpiece is 7 ft. long, 14 in. wide and 6½ in. deep, the bottom part consisting of two of the sample form slabs set side by side. This was to represent the conditions of the complete floor, and was, therefore, reinforced with additional rods as shown on the drawing. The center rod is a ¾-in. square bar and the two side rods are ½-in. square bars because they provide reinforcement for only about one-half the width of that in the center. The integral testpiece shown is such as the floor would be if constructed without the precast slabs. The reinforcement of this testpiece was made the same as that in the composite testpiece. The distance from the top of the slab to the center line of the reinforcing rods is 5¾ in., the same as the distance from the top to the neutral axis of the steel reinforcement in the composite testpiece.

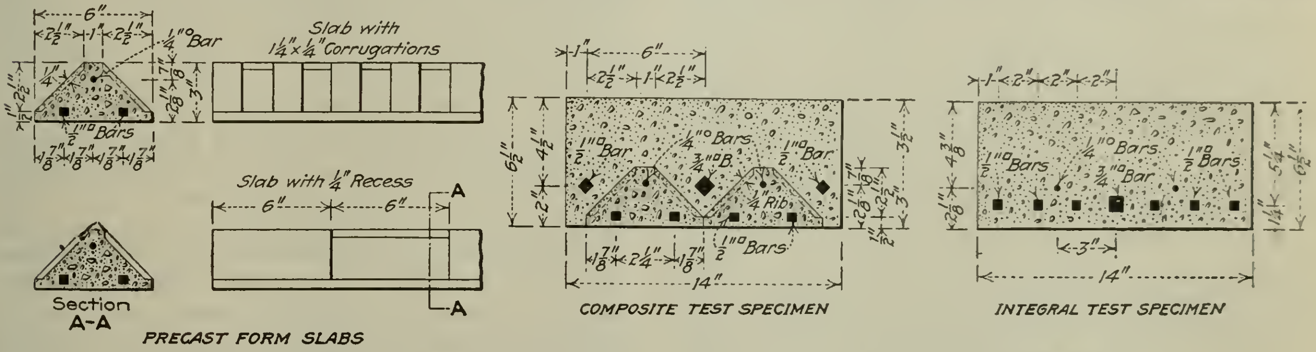


FIG. 3. FORM SLABS, AND COMPOSITE AND INTEGRALLY CAST TEST SPECIMENS

The testpieces were tested to destruction from 19 to 34 days after being made. At the same time one of the triangular precast slabs was tested which was 51 days old. The test was carried out by supporting the ends of the slabs so that there was a clear span of 6 ft. and the load was applied gradually at the center until failure. Three slabs of each type were tested. The accompanying table of results shows that the slabs in which the precast pieces were incorporated broke at a higher load than the monolithic slabs. The explanation of this is probably that while the distance from the top of the slab to the neutral axis of the reinforcement bars was the same as the distance from the top of the slab to the center of the reinforcement bars in the monolithic slab, some of the steel was at a greater distance from the top and that, therefore, the effective depth of this slab was greater.

Test No.	Type, Fig.	Mix	Steel, per Cent	Age at Test, Days	Age of Precast Slab When Placed in Test Slab, Days	Span, Ft.	Breaking Load Lbs.	Type of Load	Remarks
1	1	1:2½:5	6.6	51	..	6	1,062	Concentrated at center	
2	2	1:2½:4	2.8	28	19	6	20,380	Concentrated at center	Precast slab with corrugations.
3	3	1:2½:4	2.8	28	..	6	16,350	Concentrated at center	
4	3	1:2½:4	2.8	34		6	17,430	Concentrated at center	
5	2	1:2½:4	2.8	34	11	6	19,868	Concentrated at center	Precast slab with corrugations
6	3	1:2½:4	2 8	19		6	16,960	Concentrated at center	
7	2	1:2½:4	2.8	19	10	6	20,660	Concentrated at center	Precast slab with recess at ends.

Owing to the satisfactory results obtained by the tests, it was decided to use this method of construction of the concrete deck, and the precast concrete pieces are now being made.

The question may suggest itself, why were not the precast slabs made of such a depth that no additional concrete would be required. That this was not done is due to the following reasons. The anchorage of such a bridge deck would be uncertain and expensive; the slabs would have to be cast in a number of different sizes to fit the structure; the thickness of the slabs would have to vary in order to conform to the slopes required for drainage; and a top coating of mortar would probably have to be applied in order to make a smooth surface for the waterproofing.

On the concrete floor built as described will be placed felt-and-asphalt waterproofing, on this a 2-in. protective layer of cinder concrete, and on this the ballast, 6 in. deep under the tie. At the ends of the solid-floor section of track, ballast curbs of steel are provided.

George H. Pegram is chief engineer of the Interborough Rapid Transit Co. Design and construction of the work described are in direct charge of F. W. Gardiner, principal assistant engineer.

Southwark Bridge Being Reconstructed

Good progress is reported in the reconstruction of the Southwark Bridge over the Thames River in London. The old structure, built more than 100 years ago, consisted of three cast-iron arch spans, the central one of 240 ft. and the others of 210 ft. each. Each arch consisted of eight cast-iron ribs, connected by cross-frames and lateral bracing. The structure is being replaced by one of five steel spans ranging from 123 to 140½ ft. The width of the deck is also being increased from 42½ ft. to 55 ft. (35-ft. roadway, two 10-ft. sidewalks). The new piers were constructed on pneumatic caissons, the largest being 30 x 102 ft.; an air pressure of 22 lb. was required in sinking them. A total weight of steel of 2,000 tons is represented in the new bridge, while the old structure is said to have contained about 5,000 tons of cast iron and to have cost £800,000. For the reconstruction, the old bridge was closed to traffic; vehicle traffic was cut off entirely, but a by-pass trestle was provided for foot passengers.

Proposal Advertisements Should Attract Bidders

Under Present Conditions Contract Terms Must Be Explicitly Stated or Else Contractors Will Not Reply

By E. W. Bush
Engineer, Aetna Casualty and Surety Co., Hartford, Conn.

At the present time an unusual condition exists in regard to the letting of contract work. A large majority of the contractors doing certain lines of work have already obtained nearly all the work they desire, and are now only considering new work that looks especially attractive to them; there are other contractors who, because of the unsettled conditions as to labor and material costs, will only bid on contracts in which they are protected against increased costs. Frequently only one or two bids or possibly none have been offered on work that a few years ago would have attracted at least six to ten bids. Contractors must protect themselves by bidding extravagantly high prices on many contracts that make them carry all of the risk. They cannot do otherwise, and if engineers and owners desire to attract bidders and to let their work at reasonable prices they can best do this by modifying certain of the contract terms that have been generally used in the past so that the contractor is relieved of many of the risks that are so prominently before us at this time. Now is a good time to clean house in this respect, and readjust the contractual relations between owner and contractor on a more equitable basis.

Why not make the advertisements attract bidders to the job? Space which costs from ten to fifty dollars per issue is in many instances practically wasted as far as conveying to the prospective bidder any adequate idea of the proposed work. Frequently the "ad" merely tells him that bids will be received on a certain kind of work but nothing indicates whether the job will amount to $10,000 or $100,000, and he does not know whether his plant and organization will fit the work or not. He can find out, however, by spending the time and money necessary to go to the job, but it would be more satisfactory all around if this information was conveyed to him directly by the advertisement.

Glance at the proposal advertisements in this issue of *Engineering News-Record* and you will note that most of the matter reads as if it was prepared by a lawyer intent on setting forth in precise detail all the safeguards with which the owner surrounds the letting in order to protect his interests, and but little, if any, space advertises anything that is favorable to the contractor. Is it not better to put about all of these safeguards into the "Instructions to Bidders" which the contractor receives with, or is included as a part of, the "Proposal" form and to use the advertising space to convey to the contractor the kind of information that will tell him whether or not he wants to bid on the job?

A recent issue of *Engineering News-Record* carried fifty-six proposal advertisements, and of these only one gave the approximate cost of the work, although this information could in most cases be given without prejudice to the owner. One other proposal conveyed an idea of the working conditions at the site of the proposed work, the price at which labor could be had, the length of haul, etc., for the benefit of the contractor. Seventeen of the fifty-six included the approximate quantities of the main items of the work so the contractor could form a rough idea of the contract, but there were twenty-five others that gave only a very poor idea of the work, and fourteen that conveyed to the contractor no idea whatsoever other than the work was say a sewer rather than a road job. It may be of interest to record in passing that twenty-nine of the fifty-six made no charge, or at least advertised no charge, for the plans and contract, but that nine of them charged $5 or under, and eighteen of them charged from $10 to $50 for supplying the prospective bidder with the plans and contract forms.

It is believed that fair prices and competitive bids can be obtained in every case where the owner and his engineer will draw up an equitable contract, one that lets the owner carry a reasonable share of the unknown factors of cost, and then advertises all of the favorable facts as well as full information in regard to the work.

What the Ad Should Contain

Such an advertisement would look attractive to a contractor if it told him that bids were to be based on present prices of labor, materials and freight, and if there were increases in these, that the contractor would be allowed the increase, also that he *would* be allowed (not *might* be allowed) an extension of time for causes beyond his control. He will be interested to know that monthly payments will be made on materials delivered to the site as well as covering the work performed. If it is a road contract, he will be pleased to learn that there is no five-year maintenance clause in the contract, also that the owners will accept and take over any portions of the road that are completed and opened to traffic. If the engineer has investigated and states in the advertisement that there is a local supply of gravel and sand which will be acceptable in the work, the contractor knows that the job is not likely to be tied up by the failure to keep materials coming. Other pertinent questions are: Is water available at the site; can help be obtained locally or housed locally if brought in from outside, whether there is a trolley to carry men and materials to and from the work, where railroad switches are located, and the length of haul, the character of the roads and country hauled over, the character of the excavation and whether it can be done by steam shovel, grading machinery, etc.

Frequently, public work is advertised and bids are received in order that the amount of the necessary appropriation or bond issue may be fixed, and the work may not be awarded or the contract signed until weeks or months after the bids are received. This ties up the contractor's check and works a hardship on him if the market is rising on labor and materials, as well as leaves him in doubt as to what other work to bid on in the interval. In many parts of the United States public works, like sewers and pavements, are not paid for by cash but by warrants drawn as assessments against abutting property owners, and the contractor must arrange to get these discounted, often at a considerable percentage under their face value, in order to finance his work. Sometimes these warrants are not issued to the contractor until say thirty days after the completion and final acceptance of the work. After a contractor has journeyed a considerable distance once or twice to bid on work let under these peculiar conditions, he becomes quite wary in following up advertise-

ments on work concerning which he knows but little, and in any event he will be much more favorably disposed if he reads in the advertisement that cash payments will be made, and a decision as to the award will be made inside of two weeks after the bids are received.

If a real estate agent has a suburban home to sell he advertises the beauty of its surroundings, its well-built construction, the admirable planting and arrangement of the grounds, etc., in order to attract the prospective buyer. He tries to awaken a desire in the reader of the "ad" to possess this home, or at least go to the site and investigate. Why not break away from the usual form of advertisement and go after bidders for contract work in the same manner; change the contract so the owner assumes a fair share of the risk and then tell the bidder what you have done as well as all the other pertinent facts about the work that will inform him whether or not his organization, plant and financial strength are fitted to the work, and you will without doubt receive fair bids on the work advertised, and enough of them to let the work on a competitive basis.

Water-Works Laboratories in Michigan Are "Manned" by Women

SEVERAL smaller municipalities in Michigan have water analysis laboratories managed by young women. Men are not attracted to the places because of the limited funds available and the "blind alley" status of the positions. The salary question is especially difficult of solution in connection with disinfection plants. Here the work consists largely of chemical and bacteriological analyses, the technique of which can usually be grasped by a woman more quickly than by a man of equal mental training.

When a water supply needs purification either by filtration or disinfection the Board of Health requires laboratory control and the submission of a monthly report of results of analyses. It is desirable that the person selected for this work have some training in bacteriology and chemistry although experience is not absolutely essential. It is necessary that the operators at the pumping station attend carefully to the mechanical details of control in accordance with the findings of the analyses. A man capable of caring for pumping machinery can easily care for the mechanical operation of a disinfection plant.

When a laboratory is to be established a list of equipment is furnished by the State Department of Health and a suitable room selected, sometimes in a school building. A representative of the Department spends two or three days with the analyst giving initial instructions, after which a visit is made once a month for two or three months to correct errors and give further instuction.

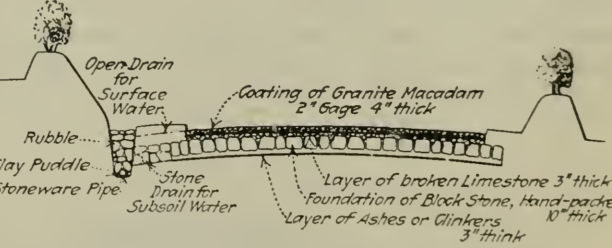
By using the dehydrated, prepared media made by the Digestive Ferments Co., Detroit, bacteriological work is simplified. One who would not be able to prepart media as it is made in large laboratories can easily prepare these media and observe and report the results of incubation with instructions to the operators handling the disinfection apparatus.

According to Edward D. Rich, state sanitary engineer, from whom these notes were obtained, ararngements with teachers in high schools, who do the work in one of the school laboratories, have been made at Hillsdale, Marine City, Sault Ste. Marie, Stambough and Travers City. At Highland Park, Iron Mountain, South Haven and St. Joseph the work is being done by young women in laboratories of the city board of health or in those fitted up by the water departments. Salaries paid range from \$30 to \$60 monthly for these part time employees. If prepared media are used only one or two hours' time daily is required.

Drainage System for Road With Wet Clay Sub-Base

A SUCCESSFUL method of draining a water-logged clay sub-base was developed in reconstructing 9 mi. of telford-macadam highway from Exeter to Okehampton in England. Along this road the ground is higher on both sides, and surface and subsoil water penetrated under the roadway and softened the clay to the consistency of cream. To remedy this faulty drainage the highway was reconstructed as indicated by the accompanying cross-section redrawn from an article in *The Surveyor* of Jan. 23, 1920. As described by W. P. Robinson, County Surveyor, No. 2 Division of Devon, the construction was as follows:

An intercepting drain of open jointed, socketed stone-ware pipes is constructed along the high side of the road. The trench is filled in with clay puddle up to the level of the center line of the pipes to prevent water from finding its way to the excavated bottom of the trench, and either remaining there stagnant or flowing along the trench under the pipes. The remainder of the trench is filled with hard rubble free from small stones and dirt. Catchpits are constructed at frequent intervals, some in 9-in. brickwork and some in concrete, covered in with reinforced concrete slabs $2\frac{1}{2}$ in. thick, an opening being formed in the side wall of the pits for the entrance of surface water from the carriageway.



DRAINS PREVENT WATER FROM PENETRATING SOFT CLAY SUBSOIL

Having in view the importance of not only intercepting water from the higher ground but of draining the road-bed, the old road crust was removed to allow of the new road-bed being formed to a camber of not less than ½ in. to a foot, and this camber was extended outside the width of the new carriageway to meet the intercepting drain-trench on the higher side of the road, and on the lower side frequent trenches were cut and filled with rubble below the level of the new road-bed and leading therefrom through the fence to suitable outlets.

In some places it was deemed advisable to construct, in addition, subsoil drains in the new road-bed, these being laid herringbone fashion leading to the main intercepting drain and consisting of trenches filled with rubble or fascines. With the object of preventing the crossfall of the new road-bed being pressed by subsequent rolling out of its proper shape and the consequent interference with the efficient drainage of the road-bed, fascines and loppings of fir trees were laid in the clinker and the clay subsoil removed to a greater depth adjoining the drain trench.

State University of Iowa's New Hydraulic Laboratory

Description of the New Hydraulic Testing Plant Built by Students of the College of Applied Science

By Stuart Sims

Formerly Associate Professor of Mechanics and Hydraulics, State University of Iowa; Now Professor of Civil Engineering, Oregon Agricultural College, Corvallis, Ore.

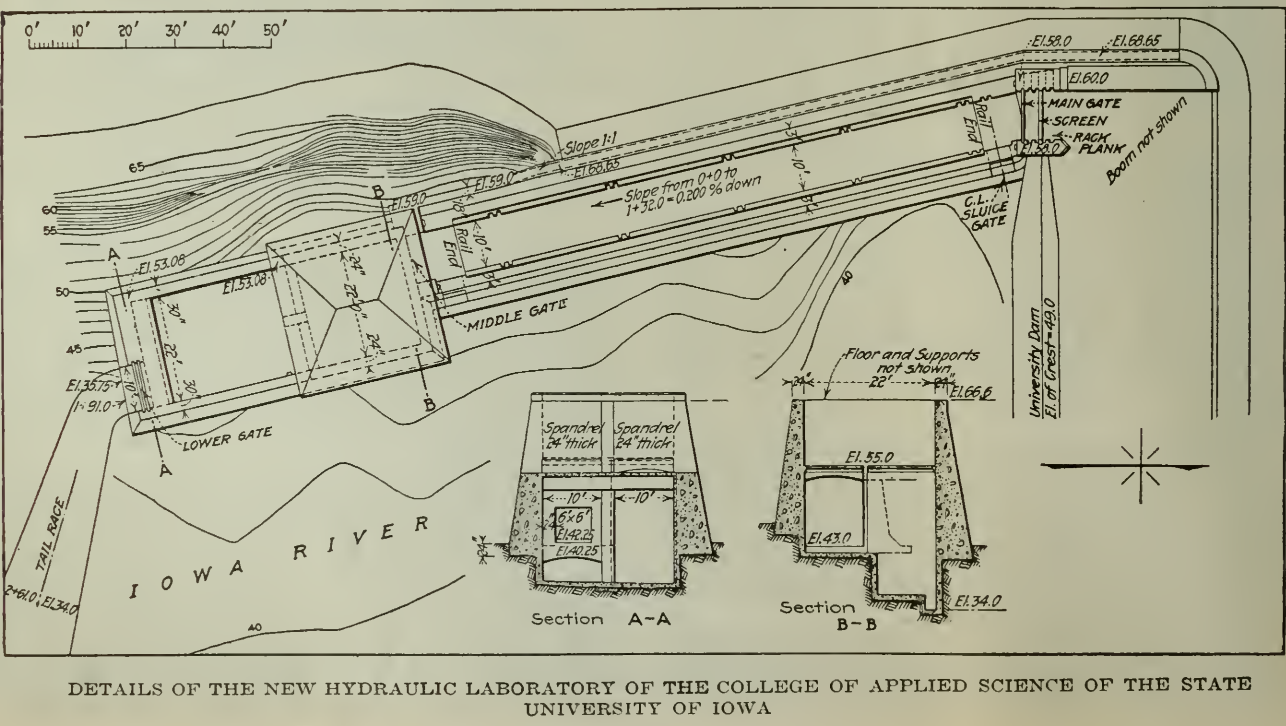
The State University of Iowa has completed a hydraulic laboratory in connection with a water-power site near the campus. As the laboratory will offer facilities for doing much important experimentation and research work a brief description of the structure should be of interest to those engaged in engineering education and to hydraulic engineers.

Sometime previous to 1905 the College of Applied Science was given a deed to a water-power site in Iowa City upon the Iowa River, upon which was constructed a concrete dam, and power house located upon the east bank. At the western end of this University dam provision was made for a future connection to the proposed hydraulic testing laboratory, which, as then planned, was to consist of a concrete tank 100 ft. long by 10 ft. in width and depth. In the spring of 1915 revised preliminary plans, and estimates of cost were made. In 1917 a legislature appropriation of $15,000 was obtained, which sum has been further increased by an additional grant of $7,000 made during the legislative assembly of last winter. Early in 1918 trips of inspection to the hydraulic laboratories of the Universities of Wisconsin and Illinois were taken, many valuable suggestions and ideas being received. Careful studies of all available matter descriptive of other laboratories were made also, and final plans for the Iowa Laboratory were completed in readiness for construction in June, 1918.

The laboratory is located on the west bank of the river south of the University dam. It consists of three main parts; the testing canal, the basin, and the tail race, this last being merely a canal, cut into the rock, which connects the south end of the basin with the river. The entire structure rests upon a hard blue limestone foundation.

The testing canal, made of concrete, is 130 ft. long, 10 ft. wide and deep; the top of the walls being 4 ft. higher than the crest of the dam. At the northern end where it connects with the dam are located in the order named, a boom, a trash rack, wooden regulating gate 10 ft. wide by 12 ft. deep, with hand operated hoist, and screen slots. Just below these in the east wall nearest the stream, is provided a wooden sluice gate, 5 ft. wide by 4 ft. high, for flushing out the silt which collects above the dam near the mouth of the intake. At intervals of 25 ft. down the canal recesses are placed in the walls to receive stop planks; and on 10 ft. centers, 1 ft. above the bottom of the canal, are 2-in. pipes running transversely through the east wall for the insertion-during tests of piezometer tubes. These pipes, when not in use, are closed by plugs set flush with the wall face. A track of 20 lb. rails, set on the tops of the two canal walls will, with a car, provide facilities for current meter rating. Another 5 by 4 ft. wooden sluice gate is set in the east wall at the lower or southern end of the canal, at which end there is another large gate to close the entrance to the basin. The floor has a grade of 0.2 per cent sloping down to the south. Ladders are located in convenient places for getting about in both the canal and basin.

The basin, formed by concrete walls, is rectangular in plan, 22 ft. wide by 54 ft. long. Twenty four feet at the northern end is covered by a building, the remaining portion being left open. That under the building is arranged so that it can be divided into four parts and so that water entering from the canal can be diverted in any desired direction. In one of these parts is located a wheel setting for the testing of turbines, facilities have also been provided for the installation of weirs, of a Herschel Fall Increaser, and of a 51-in. McCormick turbine. Openings have been



DETAILS OF THE NEW HYDRAULIC LABORATORY OF THE COLLEGE OF APPLIED SCIENCE OF THE STATE UNIVERSITY OF IOWA

left in the concrete cross and end walls so that lines of pipe may be carried from the intake, down the canal, through the basin and out upon the river beach to the south. In the south end wall, at the south corner of the basin, is an opening to the tail race which can be closed by a third large wooden gate.

The floor of the basin, which is pitched to drain to a sump in the northeast corner, lies in general about 8 ft. below that in the canal, and about 6 ft. below the low-water stage of the river, on the downstream side of the dam. However, the slab forming the wheel support and the part connecting it to the canal are placed at an elevation 12 in. below the floor in the end of the canal and, therefore, approximately 7 ft. above the general floor level.

The building, over the upper part of the basin, is 26 ft. square, of brick with a tile roof. It is so planned that it can be extended to the south over the entire basin, when additional floor space is required; and when this is done the resulting structure will be 26 x 58 ft. over all.

Aside from the equipment already mentioned nothing in this connection has been definitely decided upon as yet. Funds are, however, available for this purpose when wanted.

Construction of the plant was done by force account, the majority of those working being students in the engineering college. All displayed intelligence, loyalty and industry to a very gratifying degree.

The large stones blasted from the excavation were all placed in the concrete walls, approximately one-third the volume of the forms being filled with this material so that the resulting cost per cubic yard of the finished walls was about $4.70 in spite of the very high unit prices of materials used.

As now completed the laboratory will be adapted more to the purpose of research than to that of undergraduate instruction, though it is hoped that the necessary space and equipment for the latter will be provided in the near future.

Two problems that give promise of being worked upon very soon are an investigation of the Herschel Fall Increaser, and a study of the flow of water through drain tiles of various sizes. With plenty of water available it is possible to make tests on full size models of all forms of hydraulic apparatus adapted to low heads, as well as to investigate many other phenomena not clearly understood.

Preliminary plans for the laboratory were made by Professors J. H. Dunlap and R. E. Hutchins of the College of Applied Science. Preparation of final plans and the supervision of construction were by the writer. W. G. Raymond is Dean of the College of Applied Science, S. M. Woodward, Professor of Mechanics and Hydraulics.

Current American Shipbuilding

On June 1, 1920, private American shipyards were building or were under contract to build for private ship owners 345 steel vessels of 1,060,643 gross tons, compared with 348 steel vessels of 1,391,341 gross tons on May 1, 1920. This is the first decline since July, 1919. These figures do not include government ships building or contracted for by the United States Shipping Board out of money voted by Congress.—*Commerce Reports.*

Solution for Highway Curve Problem With P.I. Inaccessible

By C. H. Olmstead
Resident Engineer, Tennessee State Highway Department, Nashville, Tenn.

In computing curves when the *P.I.* is inaccessible, the method here described gives the lowest degree of curve which will meet the requirements of location, and it is also shorter than other methods. In this case the curve is treated as being composed of two curves of the same degree and having the *P.T.* of the first coincident with the *P.C.* of the second. The limiting factor is that the sum of the tangent lengths for the two curves must equal the distance between the two *P.I.'s* which are to be used.

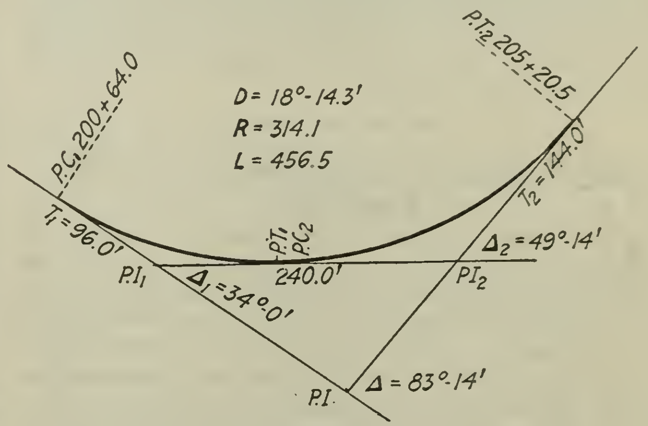


DIAGRAM FOR SOLVING CURVE PROBLEM

For example, take the curve shown in the accompanying figure. The known quantities are:

$\Delta_1 = 34°$; $\Delta_2 = 49°\ 14'$; distance $P.I._1$ to $P.I._2 = 240$ ft.

In any curve tables find the tangent for one degree curve for each Δ. These divided by the degree of curve which is to be found are the tangent lengths whose sum is 240 ft. Thus:

$$\frac{1751.8}{D} + \frac{2625.4}{D} = 240\ ft.$$

$$D = \frac{4377.2}{240} = 18.238\ deg. = 18\ deg.\ 14.3\ min.$$

$$\text{Then } T_1 = \frac{1751.8}{18.238} = 96; \quad T_2 = \frac{2625.4}{18.238} = 144$$

$$Radius = \frac{5730}{18.238} = 314.1\ ft.$$

$$Curve\ Length = 2\pi R \frac{\Delta_1 + \Delta_2}{360} =$$

$$2 \times \frac{22}{7} \times 314.1 \times \frac{34.0 + 49.23}{360} = 456.5\ ft.$$

The value $\frac{22}{7}$ can be used for π in nearly all cases and greatly simplifies computations.

The deflection for 50 ft. of arc is 4 deg. 33.6 min. and the deflection per foot of arc is 5.47 min.

Station of first $P.I.$ = 201 + 60

Station of first $P.C.$ = 200 + 64

Station of first $P.T._2$ 205 + 20.5

In running a curve it is good practice to figure the deflections from the *P.T.*, setting up over the *P.T.* instead of the *P.C.*, which eliminates one set up. Then:

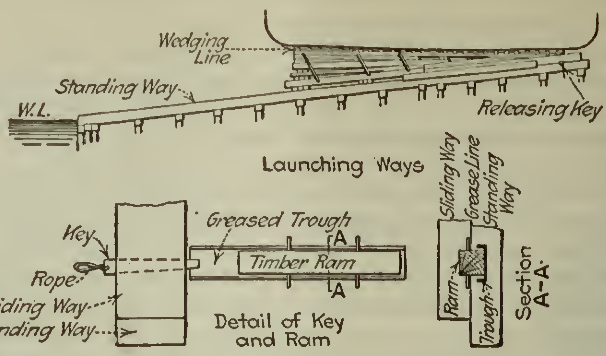
Station	Deflection	Station	Deflection
P.T. 205 + 20.5	0° 00′	202 + 50	24° 40′
205	1° 52′	202	29° 14′
204 + 50	6° 26′	201 + 50	33° 47′
204	10° 59′	201	38° 21′
203 + 50	15° 33′	P.C. 200 + 64	41° 37′ = $\frac{1}{2}\Delta$
203	20° 06′		

In cases of the inaccessible *P.I.*, the middle tangent can be made to approximate the center of the present road. With the method described the curve must touch this tangent, thus doing away with the necessity of taking the external into consideration, which must be done in any other method.

Key-Releasing Arrangement for Side Launching

A MARKED departure from standard practice in side launching is in successful use at the Merrill-Stevens Shipbuilding Corporation, Jacksonville, Fla., where 6,000-ton steel steamers are being built for the Emergency Fleet Corporation. A simultaneous key release at all of the launching ways replaces the usual rope release of current practice in the Great Lakes yards (described in *Engineering News-Record*, Jan. 2, 1919, p. 7). The new method, sketched in the drawing herewith, has the purpose of avoiding concentration of the downward pull of the ship at a few anchorages, as occurs with the rope release; it actually eliminates the pull by distributing it to all the ways, where it is neutralized by the lateral thrust of the ship's cradles due to the slope of the ways. In the soft soil in the Merrill-Stevens yard, anchorages would have been very costly, and this fact led to the adoption of the key-release arrangement, devised by Frank H. Owens, Superintendent of Hull Construction at the yard.

In the accompanying drawing are shown the essential features of the arrangement. There are twenty-one ways, spaced 16 ft., and laid on a slope of about 0.118 ($1\frac{13}{32}$ in. per ft. The way timbers are about 70 ft. long. The support of the ship on each way consists of short transverse cradles at the lower side and a longitudinal sliding way in the upper half, the two together supporting the ship by blocking timbers and wedges. Near the upper end of the sliding way, both the sliding and ground ways are notched out on the sliding surface, these notches registering in the starting position, so that a timber key thrust through the hole formed by the notches locks the sliding way in position. Thus, when the ship is wedged up preparatory to launching, it is held by the twenty-one keys. When the ship is to be launched all twenty-one keys are driven out simultaneously. The equipment for this purpose consists of a wooden ram driven against the point of the key by four men; the ram slides in a greased trough and two men can operate it easily, so that with four men at each ram there is little chance of lag at one of the keys from "stage fright" or other cause when the pistol-shot signal for releasing is given. Opposite the large end of the key a fifth man is stationed, handling a rope attached to the key, by which



CRADLE AND RELEASING-KEY ARRANGEMENT AS USED FOR SIDE LAUNCHING AT MERRILL-STEVENS YARD.

he pulls it out of the way if the blow of the ram does not send it clear.

This arrangement has proved successful in launching both steel and wood ships. In the launching of the 6,000-ton steel steamer "Wekika," only one key, No. 12, failed to release, and this one key easily sheared off under the pressure brought to bear on it by the ship. It is claimed that as many as four keys could fail to release and be sheared off without endangering the launching.

Careful measurements made during the launching of the "Wekika" by research engineers of the Emergency Fleet Corporation showed that the initial coefficient of friction was 0.11, and that after about 3½ sec., during which time the ship moved a little less than 3 ft., the coefficient dropped to 0.046 and remained at this value throughout the rest of the ship's travel.

Italy Creates Experimental Road Institute

The Italian Touring Club has recently promoted an experimental institute of roads for the study of materials employed in the construction and maintenance of highways. The objects of the institute will be to carry on laboratory experiments on the physical and mechanical characteristics of road materials; to help the progress of experimental technics relative to highway surfacing by reproducing and studying samples of pavements worn by traffic or deteriorated otherwise; to form a collection of material samples suitable for Italian road construction; to collect all descriptive and statistical matter appertaining to Italian roads; to furnish public bodies with useful advice relating to construction and maintenance of roads, and to forward by every other means the development and betterment of road work in Italy. The institute publishes monthly reports of its proceedings. The institute is financed by annual contributions from the Touring Club of Italy, by an annual subsidy from the Ministry of Public Works and by annuities, gifts and charges made for materials tests. The institute is under the direction of Sig. Italo Vambone, formerly chief engineer of the Province of Milan. More detailed information regarding the formation of this institute is given in a recent bulletin of the Permanent International Association of Road Congresses.

Stone Exportation in 1919

According to a recent bulletin issued by the U. S. Geological Survey, 1919 was the banner year for the exportation of stone from the United States. The value of the stone exported was $2,779,389.

Chlorinated Water Destroys Metals in Intake Works

Vacuum Believed Responsible for Action in Suction Lines at Sacramento, California

By C. G. Gillespie
Resident Engineer, Filtration Division, Sacramento, Cal.

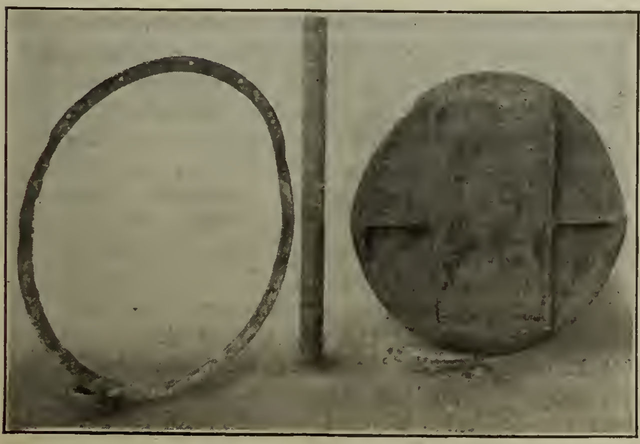
During the fall of 1919 evidence accumulated at the intake system of the city waterworks at Sacramento, Cal., indicating that chlorine gas was exerting a destructive effect on nearly all valves on the pump suction lines to which chlorine was applied for water disinfection. This led to an investigation of conditions in the intake system, resulting in discoveries set forth below.

The water supply at the intake is pumped from the Sacramento River direct into the mains. The only treatment is by liquid chlorine delivered through two solution-type chlorinators into the three suction pipes leading in from the river, the point of application being from 12 to 80 ft. from the three main pumps. All three suction lines are interconnected and are therefore drawn upon continuously unless purposely shut-down. In practice chlorine is applied to but two of them—the two which have suffered by valve corrosion.

The suction lines are 20, 30 and 40 in. in diameter respectively, and the valves affected include two 3-in. priming valves; one 12-in. valve, installed about 15 years ago; one 24-in. valve, installed about 2 years ago; two 30-in. valves, which have been installed for about 20 years, and also one 42-in. valve installed for about the same period.

The chlorination of water at this intake began in February, 1915, at which time the city used three float-type meter, solution-feed machines located at the suction inlets at the river, about 276 ft. from the pumping station. The calculated time of travel from the point of chlorination to the pumps ranged from 1 to 5 min., averaging three minutes.

In February, 1917, the chlorinators were moved into the station to afford more frequent attention. Since that time all the points of chlorine application have been within the station, and not more than 25 ft. from the valves which have since shown corrosion. All of the valves affected were installed in an upright position on active suction lines and were generally open, with the exception of the priming valves. The 24-in. valve, which was the newest one affected, has not been open more than the others. With the exception of this valve, the open valves are all operated on non-rising stems.



THIRTY-INCH VALVE DISC, STEM AND SEAT RING SHOWING EFFECTS OF ATTACK

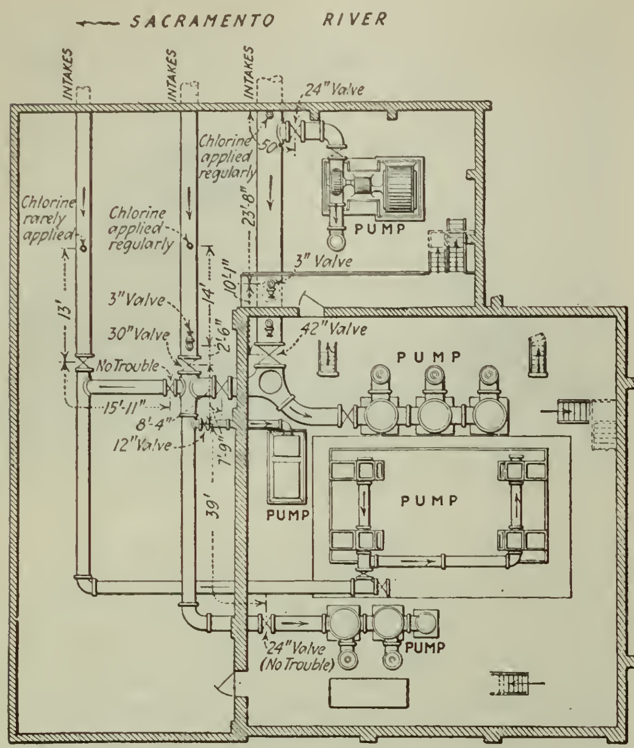
BADLY CORRODED PRIMING VALVE AND OTHER PARTS

Approximately 16,000,000 gal. of water are pumped per day and 1,400 lb. of chlorine are used annually, equivalent to an average dose of 2.4 lb. of liquid chlorine per million gallons of water. The suction lines are under a partial vacuum of 15 ft. for six to seven months of the year; the remainder of the time they may operate under a slight pressure.

One of the common symptoms of destruction which appeared early was a chattering in the valve. When the operators attempted to lower the discs, they would suddenly drop, due to the fact that the threads on the stem, just below the wedge, were completely eaten away. The 24-in. valve, however, was hydraulically operated and therefore used a rising stem. This stem did not exhibit any destruction. In this valve the principal symptom of trouble was the fact that when closed leakage past it occurred.

The trouble incident to the corrosion of the valves having non-rising stems was particularly serious. When a stem severed its connection with the disc, the only way the disc could be raised was by closing down the pumps while new stems were inserted or the bonnet removed. In a direct system, such as this one in which all pumps and suction lines were taxed to the limit, this operation contributed no small hazard in maintaining a water supply.

The general appearance of valve parts which it has been possible to examine are shown in the accompanying illustrations. They show typical conditions. Invariably the portion of the stem within the bonnet, exclusive of that protected by the threads of the wedge and that which extended into the flowing stream, was eaten away and the threads shapeless or gone. This is perhaps the most noticeable and serious aspect of the action because it may suddenly interfere with the use of the suction line at a critical time. The disc rings were usually pitted and thin with a maximum corrosion about one-third of the way back from the crown of the disc. The cast iron discs themselves were as soft as graphite and in fact greatly resembled this metal to a depth of fully $\frac{1}{16}$ in. These discs were either pitted and rough, or worn as by the action of a fine sand blast. The effect on the discs was likewise most extensive near the upper periphery. No inspection has been possible of the seat or seat rings, as none of the lines could be thrown out of service for a sufficient interval. Certain 3-in. priming valves on the upper part of the lines, usually closed, were



ARRANGEMENT OF INTAKE SYSTEM AND VALVES WHERE CORROSION OCCURRED

most affected. The wrought iron riser first gave way and frequently the upstream face of the valve itself completely disappeared as by a cancerous action and even the threads on the pipe adjacent were destroyed.

All the metals found in the valves were attacked and, so far as examination disclosed, with equal severity. In some valves the brass stems seemed to have been attacked the more severely while in others the wrought iron gave way first and in still others the cast iron had suffered the greatest deterioration. No make of valves installed near the points where the chlorine was applied was exempt. On the other hand the castiron air chamber just beyond one of the first valves to be attacked has not yet failed, although it is possible that disintegration may be going on. The steel pipes constituting the suction lines were examined by drilling and appear to be unaffected. Valves on the suction lines about 63 ft. from the point of application of the chlorine have shown no signs of being attacked.

All things considered, it seems certain that the destruction of these valves can be charged wholly to the action of chlorine gas which accumulated in the valve bonnets and high places on the suction lines, not having been absorbed by the time it reached the trap so formed. It is probable that the existence of a partial vacuum promoted the liberation of the gas from the stream. Nevertheless, valves more or less remote were apparently not affected and this would indicate gradual absorption of chlorine in spite of vacuum conditions.

Judging by the extent of the action on these several valves, and particularly on the 24-in. valve, which was but two years old, it is at once apparent that here is a phase of chlorination that should receive the most thoughtful attention.

Based on this expensive and hazardous experience it is suggested that chlorine be not applied to suction lines under partial vacuum within 100 ft. of any valve or high pocket. Moreover, it would be well to use all such helpful precautions as ample dilutions, the diffusion of chlorine in the pipe, the installation of valves horizontally rather than upright and, finally, the use of duplicate facilities to permit valves to be repaired.

S. W. Kay is superintendent of the water works and practically all of the history of this experience was obtained from him.

Impact Tests on Road Concrete

INVESTIGATIONS of the wearing quality of road concrete were made by the Highway Department of Pennsylvania recently and reported in a paper by H. S. Mattimore before the American Society for Testing Materials. The paper is entitled "Impact Tests on Concrete to Regulate Coarse and Fine Aggregate Qualities and Mixtures for Highways." The instrument consisted in a cam actuated lever at the end of which were placed vertically eight points with non-slip calks which dropped 4 in. at the rate of 90 r.p.m. on the circular upper surface of a 6-in. cylinder. These cylinders were in general cut from a road in which varying kinds of concrete and finishing methods were used. However, some test specimens of concrete were poured as cylinders particularly for the tests. The amount of loss of the specimen under the continual blows of the points was used to compute a so-called impact coefficient.

The results were not profoundly convincing, though the author has made the following definite conclusions based on a study of the data:

1. The qualities of both coarse and fine aggregate influenced both compression and impact wear tests.
2. The quality of the fine aggregate has a greater effect on the impact wear test than that of the coarse aggregate.
2. A 1:2:3 mix gives more uniform results in impact wear tests in a mix with a larger proportion of coarse aggregate.
4. The 1:2:4 and the 1:1½:3 mixes are affected to a greater extent by the quality of the coarse aggregate than a 1:2:3 mix.
5. Where an excellent quality of fine aggregate is to be used with a medium quality of coarse aggregate a 1:2:3 mix should be used.
6. Where an excellent quality of coarse aggregate is to be used with a medium quality of fine aggregate there is very little difference in impact wear between a 1:2:3 and a 1:2:4 mix, so it may be economical to use the latter.
7. More uniform results were obtained under impact wear tests on specimens from the road, than on the molded specimen.
8. There is no direct relation observed between impact wear tests and compression.
9. Machined finished concrete gives more uniform results in impact wear test than hand finished concrete, although some specimens of the latter give high values.

Insanitary Conditions at Toledo, Ohio

A sanitary survey of Toledo, Ohio, completed recently by the Health Division, shows 16,010 privy vaults and 8,118 surface wells. A state law prohibits both privy vaults and surface wells where sewers and running water are available. In the majority of cases, according to A. A. Greenbaum, secretary of the Health Division of Toledo, privy vaults and surface wells were found on the same properties. Many of these vaults and wells are in the congested portion of the city. During 1919, 915 vaults and 525 surface wells were eliminated. Mr. Greenbaum says that the violation of the state law is due in most cases to ignorance rather than intention—but the press abstract of his report on this subject does not indicate why all persons violating the law are not notified of the fact so that the plea of ignorance will no longer remain.

Decision on Lake Diversion by the Chicago Drainage Canal

District Court Rules Navigation is Paramount and is Impaired by Flow to Drainage Canal—Facts and Opinions in Case

IN RENDERING a decision against the Sanitary District of Chicago in the suit brought by the U. S. War Department to restrict its diversion of water from Lake Michigan, Judge Landis, of the U. S. District Court at Chicago, has held that "navigable rights are paramount." In effect, this decision will grant the War Department the right to an injunction against the diversion of more than the 250,000 cu.ft. per minute originally permitted but now exceeded considerably. It is understood that he has withheld the order for some years past, partly in the hope of an adjustment of differences between the Sanitary District and the War Department.

Thus far, Judge Landis has given only an oral opinion and the formal entry of an order restricting the flow of the drainage canal is suspended to permit of an appeal to the U. S. Supreme Court. Apart from this suit brought by the U. S. Government, the Sanitary District has made application to the Secretary of War and the Chief of Engineers, U. S. Army, for approval of its proposal to compromise the controversy with the U. S. Government. If this should be approved, the present case would cease to exist.

Some particulars of the case, with viewpoints of the officials of the Sanitary District of Chicago, are given further on. The main part of the report of the judge's oral opinion follows:

The charge is that the Sanitary District of Chicago is taking an amount of water (and proposing to take more) which causes the impairment of the navigable capacity of the Great Lakes, excepting Lake Superior, and that such impairment, without the consent of the Federal authorities at Washington, entitles the government to an injunction. The defense of the Sanitary District is that there is no impairment and, primarily, that if there is an impairment it is necessary for the sanitation of this great territory.

Examination of the proofs on the question whether the taking of this water is felt or not, leads me to the conclusion that there is a lowering of the surface of the lake. In making that statement I have in mind the traditional variation of the lake levels, known to all men that know anything about it. The taking of the vast volume continued unceasingly has resulted in the lowering of the level of the lake and in reversing the current of the Chicago River.

The variation is only a matter of inches in Lake Michigan. It is without doubt, in my judgment, on the evidence of the matter, a matter of inches. Even though it be no more than three or four inches, having in mind the state of proof as to the depth of the harbors in the Great Lakes, it is directly an impairment of navigable capacity The question of fact, whether there is an impairment or obstruction here, is beyond controversy. The fact is clearly established that there is such a change in the lake level, in my judgment, that in low lake level time the level is lower and in high lake level time it is less than it would be but for this diversion. [In answer to a question by the judge it was stated that at present the diversion is approximately 480,000 cu.ft. per minute.]

The finding of the court is, on the evidence in this case, that diversion has resulted in the lowering of the lake level and the reversal of these currents, which latter fact is not controverted. On the evidence that the lowering is an impairment of navigable capacity, even though it amounts to no more than three or four inches, and as to the lowering to that extent there could be no controversy on the record, the court's finding is against the contention of the defendant [the Sanitary District] on the proposition that this is a necessary thing for the salvation of this community. That is, that without this water this community will be at the mercy of disease germs from which it suffered before this diversion began and from which it has by this diversion been practically relieved, as shown by statistics.

The court has complied with this rule of law, that navigable rights are paramount, and even though the Sanitary District is driven to the necessity of making some other provision, granting that the War Department and Congress should refuse to give contention to this question of sanitation [i. e., refuse to permit the desired diversion in the interests of sanitation?], it is entitled to the law, which I must obey, that a navigable right is paramount. In the last analysis, should Congress and the War Department, in consideration of all these matters, decline to permit the necessary diversion, the burden is on the District of providing some other method of relief. In other words, the defense that the diversion is necessary for the purposes of sanitation, as against the rule that a navigable right and navigation right is a paramount right, is immaterial.

The order will not go into effect until 30 days [afterwards changed to 60 days] after the Sanitary District has an opportunity to present to the Supreme Court of the United States an application for supersedeas; that is, 30 [60] days after the date fixed for the meeting of the Supreme Court in October.

From the beginning, prior to the diversion and down to 1907 or 1908, the constant attitude of the Sanitary District was a recognition of the control of the Federal Government over this whole question, everything that was done by the Sanitary District in the way of diversion being in a permit granted by the War Department on application of the Sanitary District to that end. The Sanitary District shall have an opportunity to apply for further relief to the War Department at Washington. Under no circumstances does this order go into effect now. The thing that the court wants, being a citizen of Chicago, the thing I want, is water without microbes.

This decision restricts the diversion of water to 250,000 cu.ft. per minute, the limit set by a permit of the Secretary of War in December, 1901, after protest by the navigation interests against a flow of 300,000 cu.ft. per minute which had been granted conditionally in 1899. This restriction on the flow was based on navigable velocities in the Chicago River. The Sanitary District then commenced to widen and deepen the river, removing fifteen center pier bridges and providing wider channel openings at a cost of $12,000,000, in order to give sufficient cross sectional area for a flow of 600,000 cu.ft. per minute without excessive velocities.

Numerous applications for permission to take a greater quantity of water from the lake have been made by the Sanitary District, but without avail. After an application for an additional draft of 240,000 cu.ft. per minute through the Calumet River and Sag canal had been denied by the War Department in 1907, President Roosevelt suggested that a friendly suit be brought to determine the rights of the Secretary of War. Suit was then commenced in 1908 with reference to the Calumet-Sag diversion. Later the case was enlarged to cover the entire diversion, and an injunction was asked to prevent the original draft of 250,000 cu.ft. per minute being exceeded. It is this case which has now been decided in the U. S. District Court.

It may be noted in passing that the actual diversion has exceeded the prescribed limit, the flow through the Chicago River to the canal, according to the Sanitary District official, having been from 420,000 to 540,000 cu.ft. per minute.

Navigation interests have not been alone in their fight against increased diversion of water for the drainage canal. Cities located along the lakes have opposed such diversion on the ground of its alleged effect in lowering the lake levels and thereby reducing the depth of water in the harbors. Private power interests have joined in the opposition, since they object to the public authorities developing water power at the lower end of the canal, and possibly in future along the Illinois River if the Illinois waterway project should be carried out. It has been stated by the Sanitary District, however, that no additional draft or diversion has been made for power purposes, the power plant at Lockport simply utilizing the flow normal to the operation of the drainage canal.

Even should the present decision be reversed by the Supreme Court, Chicago will still be faced with a sewage disposal problem. At a meeting of the Illinois Society of Engineers in 1919, it was stated by C. D. Hill, chief engineer of the Chicago Board of Local Improvements, that should the government give permission to operate the drainage canal at its full capacity, it would still be necessary to install auxiliary purification works, for "the time is approaching when some method of supplementing dilution must be adopted."

Recognition of this necessity by the Sanitary District is the reason for its activities in pushing the treatment of sewage from the packing house district and studying preliminary treatment of the sewage in excess of the amount that could be diluted properly by the maximum flow in the canal. The effluent from the sewage-works, it is held, would require relatively slight dilution to render it innocuous. For the same reason the Sanitary District is studying the treatment of industrial wastes and is providing for the treatment of sewage in localities where it is impracticable to obtain the amount of water necessary for dilution, as along the Desplaines River. But if the flow should be restricted to the amount stated under the recent decision, the officials of the Sanitary District say, a much more extensive and costly program of sewage treatment would be required.

The Sanitary District has proposed to pay for the construction of controlling works at the head of the St. Lawrence River and at the outlet of Lake Erie, in order to regulate the flow from the Great Lakes and thus, the district maintains, more than compensate for any possible lowering of the levels of the lakes due to a total diversion of 720,000 cu.ft. per minute from the lower end of Lake Michigan. (See *Engineering News-Record* of July 31, 1919, p. 231). The District holds that this would provide more uniform flow for power at Niagara and along the St. Lawrence. A report on Niagara River regulation, made to the Sanitary District of Chicago by F. C. Shenehon, was summarized at length by Mr. Shenehon in *Engineering News-Record* of Feb. 12, 1920, p. 308. The cost of those controlling works, it is said, would be very much less than that for the enoromus sewage-works which would be necessary under conditions of restricted flow in the drainage canal, and the former would involve relatively little expense for operation.

The officials of the Sanitary District feel that although the most obvious function of the drainage canal is the disposal of the sewage of Chicago by dilution, yet its main function, from a health protective viewpoint, is the almost complete diversion of all sewage from the drinking water of the cities along the lake, including Chicago, Evanston, Glencoe, Winnetka, Kenilworth and Wilmette and adjacent Indiana towns.

This diversion of the sewage, together with intelligent chlorination of the water, Chicago interests hold, has been responsible in a large part for the remarkable lowering of the typhoid fever death rate of Chicago to the record figure in 1919 of 1.19 per 100,000. The success of the diversion, the Sanitary District holds, depends on a flow of 600,000 cu.ft. per minute, which is the estimated flood flow of the Chicago River. With the proposed restricted diversion of 250,000 cu.ft. per minute it is held to be impossible to keep the river from discharging into the lake at frequent intervals, thereby endangering the water supply. Extended field tests, it is said, have shown that about 24 hours are required before an increase of flow at the outlet of the drainage canal at Lockport affects the flow at the entrance of the Chicago River.

During the past year the Sanitary District has been endeavoring to arrive at a solution of the entire problem which would satisfy all parties, including navigation and power interests, in both the United States and Canada, and also the people along the Illinois River. The program suggested has included not only the control of the Great Lakes, but also a progressive installation of sewage-works, so as to reduce in twenty years the organic load of the canal, both industrial and domestic, to one-half the present domestic load alone. As the population of Chicago increases at a rate of about 500,000 every ten years, this is equivalent to constructing sewage-works for a city of that size every decade merely to keep up with the growth. The Sanitary District holds that the control of the eastward flow at the lakes will not only enable the flow of the St. Lawrence to be maintained in the early fall, so as to benefit harbor conditions in Montreal, but will tend also to make the flow more uniform at Niagara and along the St. Lawrence. In return the Sanitary District requests an assured diversion of 600,000 cu.ft. per minute. This is now under consideration by the War Department.

It is of particular interest to note that at present there appears to be greater harmony between the War Department, shipping interests, the Canadians and the Sanitary District than at any previous time. In a recent public hearing on the report of the Board of Engineers on Rivers and Harbors, at Washington, a plan was presented which appeared to appeal to all as a practical solution. This report recommends:

(1) The Sanitary District should be allowed the use of water necessary for the dilution of sewage now entering the Chicago River and to prevent the river from flowing into the lake. This flow is taken at 600,000 cu. ft. per minute. (2) Works to compensate for lowering the levels of the lakes by this diversion to be built at the expense of the Sanitary District. (3) Diversion from the lake not to exceed the amount mentioned above, but the Sanitary District must be obligated to proceed with a comprehensive plan for treating the sewage of the population beyond the limits of dilution by the maximum prescribed flow. (4) Diversion of water from the lake must be so effected as not to injure navigation in the Chicago River. (5) The Calumet-Sag channel project and diversion is to have special consideration, with particular reference to needs of Indiana towns. (6) Pollution of lake waters by ships is to be prevented.

Engineering Literature

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

The Growth of Technical Journals and of Technical Books

Experiences and observations in the fields of technical journalism and the publication of technical books were a feature of a recent address by Edward H. Caldwell, treasurer of the McGraw-Hill Co. and also of the McGraw-Hill Book Co., at a dinner given in honor of his completion of thirty years of service with the companies named and their predecessors. After leaving Cornell in 1888, Mr. Caldwell was first engaged in electric railway work with the old Sprague company. He then joined the staff of *Modern Light and Heat*, published in Boston. In May, 1890, he met Dr. Louis Bell, then editor of the *Electrical World*, who invited him to become his assistant. For a year or so these two were the entire editorial staff of the *Electrical World*. After sketching the growth of various engineering journals Mr. Caldwell said: "It is interesting to note that six of our present group of 10 papers [published by the McGraw-Hill Co. in New York] have been published for more than thirty years, having absorbed at least ten others, while the other four were established as necessary to carry out the ideals of service to be rendered." Mr. Caldwell's remarks in passing from technical journals to technical books and on the latter subject were, in part:

"I might go on indefinitely pointing out the great strides that have been made in the material development of the country since the clear vision of Rothwell, Wellington, Frost, Johnson, Swetland, McGraw and others first saw the need of the periodicals which they founded; and just as clearly saw the great service which these periodicals could render in spreading engineering information, and in giving assistance in the expansion and upbuilding of the material elements of our modern civilzation."

The story of the growth of technical book publishing is just as fascinating and has developed along similar lines and for like reasons. The *Electrical World* in 1890 had published a few books, some of which were technical. In addition to my duties as managing editor, make-up, news editor, purchasing agent for engravings, and as treasurer of the company I was given the job of looking after the manufacture of new books. One of the first that I put through the press was Tesla's "Alternating Currents"—a book still in print. It was at this point that Mr. Weaver joined the staff and took over the book work—especially its editorial supervision—as his first duties. Both the *Engineering and Mining Journal* and *Engineering News* at that time had book departments.

With the expanding industries and the increasing army of graduate engineers the supply of technical information in book form became more important. Editors frequently speak of books as the morgue in which the journalistic product is embalmed. But it is more nearly the truth to say that the book gives a new and greater life to the journals' dying output. The products of the McGraw-Hill Book Co. go far beyond the fields over which the McGraw-Hill papers spread their circulation. I think exact figures would show that the McGraw-Hill Book Co. sells annually about four books for every subscriber on the circulation records of the eleven McGraw-Hill papers.

The growth of the McGraw-Hill Book Co. has been rapid and phenomenal. But there is no mystery about the causes of its growth, for here, as in the publishing company, the governing principle has always been to render the highest *service* to that great army of engineers and students of engineering who not only carry on the world's great undertakings, but who are always in the front ranks doing research and pioneer work for the benefit of society and modern civilization.

I take great pride, with my colleague, Mr. Foss, in the part which the McGraw-Hill Book Co. has had in the widespread circulation of engineering literature of real value. Some idea of the influence of American engineering thought on the far countries of the world may be gained from the fact that we distribute through our London branch not less than 25,000 books a year; that Japan takes nearly or quite 1,000 a month, while China, Australia, South Africa and South America are ordering in constantly increasing numbers.

The growing influence of the engineer in the world's affairs is not an accident. His efforts and his accomplishments would be narrow and almost unknown were it not for the world-wide publicity given by the engineering periodicals and books. Who first spread broadcast the details of the Edison electric light and the Sprague and Thomson-Houston electric railway systems? Probably the *Electrical World* and the *Street Railway Journal*. Who first gave engineers full information about the flotation process? Probably the *Engineering and Mining Journal*. Where do engineers the world over look for the time saving and money saving ideas of their colleagues? You know the answer—to engineering periodicals and books. A good example of this is the Japanese engineer, whether educated at home or abroad, who has read and profited by every line of American and other engineering literature.

Map Reading and Making Simplified

REVIEWED BY H. J. HUGHES

Dean of the Engineering School, Harvard University, Cambridge, Mass.

TOPOGRAPHIC MAPS AND SKETCH MAPPING—By J. K. Finch, C.E., A.M., Associate Professor of Civil Engineering and Resident Director of the Summer School of Surveying. Columbia University. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6 x 9 in.; pp. 175; illustrated. $2.50.

During the war it was necessary to teach large numbers of young men, without much mathematical knowledge and unaccustomed to the use of instruments, how to read and use maps and to make topographical and landscape sketches by quick methods for military purposes. And to do this most of those who taught had to change very radically their own method of handling these subjects. Previously, map making had in general been assumed to be engineering work; and engineers for the most part have dealt with maps made by somewhat costly and cumbersome methods, and often with needlessly high precision. It was assumed also by many that the best and perhaps the only good way to learn how to interpret maps was by making them. The experiences of the training camps have not only greatly improved methods of instruction in map reading and making, but also have shown clearly that cheap and quickly made maps may be quite as useful in many kinds of engineering investigations and explorations as more laborious and costly productions. Maps are recognized as essential to the work of geologists, engineers and geographers; but the ability to use maps intelligently and skilfully is also necessary in many other fields. To the trained interpreter a

topographic map is a storehouse of varied information. Maps are a necessity to automobilists and many other travelers, and there is an increasing number of people who find map sketching a pleasant pastime. Many of the schools and colleges have continued the work on map sketching begun during the war for students in the Reserve Officers' Training Corps or in connection with geology or surveying. There is an increasing demand for instruction both in map reading and map making, and this book, which has been written to supply a short treatise on these subjects, is admirably adapted to its purpose.

The text is divided into three parts. The first part takes up methods of indicating on, or getting from, a map the information that it is intended to convey, such as: Location, orientation, scale, relief, drainage, and other features; profiles and sections, slopes or grades of hills, roads and railroads; the determination of visibility and areas, the use of topographic maps in the field for military purposes, and the coördinate and grid systems. A comparison is made of the maps of the United States Geological Survey, the Ordnance Survey of the British Isles, and the Carte de France de l'Etat Major. The second part is devoted to the making of topographic sketches by means of the army sketchboard and the simple equipment which goes with it; free-hand lettering, topograhic drafting, enlargement and reduction, pacing, traversing, position sketching, contouring and the determination of elevations. Part three is devoted to landscape sketching, which is a useful and generally not well understood practice.

The most serious criticsm is that the part on landscape sketching is somewhat brief and could be better illustrated. The reviewer thinks that more should be said about simple solar observations to determine meridian, and that the usefulness of the compass in traversing should be explained and emphasized, and that the use of the "stride" is preferable to the "pace." But these are only minor criticisms of an excellent piece of work.

An appendix of thirty pages contains a descriptive list of the principal topographic maps of the world, which will be of value to anyone whose interest or business requires him to use maps of foreign countries.

The book is a simple, straightforward treatment of the subject of map reading and the making of simple maps, well presented and with commendable brevity. It is a good textbook for schools which give instruction on this subject, and also for anyone who wishes to take it up in a non-technical way.

American Labor: Historically and Today

ORGANIZED LABOR IN AMERICAN HISTORY—By Frank Tracy Carlton, Ph. D., Professor of Economics, De Pauw University. New York and London: D. Appleton and Co. Cloth; 5 x 8 in.; pp. 313. $2.50.

THE NEW INDUSTRIAL UNREST: Reasons and Remedies—By Ray Stannard Baker Garden City, N. Y.: Doubleday, Page & Co. Cloth; 6 x 9 in.; pp. 231. $2.

Professor Tracy outlines various phases of organized labor in its relation to American history and Mr. Baker deals with the labor unrest of the present day. Each volume is short and readable.

After an introduction and a chapter on "Epochs in the History or Organized Labor," Professor Tracy takes up the American constitution, free schools, land reform and other matters in relation to the wage-earner. There is a chapter on labor parties, Socialism, etc. The last part of the book discusses "The Ideals of the Wage Earner" and pre-war tendencies.

Mr. Baker's book, as its title indicates, is a discussion of the present labor situation, based largely on personal studies during the recent steel strike and other first-hand information. The viewpcints of both employers and employees are presented, those of the latter perhaps in more detail. The last part of the book goes into the shop-council system, co-operation in industry, labor management as a profession and the struggle between autocracy and democracy for industrial control Some results of co-operative experiments are presented.

Both books are well worth reading and the two may well be read together, taking the historical sketch first.

Centrifugal Pump Impellers

REVIEWED BY ROBERT E. HORTON

Consulting Engineer, Voorheesville, N. Y.

RESEARCHES ON THE THEORY OF THE ACTION OF CENTRIFUGAL PUMP IMPELLERS—By Otogora Miyagi, Kogakuhakushi. Technology Reports of the Tohoku Imperial University, Sendai, Japan. Tokyo: Maruzen Co., Ltd. Paper; 7 x 10 in.; pp. 100; 25 figures in the text.

This is a very complete and clearly written analysis of the theory of centrifugal pump impellers. The analysis is mainly algebraic, and in a form easily followed, although differential equations and integral calculus are used to some extent. It covers the theory of centrifugal pumps in a more extended and complete manner than most standard books in English dealing with this subject.

The general theory is first developed. This is followed by a discussion of natural flow through the impeller when working under no load. The paths of the water particles are then treated for impeller blades developed in different forms of curves. The effect of hydraulic resistances is then considered, and finally, using Weisbach's formula for loss of head due to bends and ordinary coefficients of friction between water and iron surfaces, practical working formulas for impeller design are obtained, including an approximate solution of the problem of determining the efficiency of an impeller having a given design. A single complete example is presented, and solved.

Control and Utilization of the Nile

NILE CONTROL—By Sir Murdoch MacDonald, K.C.M.G., C.B., Adviser, Ministry of Public Works, Egypt. Cairo, Egypt: Government Publications Office. Paper; 8 x 13 in.; pp. 262; illustrated. P.T.20. Vol. I—A Statement of the Necessity for Further Control of the Nile to Complete the Development of Egypt and Develop a Certain Area in the Sudan, with Particulars of the Physical Conditions to be Considered and a Programme of the Engineering Works Involved. Vol. II—Folding Maps.

How to control and utilize the Nile so as literally to make two crops grow where one or none grew before is a problem as old as the Pyramids. A partial control for limited areas was secured centuries ago. In recent years large two-crop areas were established by the Assuan dam and several barrages lower down the river. The present report sums up and carries forward studies made during some years past for the purpose of reclaiming every possible additional acre of Egypt that needs flood protection, or drainage or irrigation. The works recommended to this end are reservoirs on the White, the Blue and the Upper Blue Niles and also at Lake Albert; a barrage at Nag Hammadi "to protect flood cultivation in the part of Upper Egypt as yet unconverted to perrenial irrigation, and to supply it with summer

water when conversion does take place;" and a channel in the Sudd region to assure that the Lake Albert reservoir reaches the Main Nile. It is proposed that these works, including each of the four reservoirs, be carried out in the order given above.

The report deals first with the area, population and water requirements involved in the whole project, then with the several proposals to meet these requirements. Many meteorological and stream-flow data are presented. Among the appendixes is one on the rating and the accuracy of current-meters, one on taking weir discharges through the sluices of the Assuan dam and one discussing briefly the possible value of a second heightening of the Assuan dam.

The Art of Iron Production

NON-TECHNICAL CHATS ON IRON AND STEEL—By LaVerne W. Spring, A. B., Chief Chemist and Metallurgist, Crane Co., Chicago. New York: Frederick A. Stokes Co. Cloth; 5 x 8 in.; pp. 358; illustrated. $3.50.

Mr. Spring makes an unusually successful attempt to explain in language that a school boy can understand the complex and difficult art of iron production. Taking account of the fact that this art has a historical background reaching into the obscurity of earliest ages, and that its present development extends into all the intricacy and refinement of micrometallography, the task grows formidable, and its successful performance is the more to be appreciated. A soundly logical plan of development has been followed in the arrangement of the text; the discussion proceeds from history to raw materials, and then through the successive processes of the iron industry from furnace stock pile to rolling mill. There is even something on the various features associated with the critical points of the cooling curves of iron. While not all of the many photographic illustrations are as clear as desirable, taken as a whole the pictures and the various drawings and diagrams illustrate the work sufficiently for all requirements of the reader. It should be an instructive diversion rather than a piece of hard work to read the book.

Publications Received

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS: Proceedings of the 1919 Convention—Valparaiso, Ind.: Charles Carroll Brown, Secy. Cloth; 6 x 9 in.; pp. 725; illustrated.

BACK TO THE REPUBLIC: The Golden Mean; The Standard Form of Government—By Harry F. Atwood. Chicago, Ill.: Laird & Lee, Inc. Cloth; 5 x 8 in.; pp. 157. $1.

Enthusiastic propaganda for a return to the most elemental form of representative government contemplated by the American constitution and its application here and everywhere to not only federal but also to state, county and city government and to a single world republic. Against all boards, commissions, and popular or direct legislation. Overlooks possible evolution in government since 1788 or need for variations in government to suit national or more local differences. Short and readable but could be condensed and made more readable by cutting out tiresome repetitions.

A HISTORICAL AND CRITICAL REVIEW OF MATHEMATICAL SCIENCE: Bulletin of the American Mathematical Society. Vol. XXVI, No. 9, June, 1920—New York: The Society. Paper; 6 x 9 in.; pp. 47.

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING: Annual Report of the President and of the Treasurer, 1919—New York: The Foundation. Paper; 7 x 10 in.; pp. 148. Free upon request.

EMPLOYMENT MANAGEMENT AND INDUSTRIAL TRAINING: Employment Management Series No. 4—Washington, D. C.: Federal Board for Vocational Education. Paper; 6 x 9 in.; pp 107; illustrated.

ENERGY NECESSARY TO SHEAR STEEL AT HIGH TEMPERATURES—By Guy D. Newton, Associate Professor of Engineering Drawing and Machine Design. Columbia, Mo.: Engineering Experiment Station of the University of Missouri Bulletin. Paper; 6 x 9 in.; pp. 16; illustrated.

HOGG'S WAGE TABLES FOR BUILDING CONTRACTORS—Compiled by Jas. Oliver Hogg, Jr., Assoc. M. Am. Soc. C. E. Kansas City, Mo.: Jas. O. Hogg, Jr., & Co. Leather; 5 x 7 in.; pp. 62. $5.

A set of 59 rate tables worked out for every quarter hour, from 1 to 60¾ hours at varying rates per hour from $0.30 to $1.50

HYDRAULIC TURBINES: With a Chapter on Centrifugal Pumps—By R. L. Daugherty, A.B., M.E., Professor of Mechanical and Hydraulic Engineering, California Institute of Technology; Formerly Professor Hydraulic Engineering, Rensselaer Polytechnic Institute. Third Edition. Revised, Enlarged and Reset. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 281; illustrated. $3.

A third edition of a valuable short treatise. Chapters have been added on governors and design.

HYDRO-ELECTRIC POWER COMMISSION OF THE PROVINCE OF ONTARIO: Report, 1919—Toronto, Can.: The Commission. Paper; 7 x 10 in.; pp. 287; illustrated.

HYGIENE AND PUBLIC HEALTH—By George M. Price, M.D., Author of "A Handbook on Sanitation," "Tenement-House Inspection," etc. Second Edition, Thoroughly Revised. New York: Lea & Febiger. Cloth; 5 x 7 in.; pp 280. $1.75.

In this edition some revisions have been made and there has been added the report of a committee of the American Public Health Association giving Standard Regulations for the Control of Communicable Diseases. Although containing much information in small compass, the book is marred by misleading statements on engineering subjects and encumbered by mere definitions and categorical statements of little possible value to anyone. The volume appears to be designed for students and amateur health officers.

JAMAICA BAY-PECONIC BAY CANAL BOARD: Supplemental Report Relating to the Construction of the Proposed Canal and the Effect Upon the Present Source of the Water Furnished to Residents of the Town of Hempstead and the Borough of Queens. Albany, N. Y.: The Board. Paper; 6 x 9 in.; pp. 15; illustrated.

THE PORT OF NEW YORK—By Thomas E. Rush, Surveyor of the Port. New York: Doubleday, Page & Co. Cloth; 6 x 9 in.; pp. 361; illustrated. $3.50.

Devoted mostly to the non-engineering features of the country's premier port: history, commerce, smuggling, "port salesmanship," etc. Some concluding chapters on the details of port operation may serve to enlighten the laymen on what the engineer contributes to the port, as distinct from the harbor.

PROPOSED IMPROVEMENT OF THE HARLEM RIVER: Report of the Board of Conference. Albany, N. Y.: The Board. Cloth; 6 x 9 in.; pp. 195; folding maps.

PROPOSED WATERWAY BETWEEN GRAVESEND AND JAMAICA BAYS: Report of the Board of Conference. Albany, N. Y.: The Board. Paper; 6 x 9 in.; pp. 58; folding maps.

THE RELATION OF THE CHEMICAL INDUSTRY OF NIAGARA FALLS TO THE WATER WORKS—By John A. Kienle. Reprinted from Journal of the American Water Works Association, Sept., 1919. New York: Electro Bleaching Gas Co. Paper; 6 x 9 in.; pp. 20; illustrated.

SERVICE AT COST PLANS: An Identical Analysis of Statutes, Ordinances, Agreements and Commission Orders in Effect, or Proposed, Together with a Discussion of the Essentials of Local Transportation Franchises—By Harlow C. Clark, Editor of *Aera*. New York: American Electric Railway Association. Cloth; 6 x 9 in.; pp. 315. $2.50.

After nine short chapters on franchise principles, capital risks, etc., and a single general chapter on "Existing Plans." the remainder of the book is devoted to a topical analysis of service-at-cost plans in effect and proposed.

SUPPORTING STRENGTH OF DRAIN TILE AND SEWER PIPE UNDER DIFFERENT PIPE-LAYING CONDITIONS—By W. J. Schlick, Drainage Engineer, Ames, Iowa: Engineering Experiment Station of the Iowa State College of Agriculture and Mechanic Arts. Paper; 6 x 9 in.; pp. 68; illustrated.

A review of tests made in 1915, 1916 and 1917. The tests were undertaken, primarily, to determine by actual tests the relation of the "ordinary supporting strength" as given by standard laboratory tests to the supporting strengths developed by pipe under "ordinary" pipe-laying conditions, to determine the definite ratios thereto of the supporting strengths developed with other pipe-laying methods and to determine the most economical methods of increasing the supporting strengths of pipe, through better and more careful methods of laying, under different ditch conditions.

TEXT-BOOK OF THE MATERIALS OF ENGINEERING—By Herbert F. Moore, Research Professor of Engineering Materials, Engineering Experiment Station, University of Illinois, Member American Society for Testing Materials; with a Chapter on Concrete by Harrison F. Gonnerman, Research Assistant Professor in Theoretical and Applied Mechanics, Engineering Experiment Station, University of Illinois, Member American Society for Testing Materials, Member American Concrete Institute. New York and London: McGraw-Hill Book Co., Inc. Paper; 6 x 9 in.; pp. 315; illustrated. $3.

A second edition. New matter is mainly in the chapter on Concrete, by H. F. Gonnerman, which contains an admirable résumé of the current proportioning theories. Some question might be raised as to the permanence of those theories and the desirability of dignifying them yet in book literature.

THE TIDES AND TIDAL STREAMS: With Illustrative Examples from Canadian Waters—By Bell Dawson, M.A., D.Sc., M. Inst. C.E., F.R.S.C., Superintendent of Tidal Surveys. Ottawa, Can.: Dept. of the Naval Service. Paper; 7 x 10 in.; pp. 43; illustrated.

WATER AND SEWAGE PURIFICATION—By Sir Alexander C. Houston, K.B.E., C.V.O., M.B., D.Sc., Director of Water Examinations, Metropolitan Water Board, London. Reprinted from the Reports of the Progress of Applied Chemistry, Vol. 4, 1919. London: The Author. Paper; 6 x 9 in.; pp. 24; illustrated.

WATER RESOURCES: Present and Future Uses—By Frederick Haynes Newell, Professor of Civil Engineering, University of Illinois. A Revision of the Addresses Delivered in the Chester S. Lyman Lecture Series, 1913, Before the Senior Class of the Sheffield Scientific School, Yale University. New Haven, Conn.: Yale University Press. London: Oxford University Press. Cloth; 7 x 10 in.; pp. 310; illustrated. $4.50.

Letters to the Editor

The Professional Spirit in Education

Sir—Inspiration to the individual is the thing which each educator is seeking. How "to get it across," how to awaken an impelling force in the mind of the student is the great problem. In each person there is a more or less latent motive or desire to achieve something; but this desire being unknown and unformulated, even to the consciousness of that person, the motivation may not take place until the eleventh hour—if ever!

Charles R. Mann, in his article in *Engineering News-Record* of June 24 (p. 1242), calls attention to the power of the World War in inspiring men to supreme effort and in bringing out the spirit of service and of sacrifice, existing everywhere, but overlaid by the "crust of the commonplace." He asks what is the thing which may become "the moral equivalent of war," effective to arouse our students? He answers in effect that it is the spirit of service, not self seeking, but service for the public welfare.

In this presentation Dr. Mann has put into words the underlying principles which have been the source of strength of the rapidly growing American Association of Engineers and which are needed in engineering schools. The A.A.E. is making a practical demonstration of these principles so well outlined by Dr. Mann. The association is growing largely because it is inspiring individual engineers everywhere with the spirit of service and of sacrifice for the common good. To the degree that it touches and quickens this spirit, to that extent it flourishes. Where, on the contrary, there is little or none of this spirit, it languishes.

In the engineering schools the American Association of Engineers is doing missionary or inspirational work such as outlined by Dr. Mann. This is attempted in the hope of arousing or keeping alive, in the midst of the distracting technical details, this all important thought that the true engineer "builds for people, not for individual." It is doing this by creating student chapters, all inclusive, bringing together every kind and class of engineering student. It is urging these chapters to take up, not the technical details of the class room, but the larger view of human relations, the duty and opportunity of the young engineer in the so-called "spiritual" or ideal, as contrasted with the purely material, objects embodied in the usual curriculum. It is trying to inculcate by repeated and tireless effort and by approach from every direction, this principle so well stated by Dr. Mann that "a technical school surely does not realize its true destiny when it is merely a factory for quantity production of standardized, technical and intellectual skill."

The student chapter primarily promotes acquaintance. It is about the only force which brings together seniors and freshmen, civils and mechanicals, as fellow workers in the public welfare. It gives opportunity for the exceptional man to demonstrate leadership and to do something immediate and tangible for the student body which, for the time, takes the place of larger public service. It offers to each eager student something of opportunity for the "great adventure", for trying out his mental alertness, his ability to think and express his thought not under the compulsion of the class room but in the democratic atmosphere of a self governing body, free to act and to accept or reject any proposition on the merits as presented by its proponents.

Here, if anywhere, is the agency to which we educators must look for the upbuilding of character—for the development of the force which offsets the tendency of the schools "to inspire the individual to make the most of himself for the sake of his *own* success," and to give the inspiration to the spirit of service for the public good, the spirit whose manifestation cannot fail to bring the largest measure of true success. For, as so well brought out by Dr. Mann in his conclusion, "All are ready to do (the engineer) honor and grant him credit for public service well done."

Urbana, Ill. F. H. Newell,
Professor of Civil Engineering, University of Illinois.

Sir—Dr. Mann, in his article appearing in *Engineering News-Record* June 24, p. 1242, considers an important subject, and one which faculties of leading schools of engineering have had in mind for some time. Many have gone so far as to do what Dr. Mann suggests to the extent possible in a four-year college course following only high school preparation. A good many years ago students of the Rensselaer Polytechnic Institute were discussing in their senior theses just such problems of sanitation and transportation as Dr. Mann suggests, and for many years the seniors of the College of Applied Science of the State University of Iowa have been doing this same thing.

The engineering schools have been criticized a good deal for the narrowness of their curriculums, and for the failure of their graduates to get into positions of leadership in industry and public welfare movements. Doubtless the training has been somewhat narrow, emphasizing more the trade of engineering than the profession of engineering. But one wonders somewhat whether this criticism is wholly well founded. The engineering schools like others have been growing—as new visions are seen, new methods and curriculums are adopted. The perfect has not been attained, but growth has been apparent and is even now in evidence in a decided movement toward greater generalization, with greater emphasis on the fundamentals of all engineering rather than on specialization in the work of a single branch.

Formerly it was quite customary for the engineering schools to have two of the four college years alike for all engineering students. Then, as the branches became more and more differentiated by the increase in knowledge and devices, the two years dropped to one, and then to none, and at least one strong school differentiated even between the various branches of what is generally classed as civil engineering, offering specialization in structural, sanitary, railway, and geodetic engineering.

Now the movement is backward, as engineering practitioners are telling the schools *to train in fundamental principles*. As one great industry says, "We don't care whether your men graduate as civil engineer, structural engineer, or mechanical engineer; if they have been trained in the fundamentals, they can learn our business." So two years ago the College of Applied Science of the State University of Iowa adopted the plan of differentiating between its courses in civil, electrical, and mechanical engineering only in the fourth year, and then only to the extent of about two-thirds of the work of that year. Other schools are following this lead. The College of Applied Science would not differentiate in the fourth year if it did not feel called upon to continue a school of engineering which can't be done without students who, in the presently existing attitude of mind, demand to be trained as civil engineers or mechanical engineers or electrical engineers, or in some other definitely classified branch of the profession.

Just at this time engineering schools are in a situation not wholly without unfortunate possibilities. As was brought out by Prof. J. H. Dunlap at the recent convention of the Society for the Promotion of Engineering Education, twenty years ago in the matter of entrance requirements engineering schools stood at the top of the group of professional schools including law, medicine, dentistry and engineering. Now they stand at the bottom.

With the better schools of medicine requiring from six to seven years work after high school, two of which is in training in letters; with law schools requiring two years of work in letters and arts for entrance; and with dentistry schools requiring one or two years of such work for entrance, there would seem to be great danger that these professional schools will draw the cream of the young men looking to a professional career, leaving the overflow to the engineering schools.

Broader training? Yes, but how much broader in four years? There is so much now of fundamental technology that is essential to the training of the engineer who would have breadth of technical training, that training in the humanities, so-called, must be added at the top or bottom, or possibly strung along ribbon-fashion as proposed at Michigan. But however given it means more years.

Breadth of training requires time. The national societies, if they will, can compel engineering schools to take the time, just as the American Medical Society has demanded of the schools of medicine.

Do the industries employing engineering graduates and the older practising engineers want breadth of training? The engineering schools will give it if they are backed in their efforts by the profession.

Iowa City. WILLIAM G. RAYMOND,
Dean, College of Applied Science, State University of Iowa.

Sir—Dr. Mann in his article "The Professional Spirit in Engineering Education," *Engineering News-Record*, June 24, 1920, brings to life an old idea at a moment we all hope may be propitious. It is timely, not only for the reasons given, but also because engineering colleges generally are engaged in revising their curricula the better to meet modern conditions.

Even before the war teachers of engineering subjects were realizing the necessity of changes. It is interesting and significant that these changes contemplated a more liberal education for the engineer. It was realized that the trend during the past thirty years had been too much toward the technical. We were developing technicians rather than engineers; that is, our instruction was narrowing rather than broadening.

Dr. Mann hits the nail on the head when he says: "The required training must inspire the individual to make the most of himself for the common good." And he touches a sore spot in saying "relatively few of the graduates of engineering schools win recognition as professional men." Why? In part, at least, because the modern graduate is a technician rather than an engineer.

A further answer may be found in the engineer of fifty years ago. They won recognition—became world known. Why? All the engineering books they studied could be carried under one arm—a half dozen at most. Now there are wheel-barrow loads of them, but no wheel-barrows. To fill out his course the older engineering student had to take a good part of the college literary courses. He studied dozens of non-technical subjects and came out of college with an outlook upon his career quite different from the graduate of today.

The fact that the engineer of today must have knowledge of technical subjects unknown in earlier days, and the further fact that his course of study is still four years, explains why his vision is fore-shortened. The obvious answer is a longer course—five years or even six. We must come to it as soon as practicable if we would put the engineer in position to "win recognition as professional men." At least, so I think. M. E. COOLEY,
Dean Colleges of Engineering and Architecture,
Ann Arbor. University of Michigan.

A Tribute to General Gorgas

Sir—With the passing of Gen. William C. Gorgas earth is the poorer in its loss of him, but in his life humanity is the richer for his unceasing activity in the alleviation of suffering and the advancement of those things which make for the best in life—service to mankind. The record of his work at Havana, at Panama, at Johannesburg and lately at Peru, is well written in enduring history. Never spectacular, never self-assertive, never jealous of his own fame or fearful of allowing credit to others Dr. Gorgas attained distinction which easily placed him pre-eminent among the builders of the Panama Canal.

Not of engineering education, but a great engineer in the true sense of the word. By his devotion to duty, his confidence in the right and untiring service in face of natural difficulties and personal humiliation General Gorgas made possible that condition which allowed the United States to undertake and complete the colossal work which had been a dream for centuries, but a failure in accomplishment to the time of his coming. However great the engineering feats accomplished, for centuries this canal had been thought of, its plans had been made, its work had been begun and there was no lack of money for its accomplishment. The sole reason for its delay and previous failure to proceed was lack of human help to do the work, and that lack was caused by the inability of men to live on the disease ridden Isthmus. The problem of help was solved and the remedy applied by the work of General Gorgas in banishing yellow fever, not only from the Isthmus, but from neighboring infected ports, and safeguarding the health of workmen against malaria and other disease of tropical lands. With yellow fever gone and malaria under control nothing remained but to go ahead without fear and do the work. General Gorgas made possible the building of the Panama Canal and to him the United States owes its prestige in the completion of the work.

Personally General Gorgas was a most kindly and gracious gentleman in everything that word means; true, loyal, steadfast in duty and without reproach, he had what so many men in high position fail to achieve—the wholehearted loyalty of his staff of helpers. This attribute of binding to himself staunch and friendly co-workers brought to Dr. Gorgas, without striving for it, that which mere ability could not attain but which coupled to his ability gave to him international prestige.

Perhaps General Gorgas' most notable characteristic was his readiness to give credit, and his willingness to consider plans of others. Never arbitrary, never vindictive, unconsciously he attained position eagerly sought by others and missed. The work accomplished by him is written for enduring fame, well recognized by his contemporaries and sure of even brighter recognition as the result of his well-laid plans worked out to maturity.

General Gorgas seemed beset with his desire to overcome pestilence and disease, not content with the laurels so well deserved which were his for work well done, and of quantity and quality that well might satisfy an ordinary man; at the time of his death it is understood that he was planning even a more far-reaching health crusade. With his past record there is no doubt but that he would have gone far in its accomplishment. So I say earth is the poorer for his passing.

Naturally great hearted, courteous and thoughtful for others, ever ready to help, ever ready to serve, there are all too few of his kind for us to spare, but even "as ships that pass in the night and speak to each other in passing" so with us who had the privilege of knowing Dr. Gorgas personally, while there is a sense of loss in his going, our own lives are the richer for the contact and cheer from one of earth's noblemen. CALEB MILLS SAVILLE.

Hartford, Conn.

Shrinkage of Loosely Filled Earthwork in Embankments

Sir—In *Engineering News-Record* of June 24, Mr. E. E. R. Tratman has called the attention of engineers to the much vexed question of the shrinkage of the earth in embankments. I think it is more a question of words than of facts, the controversy arising upon the terms of the question, and because of the attempt to establish a relation between two facts which are entirely independent of each other. The Illinois Public Utilities Commission would have reached different conclusions if the case had been presented in a more proper form.

The engineer of the Commission who made his conclusions according to my position on the question, regrets that I based my opinion upon abstract reasoning and not upon experimental data; and Mr. Tratman says that I made statements, but failed to give evidence in support of my view. A word of explanation will not be out of place and it will invite discussion.

The complex question of the shrinkage of earth is greatly simplified when examined under two distinct points of view, viz., the removal of the earth from its natural position, and then when it has been deposited in the embankment.

Concerning the first part of the question, everyone agrees that the earth removed from its natural position increases in volume, or swells, as it is commonly called. As there is common consent on this point, any further discussion will be

useless. It will be convenient, however, to remember that the bulging or swelling of the earth, is caused by destroying the cohesive force which holds together all the different particles; these being now loosened, there are an infinite number of voids between them, and it is these voids which cause the increase of volume of the earth after removal as compared with its volume in its original place.

Now, if the earth after it has been removed from the natural bank (and consequently of larger volume) is deposited in such a way so as to form an embankment, this will be found of a larger volume than the original cut. Theory teaches that the cohesive force of the material once destroyed is never resumed to the same former intensity; which means that the particles of earth in the embankment will never be so compact as they were in the material in its original position, and since voids will always exist in the embankment, thus the embankments will always be found of larger volume than the cuts from which they were taken. Such an assertion is not an abstract reasoning but it is based on facts and practical experience. It is an ascertained fact that it is easier to remove the earth from an embankment than from its natural position, which indicates a smaller cohesive force in the embankment, and the consequent presence of voids which are the real cause of the swelling. It may be concluded, therefore, that the earth deposited in the embankment will always occupy a larger volume than in its original position.

Engineers and trackmen know by experience that the earth in the embankments decreases continuously, and such a reduction of the volume is attributed to the shrinkage of the earth itself. The earth in a new embankment is in a very loose condition on account of the numerous voids existing between its different particles, and it will yield a great deal under the pressure of traffic and rain, such a subsidence is called the shrinkage and it is very sensitive in the green fills. The subsidence of the embankment will continue for a very long time, although in old embankments it will not be so apparent as in the new ones, and such a slow but continuous yielding is due to the fact that the cohesive force will never be restored to its former intensity. The earth in embankments may be compared to the piles which yield a great deal under the first blows of the hammer and their sinking under the successive blows will be less and less. Consequently the distinction between Settlement and Shrinkage as suggested by the engineer of the Illinois Public Utilities Commission does not seem to be correct as the embankment will settle continuously on account of the voids which in larger or smaller number will always exist between the various parts of the material. Here in New York we have a splendid example of the continuous subsidence of old fills. In front of the New York Library at 42nd Street, the earth has been deposited on the roof and sides of the Subway for over fifteen years, and the slabs forming the sidewalk alongside the Library have been edged off several times on account of the subsidence of the street. This continuous yielding cannot be explained except for the voids between the various particles of the earth, which are constantly reduced, thus compacting the fill more and more all the time. If such a subsidence is so noticeable in a restricted fill confined by the walls of the surrounding houses, the structure of the Subway, and covered with an almost impervious pavement, what will not happen in embankments exposed directly to the action of heavy traffic and atmospheric influences?

When the volume of the earth in an embankment is found less than the volume of the original cut, it does not mean that the earth itself had shrunk, but instead that all the quantity extracted from the cut is not found in the embankment. Portions of it might have been lost in transportation, but a larger part was carried away by rain, frost, wind, etc., and other causes which are not controllable and which cannot be converted into mathematical formulas. Hence any attempt to determine the amount of these losses in relation to the volume occupied by the earth in its natural position, would be too empirical and unpractical.

In conclusion, it can be said: 1st. That the earth in embankments will always be found of larger volume than in cuts. 2nd. That the earth does not shrink. 3rd. That the observed decrease in volume in the embankments as compared with the cuts, is caused by the material which has not been deposited in the embankment or it has been removed by atmospheric influences.

New York City. CHARLES PRELINI.

Drainage of Road Surfaces

Sir—On p. 33, your issue of July 1, is contained a synopsis of A. R. Hirst's paper "Earth, Clay and Sand Roads." This gives very valuable advice written from a practical standpoint.

There is one point, however, that does not seem to receive proper attention, and that is the matter of drainage of the road surface. The proper crowning, side ditches, etc., are always carefully considered. In flat countries, however, roads may have very deep ditches on each side but in wet weather wagons and automobiles cause longitudinal ruts, which become deeper and deeper, are always filled with water, and if the road material is of an impervious clayey nature cannot possibly drain into the side ditches, and soon the roadway becomes almost impassable. The obvious remedy, which does not seem to have received any attention whatever, is to produce artificially longitudinal grades of say 1 per cent. If the summits of these grades are 200 ft. apart the drainage can go in both directions and be taken care of by transverse prepared gravel or broken stone short sections at the hollows, which can drain into the side ditches. With this arrangement it is not difficult to keep the road bed in fairly good shape even in the worst weather, and the expense of making such a road is very little greater than if the road were made in the ordinary way.

J. W. LEDOUX,
Philadelphia, Pa. Consulting Engineer.

How Should Motor Vehicles Be Taxed to Supply Highway Funds?

Sir—In his article, "Motor Vehicle Instead of Gasoline Tax Probable in Great Britain" in *Engineering News-Record* July 1, p. 4, Mr. Mehren touches a topic which is very interesting and very important to the highway engineers of the country. It opens up a broad field for investigation.

I have long been of the opinion that some equitable method should be worked out whereby the motor vehicle owner or operator should pay a fair amount toward the improvement of highways. This amount should vary in proportion to the amount of use and the amount of damage done by the different classes of vehicles. It would sometimes appear that it may be even necessary in the future to establish weighing devices along the highways and collect a fixed charge per ton for the operation of trucks and other types of commercial vehicles.

One thing seems evident at the present time—that the motor vehicle licenses, particularly those of trucks, are not sufficiently high to take care of the upkeep of the highways.

One of the great troubles, of course, is that there is a comparatively small percentage of roads improved in this country as against the large percentage in Great Britain indicated by Mr. Mehren in his commendable article. In order that we may secure all possible revenue for the purpose of developing further highway systems to accommodate the constantly increasing traffic, it will be necessary to secure income from every possible source and of the greatest magnitude. The proportionate charge to each class of vehicle should be worked out on a fair basis; and co-operation between the motor vehicle manufacturer, highway engineer and the operator of the different types of vehicle should result in something of benefit not only to the highway systems of the country, but to the general public as well.

I shall be very glad to read any remarks made by other engineers on the question of motor vehicle taxes.

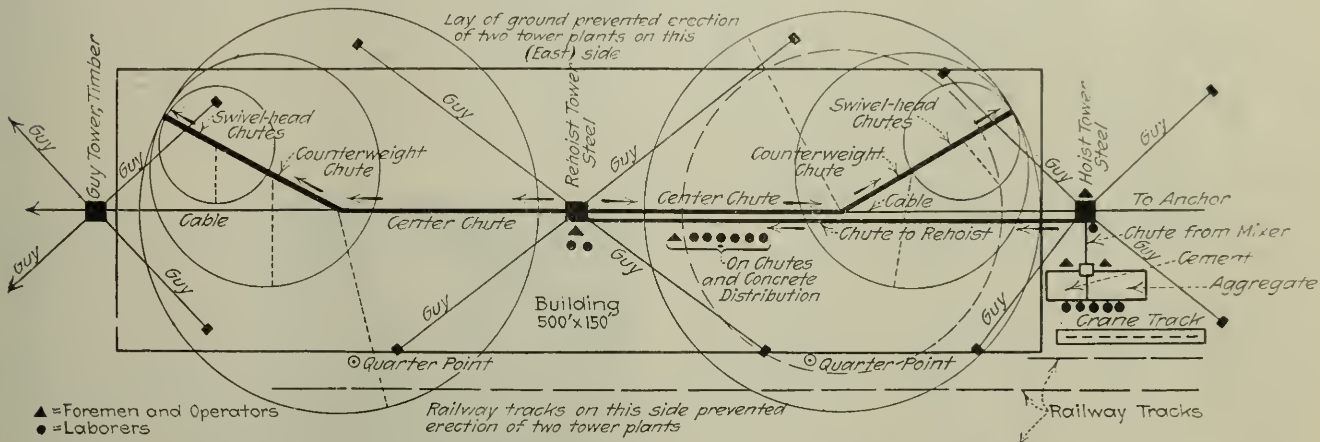
Hartford, Conn. C. J. BENNETT,
State Highway Commissioner of Connecticut.

Hints for the Contractor

Concrete Building Plant Plan—II

Tower and Rehoist Substituted for Two-Tower Plant

THE ground level and existing railway tracks prevented the nominally preferable arrangement of two tower-plants for concreting a 500 x 150-ft. four-story building at Kokomo, Ind., and a tower-plant and rehoist were substituted with successful results. As shown by the diagram plan, the building was rectangular and the nominally economical arrangement would be a tower-plant at each of the quarter points on one of the long sides. With a two plant arrangement, the erection cost would have been less, the operating expense smaller and the equipment cost about the same, in comparison with the plant layout adopted.



CONCRETE BUILDING PLANT LAYOUT WHERE SIDE TOWERS WERE IMPRACTICABLE

The only practicable location for the materials plant was at the south end over an old quarry which made necessary a trestle for the crane track as well as for the two-compartment bin. Bin storage provided for 270 cu.yd. of aggregate, and about 1,000 cu.yd. could be stock-piled between the crane track and the bins. Bulk cement was unloaded from gondola cars by clamshell into the 1,000-bbl. cement bin. The clamshell was ¾ cu.yd. and the mixer capacity was 30 cu.ft. The mixer chuted into the bucket of the hoist tower, which was of steel and 120 ft. high, and delivered the concrete to the foot of the rehoist tower 200 ft. high.

For direct delivery of concrete to lower floors of the south end of the building there was hung to the chute from hoist to rehoist a counterweight chute covering the circle shown by the dash line. Tripod-supported extension chutes served areas outside the circles.

With a crew of 19 men, as shown by the diagram, a rate of 295 cu.yd. of concrete in place in 9 hrs was secured; the average output per 8-hr. day for the job was 200 cu.yd. Concrete work was begun July 28 and completed Nov. 1. Delays due to shortage of material were 4½ weeks, making an actual working period of 10½ weeks.

The building was constructed for the Haynes Automobile Co., by the M. J. Hoffman Construction Co., Indianapolis, Ind.

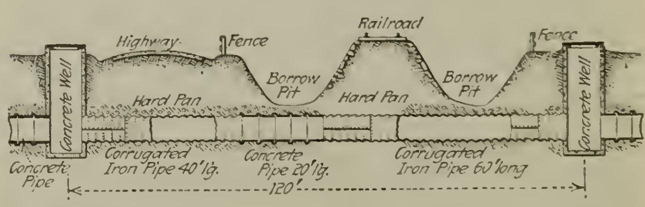
Pipe Jacked Under Railroad and Highway

JACKING a 30-in. corrugated-iron pipe 120 ft. in length underneath main line railroad tracks and the state highway in constructing a siphon in Stanislaus County, Cal., was a task recently accomplished by R. V. Meikle, chief engineer of the Turlock Irrigation District, according to a recent issue of *Highway Magazine.*

There was a layer of hardpan a few feet below the surface and the pipe had to be placed below that. Conditions demanded a thoroughly strong and watertight construction, yet it was deemed impracticable to disturb railroad and highway traffic by following the usual methods for such installations. Difficulty was added because considerable water had to be cared for during the installation.

Three weeks of preliminary work were necessary, work pits being dug at each side of the rights of way to allow room for the jacking operations. After the pumps were installed and the ditches had been dug up to the rights of way of highway and railroad, but a day and a half were consumed in the actual jacking operations. Traffic was interrupted little, trains slowing up as a precautionary measure for one day only.

Pipe lengths as received were coupled and riveted in the field to make one section 60 ft. long and another 40 ft. long. The 60-ft. length was first jacked into place and then the 40-ft. length was installed. A man worked inside of the culvert removing earth as the operations proceeded. While the operations were going forward it was found that an additional 20 ft. of pipe would be needed, so some concrete pipe on the job was put in as a middle section. This concrete pipe forms the only joint in the siphon.



CROSS-SECTIONAL VIEW OF INSTALLED SIPHON

The crew consisted of five men, operating a 50-ton jack, a clamshell dredger, one 2-in. and one 4-in. centrifugal pump, and a 2½-hp. gas engine.

Horse Cuts Truck-Loading Cost

By Dan Patch

Aberthaw Construction Co., Boston, Mass.

THE cost record on a job of the Aberthaw Construction Co. in Danville, Va., showed a high charge for unloading the first car-loads of reinforcing steel. The writer happened to be visiting the job and went over to the freight yard while waiting for his train, and pulled his watch on the unloading gang, making notes at the same time of the unloading operation on lumber.

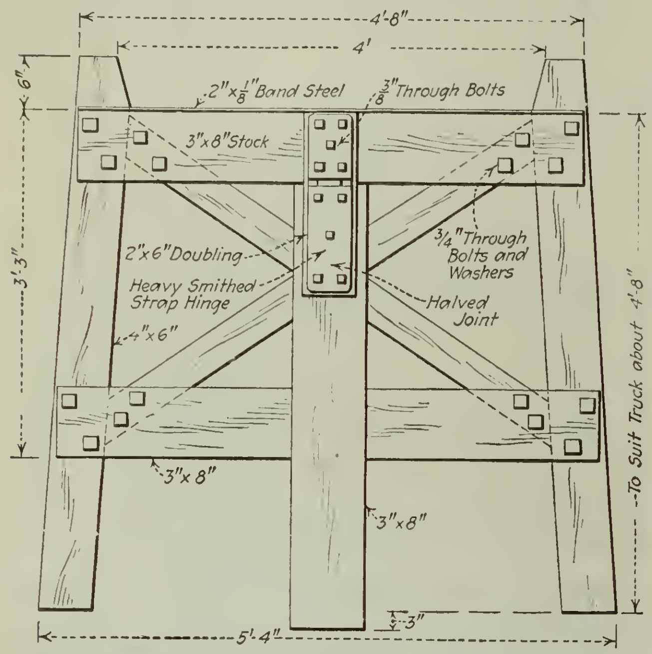


FIG. 1. DETAILS OF HORSE USED IN STEEL UNLOADING

The unloading was being done by 5-ton trucks with trailers, one unloading gang and two trucks working. The time for loading one truck was about equal to the time necessary for a round trip to the job. This meant that each truck was idle about one-half of the time. As trucks are high priced equipment it was easy to see why there was a high cost for trucking the steel.

On arriving at the home office, the writer made a rough sketch of a horse which he suggested might be used to release one of the trucks working on steel. Fig. 1 shows the horse as made up by the job mill carpenters.

FIG. 2. READY FOR THE TRUCK

Fig. 2 shows the steel unloaded over the trailer and horse and ready for the truck to back under the load.

This gadget allows one truck to do the work of two and allows the unloading gang to unload steel after the truck has left on its last trip at night, or before the truck arrives in the morning. The cost of the horse was about one-half of one day's cost of a truck and driver.

Temporary Footway Built on Viaduct Under Construction

PEDESTRIAN traffic across the Abbott Road Viaduct over the railway yards at Buffalo, N. Y., is so heavy that in the recent reconstruction of the viaduct it was felt to be necessary to provide some footway during the interval between the taking down of the old trusses and the completion of the new floor system. Some 4,000 people cross the bridge each day and detours are not convenient nor use of the tracks themselves safe. As an expedient, therefore, a temporary wood sidewalk was built half way up one of the new trusses, as shown in the view. There was a period of 10 days only in which a crossing was not available.

The footway consists of inverted A-frame bents spaced about 7 ft. c. to c. with 2-in. yellow pine decks nailed to horizontal floor-beams, thus providing a double sidewalk about 3 ft. 9 in. clear width on each side of the web members of the south truss of each span of bridge. The inverted A-frames as well as the end stairways and floor-beams are 2 x 10 in. yellow pine and railing and posts are constructed of merchantable sizes and lengths of lumber. The frame connections are bolted with ½-in. bolts and the railing and braces are nailed with 20 d. nails, clinched. The footway was carried at a height of 9 ft. 6 in. above the floor beams of viaduct to permit the operation of a traveling "horse" which carried a hoist for erection of cast-iron protection plates to be attached to the bottom of the structure over the tracks.

The viaduct is being constructed for the City of Buffalo by the American Bridge Co., F. K. Wright, resident engineer and the sidewalk was erected by Alvin F. Goehle, under the direction of Frank D. Jackson, assistant engineer, Bureau of Engineering. The cost of the sidewalk was $6 per lineal foot and much of the material can be recovered or used on other structures which will be reconstructed in the near future.

NEWS OF THE WEEK

New York, July 15, 1920

Construction Throttled by Car Priority Order

Material Men Object to Wholesale Allotment of Transportation to Coal Interests by Interstate Commerce Commission

Despite earnest pleas on the part of those interested in building construction, road building and other enterprises, it seems evident that the Interstate Commerce Commission is unwilling to modify its service order No. 7, which gives priority in the use of open-top cars to coal mines. This view of the commission's attitude is formed from the questions asked and comment indulged in during the recent hearing on the supply, exchange, interchange and return of open-top equipment. A typical argument against the present basis of allotting railroad cars was that of A. N. Johnson, representing the Portland Cement Association. Extracts from his argument follow:

"Since November, 1918, the construction industry, second only to agriculture, has been continuously handicapped. Governmental restrictions, increased cost, labor shortage, production shortage, lack of transportation facilities, have all combined to prevent construction enterprises. The construction industry is basic. Whatever tends to curtail this industry is certain of far-reaching effect and if carried much further must result in great industrial depression.

"The situation is rendered all the more serious as in the past three years there has been a marked deficiency of completed structures. During this time the demand and the need have been increasingly urgent for all classes of buildings, farm structures, roads and railroad construction. There is a deficiency today of not less than one million homes. At the present time there are actually available for highway construction over $700,000,000, money that cannot be used for other purposes. These roads, if constructed, will be of great help in lessening railroad terminal congestion.

"It is recognized that terminal congestion plays a far larger part in the present difficulties of the railroads than the moving of business over the roads out on the lines. Much of the terminal congestion results from the short-haul shipment of necessary food products for the daily subsistence of the people living in our large cities. Therefore not the least among the structures for which need is most pressing are improved roads, in order that motor trucks operating over such roads may

(*Continued on p. 142*)

City Manager for Colorado Springs

The city manager form of government, effective next April, was adopted by Colorado Springs at a popular election held July 6.

Milwaukee Filters of 160 Million Gallon Capacity Recommended

Following investigations of the water problem in Milwaukee for a year, J. W. Ellms, consulting engineer, Cleveland, has recommended the construction of a 160,000,000-gal. daily rapid filter plant. This action is taken, he states, in a printed report of 156 pages, "in view of the present polluted condition of the city's water supply, and the probable continuance of dangerous contamination, even if the best methods now known are used to dispose of the sewage of the city."

The proposed plant, which is to be located on the lake front near the shore shaft of the Linwood Ave. intake tunnel, will take advantage of the following information obtained from the experimental work: That adequate mixing of coagulants with the water may be obtained in comparatively cheap and simple devices, such as a flume with a "hydraulic jump" at the end; that a sedimentation period of not less than three hours nor more than four hours is necessary; that the effective size of the sand be between 0.35 and 0.40 m.m.; that conduits and pipe lines be provided of such size that rates of filtration of from 15,000,000 to 20,000,000-gal. daily in excess of the normal rate may be utilized. Chlorine disinfection is approved as the "second line of defense" against contamination. Ozone apparatus was found not to be developed sufficiently so it can compete in cost with chlorine.

Estimated costs are as follows: Protection wall for site and for fill back of wall, $382,700; foundations, $867,440; coagulation basins, mixing flume and discharge conduits, $782,000; filter tanks, piping, valves, gates, filter equipment and filtered water reservoir, $1,500,000; chemical house, wash water tank and low service pumping station, $448,000; contingencies and engineering, 15 per cent, $600,000; total $4,580,140. For operation and maintenance Mr. Ellms estimates the cost per million gallons at $5 to $6 and the fixed charges at as much more.

Henry P. Bohmann is superintendent of water-works and water purification. Ernest F. Badger, was the principal chemist and bacteriologist who carried out the investigation under Mr. Ellms' direction.

Dallas Club First Local to Join Federation

Joint Conference Committee Reports Action by Local and National Societies Following Organizing Conference

The first application on the part of a local engineering society for membership in the Federated American Engineering Societies has been made by the Technical Club of Dallas, Texas, which voted at a meeting June 22 to join the new body created at the Organizing Conference held in Washington, D. C., June 3-4. This news is contained in a bulletin which has just been issued by the Joint Conference Committee, representing the four founder societies, and which sums up the action thus far taken by various national and local organizations with respect to membership in the new federation. Extracts from the bulletin follow:

At the annual meeting of the American Institute of Chemical Engineers held in Montreal June 28-July 3, the question of the Institute becoming a member of the Federated American Engineering Societies was favorably discussed and referred to the Council for consideration at its meeting on July 25, at which time definite action will be taken. In the discussion it was stated that the Institute should be a member of this organization and, if its finances would not permit, the members should be assessed the necessary amount.

The report of the delegates to the Organizing Conference was read at the meeting of the Board of Direction of The American Institute of Electrical Engineers at the annual convention at White Sulphur Springs, W. Va., June 30 and the following resolution adopted:

RESOLVED, that it is the sense of this board that the A.I.E.E. should join the Federated American Engineering Societies but that as there is a small attendance at this meeting and a new board will be constituted commencing with the administrative year on Aug. 1, action be deferred until the August meeting of the board and that a letter be sent the members of the incoming board, with a request that they give careful consideration to the matter and be prepared to act at the next meeting.

The report of the delegates to the Organizing Conference was read at the meeting of the Board of Direction of the American Institute of Mining and Metallurgical Engineers June 25, was favorably discussed and referred to the Finance Committee to devise and report on means for meeting the financial requirements.

The report of the delegates to the Washington conference representing the American Society of Civil Engi-

neers will be presented at the annual convention of that society, at Portland, Oregon, August 10-12.

Replies to Critics

To critics of the plan for the Federated American Engineering Societies the Joint Conference Committee makes the following reply:

"In the aftermath of the Washington Conference there has been considerable discussion of the new organization and a number of incorrect statements have been made. One of these is that 'during the war, technical men observed the fact that many engineering problems required the joint action of the technical societies. This requirement was met by the formation of Engineering Council. Now the Organizing Conference proposes a new organization.' This is not correct, as it has been repeatedly pointed out that the work of The Federated American Engineering Societies will be administered by the American Engineering Council which will succeed the present Engineering Council. This procedure received the approval of Engineering Council at its meeting on October 16, 1919, when it endorsed the 'general plan for a national engineering council as outlined by the Joint Conference Committee of the Founder Societies.'

"It has also been suggested that 'no specific business is as yet outlined for action by the Council' that 'the federated societies is so completely nebulous that one cannot commend or condemn it and it will be some time before the new organization will begin to function.' As a matter of fact the Organizing Conference, at the closing session on June 4, adopted the following resolution:"

RESOLVED, That it is the sense of this Organizing Conference that the Joint Conference Committee should be entrusted with making provision for putting the conclusions of this conference into effect and that Engineering Council be requested to carry on its work until the new organization has been established, and by all proper means to further the program of the new organization. The Conference further recommends to the contributing societies that they continue supplying the funds required by Engineering Council until its work is taken over by the new organization.

Engineering Council at its meeting June 17, unanimously adopted resolutions endorsing the federation. (See July 1 issue, p. 43.)

Engineering Council Co-operates

The action of Engineering Council in accepting the invitation of the Organizing Conference, the Joint Conference Committee points out, means that the activities of Engineering Council which are those to be undertaken by The Federated American Engineering Societies, will be continued without interruption, until the American Engineering Council is prepared to take up the work.

The statement that this new organization "is completely nebulous" cannot, according to the committee, stand against the fact that the Organizing Conference in Washington adopted a complete constitution and by-laws to govern the organization which came into existence when The American Society of Mechanical Engineers applied for membership immediately following their adoption, and at which time assurances were given that the Detroit Engineering Society and the American Institute of Electrical Engineers had taken, or would take, similar action. To this nucleus must be added the Technical Club of Dallas so that the Federated American Engineering Societies has come into existence and the first meeting of its governing body will be held probably in November of this year.

Purpose of Federation

The committee concludes its bulletin with the following statement:

"There seems also to be confusion as to the purpose of the new organization as set forth in the constitution:

The object of this organization shall be to further the public welfare whenever technical knowledge and engineering experience are involved and to consider and act upon matters of common concern to the engineering and allied technical professions.

"The organization is to deal with what are commonly known as welfare or non-technical matters. It is not a social organization; it is not an organization of individual members. As its title indicates it is a federation of societies with whose autonomy and activities it in no way interferes. It does not create a new organization but it will succeed the present Engineering Council and will be more comprehensive as to scope and membership.

"The Federated American Engineering Societies will not in any sense be a competitor of any existing organization. Its success will depend upon the whole-hearted support given by the individual engineers and allied technologists of this country through the respective engineering and allied technical societies with which they are identified."

California Seeks Highway Survey By Bureau of Public Roads

As a result of recent charges brought against the commission and in order to secure impartial judgment upon the efficiency of its highway system, the California Highway Commission has requested the U. S. Bureau of Public Roads to study and report upon the state highway system. The commission believes that an authoritative, impartial and comprehensive report upon California work, which to date has cost approximately $33,000,000 and has given 2,500 mi. of improved roads consuming nine years to construct, would be of great interest and value not alone to California but to other states as well. The commission anticipates favorable action by the Bureau of Public Roads upon its request. It is expected that the investigation will require several months, and that it will cover location, engineering, type, permanency, surfacing, and economic value.

Sewage-Works Contract Abandoned by Contractor

The contractor for building the northeast sewage-works at Philadelphia has declined to proceed with his contract and his operating plant has been taken over by the city through the action of Joseph C. Wagner, acting director of public works, and George S. Webster, Chief of the Bureau of Surveys. The contract price was $1,025,000. The contractor supplied the bond for $512,500 through the National Surety Co. of New York. The work is about 33% completed. A greater part of the excavation has been made and a small percentage of concrete and re-inforcing steel placed.

Work Resumed on Chippawa Canal

Work was resumed on the Chippawa Canal around Niagara Falls on July 8. The Hydro-Electric Commission of Ontario agreed to establish the 8-hour day in the machine shops, the rest of the work to be on a 10-hour basis. About 800 men of a normal staff of 2,000 returned and others are expected to do so shortly, but a large proportion of the employees have left the district.

Motor Vehicles in Pennsylvania Show Increase

The Automobile Division of the Pennsylvania State Highway Department has predicted that more than 525,000 licenses will be issued in 1920 for pneumatic tired vehicles. Tag No. 469,000 was issued last week. The total number of licenses issued for pneumatic tired vehicles in 1919 was 441,224.

Truck registrations also show a great increase over 1919. The number of licenses issued up to July 9 for solid tired vehicles totaled 41,556. The 1919 total was 40,893.

Up to July 8, the total receipts from automobile registrations were $7,176,761.47. This is an increase over the total receipts for 1919 of $1,086,115.78.

The Automobile Division has received a number of requests for tag No. 500,000. It is expected that this number will be reached early in August.

The total registrations of pneumatic tired vehicles for the last six years were as follows: 104,950 in 1914, 152,365 in 1915, 218,846 in 1916, 306,001 in 1917, 363,001 in 1918, 441,224 in 1919.

Arizona Engineers Name Five Road Commissioners

Five men were recently recommended by the Tucson Chapter of the American Association of Engineers to act as highway commissioners of Pima County. These recommendations were made at the request of the county board of supervisors. The engineers so recommended have been appointed and placed in charge of an expenditure of nearly $2,000,000 on the location and construction of new roads. The commission has already employed more than 60 engineers.

Colonel Kelly Engineer-Officer With Power Commission

Lieutenant-Colonel William Kelly, Corps of Engineers, U. S. A., has been appointed by the President on the recommendation of Major-General Beach, Chief of Engineers, to serve on the Federal Power Commission as engineer-officer. Much of Colonel Kelly's experience in the Corps of Engineers has been in California, where he has been brought in contact with water-power problems. He was in command of the 117th Engineers in France and later became chief engineer of the Fourth Army Corps. From that post he was promoted to base commanding officer. More recently he has been stationed in Washington.

Retirement Pensions Provided for Government Employees

By virtue of an act of Congress signed by the President May 22, 1920, all employees in the classified civil service of the United States will after the 1st of September of this year become participants in a retirement annuity scheme. This includes, of course, a great number of engineers in the public service.

The scheme which is to be put in effect after a number of years of persistent agitation on the part of the government employees at Washington is only partly a pension scheme, inasmuch as the recipients will have to contribute each year to the annuity fund 2½ per cent of their salaries. The annuities, however, commence immediately so that all those who have served the requisite number of years will begin to receive their annuities as their terms of service reach the required period, regardless of the amount they have paid toward the annuity.

The law provides that all who have three months after the passage of the act reached the age of seventy years or shall have reached that age on any date thereafter and rendered at least fifteen years of service to the government shall be eligible for retirement on an annuity, and provides that mechanics, city and rural letter carriers, post-office clerks shall be eligible for retirement at sixty-five years of age and railway postal clerks at sixty-two if they have rendered at least fifteen years of service. The employees are divided into six classes, depending upon their periods of service. Thirty years of service entitles the recipient to not more than $720 and not less than $360 per annum, or 60 per cent of the annual salary; Class B, those who have served at least twenty-seven years, 54 per cent of salary, or not more than $648 and not less than $324; Class C, those who have served not more than twenty-four years, 48 per cent of salary, or not more than $578 and not less than $288; Class D, not more than twenty-one years, 42 per cent of salary, or not more than $504 and not less than $252; Class E, a period of eighteen years or more, 36 per cent, or not more than $432 and not less than $216, and Class F, a total period of fifteen years or more, 30 per cent or not more than $360 and not less than $180. If the employee retires from the service before the prescribed age or period of service, he will receive back from the Government his 2½ per cent payments plus 4 per cent interest compounded once a year and the same amount will be diverted to his heirs in case of death.

General Marshall Dies

Brigadier-General William L. Marshall, U. S. A., Chief of Engineers from 1908 to 1910, died at Washington, D. C., July 2. He was born in Washington, Ky., 1846, and was graduated from the U. S. Military Academy in 1868. Among the important works constructed under his direction were levees in Mississippi, Louisiana and Arkansas, harbor improvements on Lake Michigan, improvement of the Mississippi, Chicago, Illinois, Rock, Fox and Wisconsin Rivers, and the Hennepin Canal. From 1900 to 1908 he was engineer in charge of the construction of fortifications at the eastern and southern entrances to New York harbor and improved the main channels of the harbor, constructing a new 40-ft. channel, known as the Ambrose Channel, at its entrance. He was appointed Chief of Engineers, U. S. A., July 2, 1908, and was retired June 11, 1910, when he became consulting engineer to the Secretary of the Interior, a position which he occupied until a few months ago, when he tendered his resignation on account of ill health. General Marshall was the discoverer in 1873 of the Marshall Pass across the Rocky Mountains, while in charge of the Colorado section of explorations west of the 100th meridian. In 1914-15 he was in charge of the protection of the Imperial Valley, Cal., against overflow of the Colorado River, at which time he was a member of the central board of review of reclamation project costs. He was also the inventor of automatic movable dams, lock gates and valves.

BRIG.-GEN. W. L. MARSHALL

Waterways Service in War Department

Pursuant to the new Transportation Act, Secretary of War Baker has established a new branch of the War Department to be known as the Inland and Coastwise Waterways Service, with Brig.-Gen. Frank T. Hines as chief of that service. The new bureau will have charge of the inland waterway administration delegated to the Government as a hold-over from the war activities of the Railroad Administration.

University of Washington Building Concrete Athletic Stadium

Considerable excavation has been done and concrete pouring is scheduled to commence soon upon the new concrete stadium being built for the University of Washington by the Puget Sound Bridge & Dredging Co., formerly Lewis, Wiley & Morse.

The stadium will have a seating capacity of 55,000 and will be built entirely of reinforced concrete. Excavation and fill of the 125,000 cu.yd. of material to be moved will be handled hydraulically. The playing field is at an elevation of 25 ft. and practically half of the seating capacity will be provided on reinforced-concrete seats set upon this hydraulic fill. Above a berm, 150 ft. wide on the top, and whose top elevation is 60, the superstructure of the stadium will rise. The extreme dimensions of the stadium will be: For the interior, 308 x 487 ft.; exterior, 644 x 660 ft. It is to be built with one end open admitting future extension. On the outside of the stadium a 30-ft. plaza will be provided on both sides, widened to 150 ft. on the closed end.

Concrete steps placed directly on the fill will have a rise of 15 in. and a thread of 30 in., 3½ in. thick on the horizontal and 4¼ in. thick on the risers. In the superstructure, however, though the concrete steps will have the same rise and thread, the risers will be thickened to 5 in.

The feature of construction will be the method used in building up the berm and the concrete steps resting upon it. Sheerboards, used to build up the berm in successive steps, will be so carefully placed as to line and grade that they will not only serve as bulkheads in hydraulic fill work, but also as inner forms for concreting the steps.

Money for the construction of the stadium was made available through profits from associated student activities and through the sale of bronze souvenir plaques entitling holders to reserve-seat privileges for periods of from two to five years at every baseball or football game, fete, pageant, military or naval affair, or public gathering. These plaques sold at $25 and $50 each for the two-year free admissions, and $50 and $100 for the five-year admissions depending upon the distance from Seattle the subscriber lived. The money was raised in a week's state-wide campaign. It is expected that the stadium will be completed in November.

Army to Report on Potomac Power Development

By special provision of the Federal Water Power Act, the Federal Power Commission is directed to report to Congress before Jan. 1, 1921, on the power development of the Great Falls of the Potomac, 18 miles above Washington. This project has been under study for many years and was particularly made the subject of a report by Col. W. C. Langfitt, Corps of Engineers, in 1913. Maj.-Gen. Lansing H. Beach, Chief of Engineers, has been charged by the Commission with the present investigation and has detailed Maj. Max C. Tyler, Corps of Engineers, to assist him in the work and to conduct any further surveys that may be necessary. A sum of $25,000 was provided by Congress for the report.

An earlier text of the water-power bill had an appropriation of $25,000,000 for the construction of a power plant at this site, but this was stricken out of the Act as passed.

Construction Throttled

(*Continued from p. 139*)

in taking over a greater share of short-haul traffic contribute in still greater degree to the relief of terminal congestion. Not only should new roads be built but those now in use must be maintained.

"It should be borne in mind that the results are more than the immediate suspension of construction projects, disastrous as they are. Contractors with equipment lying idle and deteriorating, organizations scattered, and expenses continuing, will of necessity have to recoup, and it will be the cause of a continued increase in prices. For every hazard which a contractor must shoulder, the public must pay an increased price. This is the insurance the contractors will demand. Therefore, there is seen the importance not only of some immediate relief but of the establishment of a policy that will remove as far as possible such transportation hazards as have been experienced this season.

"We all recognize there is a shortage of transportation facilities just as there is a shortage of many other essential factors in the industrial progress of the country. But arbitrarily to assign to any given group of shippers an undue share of the restricted facilities creates an unbalanced situation which threatens the whole industrial structure.

"In closing, we submit that to throw the entire burden and responsibility for carrying this burden, due to the shortage of transportation facilities, upon the construction industry is an unsound business policy, is unfair to the public and unjust to the contractors and material producers who now face financial ruin. And we ask that Order No. 7 be modified to correct these conditions and that a fixed policy be established that will prevent in the future priorities and discriminations against or in favor of any industry."

Road Studies To Include Vehicle Types

In addition to tests of impact, the U. S. Bureau of Public Roads has extended its experiments to include a study of the effects of different types of vehicles on road construction. First attention is to be given to the relative effects of solid and pneumatic tires.

Forest Products Laboratory To Celebrate July 22-23

The Forest Products Laboratory, Madison, Wis., which was organized by the United States Forest Service in 1909 and formally opened in June, 1910, will hold a decennial celebration July 22-23 at Madison in response to the thought of men acquainted with the work of the laboratory that it should receive a mark of recognition at this time in appreciation of its work during the last ten years. The two-day program will include addresses by prominent men associated with the industry, inspection of the laboratory, and educational features.

To Collect Data on Tonnage of Road-Building Materials

Close co-operation among the railroads, the U. S. Bureau of Public Roads and state highway officials is planned in order to prepare systematically for the transportation of road-building materials.

At present there are no figures available which indicate on a national basis the tonnage of road materials which are transported by rail. Figures will be gathered to show the number of cars which are required for this service; the numbers which are used for each class of material; the numbers used at each of the important loading points; and the various other facts which may be necessary to point out in detail the transportation requirements of the nation's road-building program.

One of the lessons of the present transportation difficulty, according to Thomas H. MacDonald, chief of the Bureau of Public Roads, is that it is not sufficient to leave to the individual contractors the matter of arranging their own transport. The Bureau expects to be helpful in that connection in the future.

New Committee To Study Problem of Roads and Vehicles

The relationship existing between the highway roadbed and the motive unit is to be the chief subject of study of a new committee established under the Department of the Interior. It is to be known as the Committee on Education for Highway Engineering and Highway Transport Engineering. On the committee are Thomas H. MacDonald, chief of the U. S. Bureau of Roads; Col. Mason M. Patrick, Corps of Engineers, U. S. Army; Roy D. Chapin, representing the automotive industry; H. S. Firestone, representing the tire and rubber industry; Prof. F. L. Bishop, University of Pittsburgh, representing the engineering schools; Paul D. Sargent, president of the American Association of State Highway Officials; and Dr. W. C. Johns, of the U. S. Bureau of Education. Other matters which will be considered by the committee will include various important problems pertaining to highway development. The committee will submit recommendations for a more efficient and economical administration of the highway program.

Personal Notes

C. T. Dike, assistant manager, at Omaha, of the Chicago & Northwestern lines west of the Missouri River, has been appointed engineer of maintenance, with headquarters at Chicago. He succeeds W. J. Towne.

D. Rounseville, assistant engineer, has been appointed assistant chief engineer, at Chicago, of the Chicago & Northwestern lines.

Thomas S. Scott has resigned the chair of civil engineering at Queens University, Kingston, Ont. He will be in Brockville, Ont., for the summer, directing road construction work in that locality.

J. F. Deeds, of the U. S. Geological Survey, has been assigned to a study of the lower Musselshell River, in Montana, to determine the irrigability of lands along that stream.

Irving E. Moultrop, of Boston, has been elected by the trustees of the United Engineering Society, as a trustee of the American Society of Mechanical Engineers and a member of the Engineering Foundation Board, to fill the vacancy caused by the death of E. Gybbon Spilsbury.

Alfred McKee has been appointed engineer in charge of bridge construction for Polk County, Iowa, with office at Des Moines. Previously he was highway engineer for the county.

Delta Engineering Co. is the name of a new firm established at Greenville, Miss., by O. C. Kulicka and A. E. Boyte, for the practice of consulting and civil engineering.

Paul P. Taylor, office engineer and assistant superintendent of the Kansas City Railway Co., has resigned to become city manager of Grand Haven, Mich.

N. B. Garver, structural engineer, has been appointed consulting construction engineer for the Arkansas Division of the American Cotton Association, with headquarters at Little Rock. His first duties will be to make an investigation and report on the warehouse conditions in Arkansas, and to make recommendations with regard

to the most economic types of construction, taking into account available materials, first cost, maintenance, insurance rates, etc.

R. V. ROSE, recently maintenance engineer of the Niagara Falls Power Co., has been elected president and manager of the Consolidated Fuel & Supply Corporation of Niagara Falls, N. Y.

ROBERT M. WATSON, assistant to the Secretary of Labor, has been appointed president of the United States Housing Corporation, to succeed Leroy K. Sherman, who has resigned to take up private work in Chicago.

JOSEPH S. BOGGS, commissioner of public roads, has been appointed state highway engineer of Kentucky.

DAVID M. EARLE, assistant city engineer, has been appointed city engineer of Worcester, Mass, to succeed Frederick A. McClure, resigned.

RALPH G. LINGLEY, assistant street commissioner, has been elected superintendent of sewers of Worcester, Mass., to fill the vacancy caused by the recent death of Matthew Gault.

GEORGE T. BEATTIE, highway engineer, U. S. Bureau of Public Roads, has been transferred from Washington to the district office at Missoula, Mont.

R. L. RICHARDS, engineer of Douglas County, Wash., has resigned to take a Government position in Alaska.

M. O. LEIGHTON, C. T. CHENERY and A. C. OLIPHANT have formed a partnership under the name of M. O. Leighton & Co., with offices in Washington, D. C., for the purpose of engaging in general engineering practice and industrial representation before the Federal departments. Mr. Leighton and Major Chenery will continue for the time being as chairman and secretary of the National Public Works Department Association, while Mr. Leighton and Mr. Oliphant will continue service in the Washington office of Engineering Council, pending the displacement of that body by the Federated American Engineering Societies.

A. C. IRWIN, structural engineer for the Portland Cement Association, has resigned as chairman of the national qualification committee of the American Association of Engineers after continuous service in that capacity for over two years.

B. E. MOONEY, of Rexford, Mont., has been appointed city engineer and water commissioner of Whitefish, Mont.

EARL STAFFORD has become a member of the engineering staff of Arthur D. Little, Inc., Cambridge, Mass.

W. A. MURRAY, division engineer, New York Central lines east, with headquarters at Albany, N. Y., has been made engineer of track, at New York; G. N. EDMONDSON, division engineer, Pennsylvania division, at Jersey Shore, Pa., has been transferred to Albany succeeding Mr. Murray; S. E. ARMSTRONG, division engineer, Ontario division, at Oswego, N. Y., will succeed Mr. Edmondson at Jersey Shore; N. W. MCCALLUM, electrical supervisor of bridges and buildings, at New York, has been appointed division engineer at Oswego succeeding Mr. Armstrong.

HERBERT POST GREEN has opened an office in New York City, as the president of Herbert Post Green and Associates, Inc., architects, engineers and cost engineers. Mr. Green has associated with him, as vice-president, E. B. Black, of Black & Veatch, consulting engineers, Kansas City, and John C. Prior, of Braun, Fleming, Knollman & Prior, consulting engineers, Columbus, Ohio. Branch offices of the company will be in each of the two latter cities. There is also in the concern Austin W. Lord, of the architectural firm of Lord & Hewlett, New York City, and W. S. Manning, a landscape architect of many years' experience. The company will not only be engaged in regular design, construction and appraisal engineering, but is to offer a new service known as cost engineering service, to be rendered as professional service to the architect or engineer, the owner and the contractor. The company will act as an arbiter in the interests of the owner and of the contractor, so that the benefits of their service inure to both. Mr. Green and Mr. Prior were connected with the cost engineering end of the U. S. Housing Corporation.

E. V. BARON, project engineer, Attalia (Wash.) Irrigation District has completed construction work in that district and is now in charge of construction in the recently organized Priest Rapids Irrigation District, with headquarters at White Bluffs, Wash.

T. J. WILKERSON has resigned as chief engineer of the Penn Bridge Co., Beaver Falls, Pa. About Sept. 1, he will open a consulting engineering office in that city, giving particular attention to the design of steel and reinforced-concrete structures and the layout of factories. Previous to his connection with the Penn Bridge Co. in 1917, Mr. Wilkerson for nearly ten years was division engineer in the Pittsburgh division of bridges.

CHARLES E. HENDERSON, formerly assistant city engineer of Port Arthur, Ont., later city engineer of St. Augustine, Fla., and during the war principal assistant engineer with the U. S. Housing Corporation, at Washington, D. C., has been appointed division engineer in charge of the Detroit office of Morris Knowles, Inc., Burns Building, that city. Mr. Henderson is also manager of Morris Knowles, Ltd., of Windsor, Ont.

CLARK KEITH, formerly engineer in charge of design and construction for the municipality of Moose Jaw, Sask., now of Morris Knowles, Ltd., of Windsor, Ont., has been appointed assistant chief engineer of the Essex Border Utilities Commission, having jurisdiction over the water supply, sewerage and park systems of the seven municipalities bordering on the Detroit River.

WALTER J. TOWNE, engineer of maintenance, Chicago & Northwestern Ry., with headquarters at Chicago, has been appointed chief engineer, succeeding the late L. J. Putnam. From 1899 to 1902, Mr. Towne was assistant engineer of construction at Boone, Iowa, Kaukauna, Wis., and Escanaba, Mich. He was made division engineer, at Baraboo, Wis., in 1902, division engineer at Escanaba in 1904, from 1904 to 1906 division engineer at Chicago, and from March to July, 1906, engineer of permanent improvements. From that date until 1912 he was engineer of maintenance of way; appointed assistant general manager and general superintendent in 1914, and reappointed engineer of maintenance March, 1920.

G. A. RUSSELL, assistant county highway engineer, has been appointed engineer of Geary County, Kan., succeeding DeWitt C. Mickey, resigned.

J. ALBERT HOLMES, of Boston, is resident engineer for Pearse & Greeley, hydraulic and sanitary engineers, Chicago, on the construction of a new earth dam at Decatur, Ill., a $750,000 job. Mr. Holmes has recently been resident engineer for the J. G. White Engineering Corporation on the construction of the four earth dams recently completed in North Carolina for the Western Carolina Power Co.

BUSINESS NOTES

J. D. ADAMS & CO., manunfacturer of roadbuilding and maintenance machinery, Indianapolis, has established new branches at Dallas, Tex., Kansas City, Mo., and Minneapolis.

A. PEARSON HOOVER, formerly lieutenant-colonel, Construction Division. U. S. Army, has been elected a vice-president of Holbrook, Cabot & Rollins Corporation, contractors, Boston and New York.

THE AIR REDUCTION SALES CO., New York, has just completed the construction of a new acetylene plant at Gloucester, N. J., consisting of a gas house, carbide storage building and a generator house.

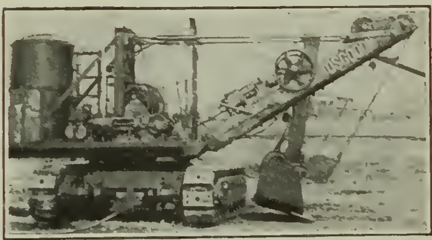
THE THEW SHOVEL CO. and the Thew Automatic Shovel Co., Lorain, Ohio, have been consolidated. The Thew Shovel Co. has assumed all the assets and business of the Thew Automatic Shovel Co. The officers of the consolidated company are: President, F. A. Smythe; vice-presidents, H. H. Harris and A. B. Taylor; secretary, C. B. Smythe; treasurer, R. B. Miller; sales manager, H. E. Billington; general works manager, J. S. Small, and purchasing agent, H. B. Newton.

A. A. E. Forms Industrial Department

The success of the railway department of the American Association of Engineers has led it to form an industrial department which is headed by A. M. Cornell, chief engineer, Pettibone & Mulliken Co., until such time as the duties warrant a full-time secretary. The new department will take up the problems in the field of mechanical, electrical and chemical engineers.

Revolving Shovel Operates in Small Space

An especially designed revolving air shovel mounted on continuous tread trucks is the Osgood 18, manufactured by the Osgood Co., Marion, Ohio, and reproduced herewith. The shovel is equipped with but a 12½-ft. boom and a 7-ft. dipper handle and is designed for low overhead clearance work. The entire height of the shovel is 10 ft., and the rear end swinging radius 7 ft. 9 in. One of these shovels is now doing underground quarrying, operating in a space only 11½ ft. high.



SPECIALLY DESIGNED SHOVEL FOR LOW OVERHEAD CLEARANCE WORK

New Horizontal and Vertical Skip Hoist

A combination of the vertical and horizontal operation of a skip hoist has been developed in a new machine called the "balanced skip hoist transporter," which is being marketed by the Exeter Machine Works, Inc., New York City. This skip is covered on all sides except for an opening in the upper part of the front side for receiving its load and single- or double-hinged doors on the opposite side for discharging the load when the skip is running on a horizontal track. The entire weight of the skip and half its load is balanced by a counterweight which operates only during the vertical motion of the skip Typical layouts are available in which the combination of the two movements permit many different types of installation.

Interlocking Building Brick

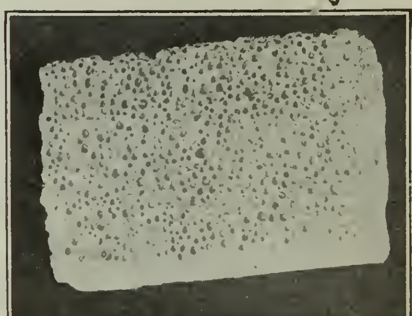
A new interlocking brick for large and small building construction is made with two circular pockets on the upper face and two circular projections on the lower face, as shown in the accompanying cut, but this view represents plaster models, the real bricks being of standard size and thickness. Bricks of this form are being made in San Francisco and are to be used in a $250,000 school building, but strikes in the brickyards have delayed production. This interlocking and self-bonding construction is said to be of special advantage in hollow-wall work. Tests are being made by the U. S. Government. It is the invention of Charles H. Brisbin, Brisbin Brick Co., Yuma, Ariz.

MODELS OF INTERLOCKING BRICK (Actual bricks are of standard thickness)

A New Light-Weight Concrete for Roofing and Siding

"Porete," a cast concrete of extreme lightness, has recently been put on the market by the Porete Mfg. Co., Newark, N. J., mainly for roof decking or sidings to which to apply stucco. The distinguishing features of the product aside from its lightness are its strength and the fact that it can be nailed to studding. The material, a sample of which is shown in the view herewith, is a concrete made up of cement and fine sand, with many connecting holes or pores formed by the dissolving of a number of soluble pellets which are incorporated in the mixture. These pellets are dissolved by a steam bath process and their essential liquid recovered for future use. At present "Porete" is supplied in 24 x 32 in. slabs, 1 in. thick for sheathing and 1⅛ in. for roofing, both being reinforced with wire netting. The 1⅛ in. roofing slab weighs with a $\frac{1}{16}$ in. cement finish, 7 lb. per sq.ft. and in test specimens have broken at 250 lb. per sq.ft. over a 32 in. free span. In application the slabs are nailed to wood studs or clipped to steel beams or purlins and the outside porous surface stuccoed. Due to the interlock the stucco holds admirably to the porous face. The other face is finished smooth if required.

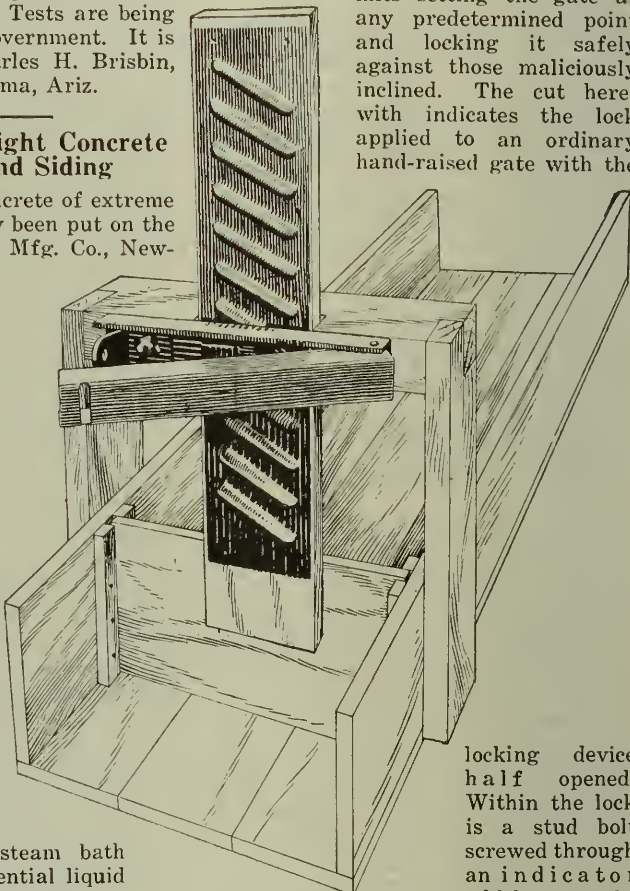
The process of manufacture has been patented.



LIGHT-WEIGHT CONCRETE "PORETE" MARKETED FOR ROOFING AND SIDING

Combined Gate Lock and Gage

As an aid to operators of irrigation properties a combined gate lock and gage has been devised which permits setting the gate at any predetermined point and locking it safely against those maliciously inclined. The cut herewith indicates the lock applied to an ordinary hand-raised gate with the locking device half opened. Within the lock is a stud bolt screwed through an indicator which may be moved horizontally permitting the gate to be raised the sloping distance between the corrugations. If a greater opening is desired the bolt is farther withdrawn and the gate lifted to approximately the position desired. Since each corrugation is numbered and a horizontal scale is provided for the fine adjustments, exact quantities may be measured. This permits resetting accurately and the making up of tables to give exact quantities. The usual method is to bore two or more rows of staggered holes in the stem, through which a pin or bolt is inserted. No fine adjustment is possible.



IRRIGATION GATE LOCK PERMITS FINE ADJUSTMENT

The device has been designed and patented by F. N. Cronholm, general superintendent, river division, Imperial Irrigation District, Andrade, California, who states that several thousand are in use.

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Selectmen-Manager Plan

THE adaptability of the manager plan of government to almost any local condition is in a way of being demonstrated at Mansfield, Mass. There, on July 12, a good old-fashioned town meeting voted 505 to 55 for a selectmen-manager plan of government. Five selectmen, elected yearly and serving without pay, will employ and direct a town manager. This democratic-representative-business form of government may shock the author of "Back to the Republic" (p. 133 of our issue of July 15), judging from his sweeping condemnation of the city manager plan. But in spirit it squares with the American constitution and with Mills' "Representative Government" in that the voters at large do not try to pick out administrative heads whose success in office depends upon technical ability. Instead they select men to do it for them.

Articles for the "Average Engineer"

A WIDE range of subjects is covered by the dozen articles for the "average engineer" published in this issue. All are short—averaging only slightly more than a column in length—and discuss both from the point of view of the designer and the constructor the problems encountered in the comparatively small engineering office or drafting room. That there is a demand for material of this sort has always been recognized by this journal. In fact similar articles are presented in practically every issue. This week, however, the space devoted to small job details has been increased and the articles have been grouped under a general heading. It is hoped by giving prominence to concise accounts of interesting details, as contrasted with longer descriptions of larger projects, that readers may be induced to contribute from the fund of their experience matter relating to the "kinks" or time-saving methods or devices which, taken in the aggregate, are a big factor in simplifying routine work, but which are not always considered, especially by those who use them, to be of sufficient importance to warrant description in a technical journal. It is only a comparatively small proportion of the engineering profession which is called upon to handle works the size of the Panama Canal or the Quebec Bridge. From the editorial standpoint the presentation of detailed articles on such projects is not difficult. This is not the case, however, with the small job. There is a real need for the exchange of information among "average engineers" on the everyday details of their work.

Holes in Concrete Hulls

IT HAS been proved in numerous cases that holes in the hulls of concrete ships can be repaired in a very short time and at a trifling expense compared to similar repairs in steel ships. There are those who would advance this as an argument in favor of concrete for ships, but in fact back of it lies one of the most serious criticisms of this new type of ship construction. Concrete hulls are altogether too easily broken. Barges and ships alike are continually coming into dock for repairs. Blows that come as a part of the daily routine of a steel or wood boat result in shattered shells or more probably punched holes in the concrete vessel. The ease of repair is quite counterbalanced by the frequent necessity for such repair. Much of this weakness against punching is probably due to the peculiar nature of ship concrete which, with its rich mix and closely spaced steel, is a different material from ordinary building concrete. Then, too, no land structure is ever subjected to the tremendous inertia exerted by the heavy mass of a ship, be it moving ever so slowly, so that experience on land is a poor guide to the probable behavior of a ship's hull under impact, and any experiments which could be devised would be only faintly comparative. These, however, are conjectural matters; what is certain is that this tendency to punch is easily the most serious structural defect in the concrete ship as demonstrated in service, though in the preliminary studies and design it was subordinated to many other considerations which have given no concern in the finished ship.

A Sewage Farming Possibility

LOS ANGELES has a possible opportunity to increase its fame and growth by an engineering enterprise that would rival the great aqueduct and man-made harbor of which it is rightly so proud. The water brought from the high Sierras by the aqueduct is already used for power on its way to the city and again for domestic and irrigation purposes. Why not make the water do triple duty by utilizing the sewage of the city for irrigation? The question has recently been under discussion by some of the city officials. Vast quantities of spent water from the aqueduct now flow uselessly to the Pacific—worse than uselessly, beach cities near the aqueduct complain. In a land of little rain it is an economic sin not to utilize sewage for irrigation if a practicable plan to do so can be devised. Outlets for sewage utilization were provided when the outfall sewer to the ocean was built. In fact some of the sewage of Los Angeles was used for irrigation in years gone by. The practice was discontinued because the districts in which the sewage was utilized became filled with houses and also because of opposition by physicians and others who claimed that the garden produce from the sewage-irrigated land was a menace to health. More recent methods of sewage treatment are now available. Land clogging and nuisance could be controlled by removing as much as need be of the organic and other solids from the sewage before it was used for irrigation and chlorination could be employed to disinfect the applied sewage. The activated-sludge process for both nuisance prevention and bacterial reduction might be worth looking into, particularly if there were promise of converting the sludge into fertilizer. If disinfection were still

thought to be necessary or desirable for safety presumably but a light dose of chlorine would be needed. In studies of sewage utilization at Los Angeles consideration would properly be given to the fact that as the rural areas now irrigated by the surplus waters of the aqueduct are given over to houses the waste water going to the sewers will be increased correspondingly, while at the same time the area of truck and fruit land in and near Los Angeles will decrease. The subject is a fascinating one. Light upon it close at hand is available in the working experience of the Pasadena sewage farm and in the activated-sludge experiments and other studies conducted for Pasadena, South Pasadena and Alhambra.

Engineers Favor Wide Piers

IS PRESENT profit or future progress the proper guide to a city's port policy? That is the question raised by New York's new Staten Island pier development. By precept and practice the city administration holds to the former. The weight of engineering opinion is for the latter. No better example can be found of the common conflict between the political and the engineering view.

The city enters its steamship piers in its books as a separate account; so much expended, so much earned. If the latter is a fair percentage of the former, it is satisfied. The engineer sees New York as the greatest port in the world, dominant partly because of its natural location, partly because of its provided facilities, but mainly because it is the tonnage market and the financial center of the country. He sees the business which must inevitably come here hampered by an unwieldy transfer system and the excessive burden of cost shifted onto the consuming public everywhere. The immediate return to the city treasury seems to him to be insignificant compared to the economic waste the present policy condones.

The Stapleton pier project is only a minor part of the problem, and is interesting because it exhibits at this particular time the city's disregard of the broad principles of port layout. It is symtomatic of the administration's attitude toward a development of New York as an economic factor in the business of the whole country; their shortsighted view of the city's own welfare is a matter for consideration by the citizens of New York themselves.

No one can escape the weight of the engineering opinion expressed in the symposium on the Stapleton development on another page of this issue. These men are experts and unprejudiced; there can be no possibility of collusion. Yet every one in set terms condemns the design and layout as being archaic and uneconomical. The issue is clear. For piers of a length of those on Staten Island, a maximum of movement—and consequently a maximum of economy—demands a pier wide enough to hold the contents of the vessels which can tie up to it and a machinery equipment sufficient to move those contents off the pier in the time that another ship is discharging. The alternative of a narrow pier requires either long storage on lighters or railway cars, or longer turnaround for the ship, both of which mean increased cost of handling goods. That present practice in New York permits the steamship companies to shift these excess costs off onto someone else is a poor argument in favor of permitting them to continue to do so.

There is a great deal of loose talk today regarding mechanical freight handling on piers. The fact is that with few exceptions the perfectly equipped piers of this country have never had enough business to demonstrate their superiority. Railway track on piers may or may not work better than tracks to the doors of the piers with tractor-trailer transport into the shed and to the ship's side. For some conditions elaborate machinery only adds to first costs and maintenance without compensating economies. But the necessity for room on the piers is obvious. Terminal operation is a traffic matter pure and simple. Material must be gotten out of the way so as to permit other material to take its place, and the flow must be uninterrupted. This can be accomplished by rapid handling, but this presupposes machine-like operation of the whole chain of movements and can be wrecked by human frailty. As a safety valve—or to change the metaphor, a reservoir—there must be provided plenty of room so that if the through progress of movement is interrupted there is always space in which to deposit the held up freight. This the Stapleton design does not provide and on this ground more than any other it must be criticised. Railroad connections and handling machinery might conceivably be added; space cannot except at the expense of the slips, which is only robbing Peter to pay Paul.

Co-operation of Material Interests

THE truly successful engineer or architect utilizes a certain material or combination of materials only after making a close analysis of service, cost and desirability. For many years the profession has seen material interests fight each other uncompromisingly in efforts to secure exclusive use of their particular products. Some anomalous and peculiar conditions have arisen, hard at times to explain to the layman. Brick streets in the past have been largely promoted by filler makers. The cement and brick interests have always been bitter competitors, although the best specifications for a brick pavement call for a concrete foundation. The broken-stone interests have advocated macadam regardless of service required, with disastrous consequences, seemingly overlooking the fact that broken stone in great quantities is needed for aggregate in concrete pavements and for foundations of both brick and asphalt pavements.

Several years ago a non-knocking policy was adopted by one of the strongest material associations. It recognized that the best results for all concerned are obtained only when a true analysis of service requirements has been made by the engineer and the material thus indicated is used to meet that service. Its mission was largely to help the engineer learn of the merits of its product and not of the demerits of competing materials. Co-operation between competing materials should give the engineer and builder more nearly what he needs.

Metal lath, formerly bitterly opposed by the lumber interests, is now advocated by a few of them for vulnerable parts of timber buildings. This promulgation will increase the legitimate sales of metal lath and reduce but slightly the aggregate sale of lumber, but it will render the whole structure much more fire-resistive and in this way give frame buildings a better reputation. Both producers and consumers will profit by the co-operative effort. Opportunities for similar co-operative effort should be looked for and seized.

Public Works and City Integration

GREAT quickening of the flow of traffic between the North Side and the business district of Chicago has resulted from the opening of the new Michigan Boulevard river crossing. A continuous, broad and direct route across the river is available in place of a traffic-congested bottle-neck in a main thoroughfare having extremely heavy automobile traffic. It is plain to all that the improvement constitutes a noteworthy public benefit of general effect upon the city, not a mere local convenience. The gain through creation of an unobstructed through route, with its incidental separation of fast and slow traffic by two decks, is something not to be measured by increase in the numbers transported across the river, or by potential toll receipts. The many thousands of hours of time saved each day mean a more thorough integration of the community.

Similar advantage to the public is realized from all city works that level barriers to free intercommunication. It is apt to constitute the principal element of value in such an improvement, and should be taken account of specifically in the engineering calculations on which the project is based. Consideration is given to this factor—it may properly be called the city integration factor—in the planning of street widenings, or new streets to be cut through districts that obstruct active traffic flows. But the case is otherwise when a bridge, a valley viaduct, a tunnel or the like is in question. The probable value of the work is often gaged mainly or wholly by the traffic it will carry, and the revenue which might be derived from this traffic when rated at a reasonable toll is taken to represent the gross earning value of the improvement. Yet in most cases such income calculation is a very incomplete estimate of service value since it ignores the distributed gain to the community resulting from integration of its separated areas. Failure to include this latter element of value in determining on the justification for a given city improvement may operate to condemn or delay an enterprise that the city sorely needs.

We refer to city work because a broader view prevails in the planning of highway improvements in the open country. When an improved road connection is under consideration deliberate allowance is made for the distributed benefits resulting from community integration. This allowance, it is conceded, is not quantitatively precise, yet it receives a primary place in deciding upon the justification of the project. Perhaps the relatively large areas and scattered populations involved make the remoter influences of improving a communication route more obvious than under the localized conditions affecting a city government. Possibly it is true also that the political methods by which most highway improvements are directed give better expression to the requirements of scattered parts of the area served, and thereby bring the element of community integration to the foreground of the question in a manner not found in the case of city enterprises. At any rate, experience shows that most city public works are entered upon without a live, forceful appreciation of their distributive value to the community.

Traffic and toll data for a bridge project or the like are easily expressed in figures, and the figures give an air of definiteness to the advance estimates. Not so in the matter of the more elusive effects of the enterprise on the efficiency of the community as a whole. The engineer may well feel disinclined to deal quantitatively with the great variety of minute scattered benefits accruing to the community from the more thorough knitting together that is to result from his project; and argument expressed generalities is often deceptive. But if he ignores the integrating effect he also misses a potent inspiration and may err seriously in his deductions.

Deliberate effort to grasp the specific meaning of community integration in the particular case before him is a necessary preliminary to the engineer's choice of a method of expressing the effect quantitatively in figures. But such a method should always be discoverable, and with the help of its results he can base his project on a true showing of costs and earnings. Unless he does this his recommendations are almost certain to be over-conservative, and time and again he will see his figures outweighed by the convincing appeal of some promoter, whose broader vision looks beyond the limited scope of the engineer's traffic estimates.

It is not only the engineer that is at fault, for the public at large also tends to ignore or undervalue the broader effect. Thus, were the value of community integration fully appreciated within the New York metropolitan territory we have no doubt that three or four vehicle tunnels under the Hudson River might now be building instead of one, or possibly a great bridge, to bind together the western industrial section of New York City and its central portion. Again, if the citizens of Cleveland gave full weight to similar integrating effects they might before this have forced construction of the new Cuyahoga Valley viaduct at Huron Road, an enterprise which has been deferred and delayed for several years and has left the city with but a single thoroughfare to its great undeveloped west side. In both cases engineers appreciate the situation in a general way, but the public does not. Engineers are not sufficiently impressed with the importance of the integration factor to compel its recognition by the people; otherwise they would be able to find means for expressing the probable effect in terms of figures and bring the dominant argument before the public consciousness in a compelling way. Because of their failure to do this many projects that are urgently required for the better service of the community are placed in an unfavorable light and must undergo a long postponement.

Traffic-improvement projects or works already under construction in many cities give equal opportunity for considering the relation of public works to integration of city areas. The Philadelphia-Camden bridge, the Second St. tunnel in Los Angeles, the Liberty tunnel or the proposed McKees Rocks bridge in Pittsburgh, the Ogden Ave. extension and street widenings at Chicago and other enterprises might be cited. With few exceptions all cities have problems of overcoming natural or artificial barriers to free communication, which cut the urban area into separate parts and throttle or inhibit traffic between them. And there are not a few cases in which the sections thus cut apart are so remote from each other in a traffic sense as to be virtually distinct communities without effective commercial intercourse. Whether the barrier be river or hillside or railroad right-of-way or gorge, so soon as the city cuts through it with thoroughfares the separated parts become one, and the community increases its activity and production far more than by mere addition. Of this integration, brought about by engineering works, engineers should prove the most competent advocates.

A Dozen Articles for the "Average Engineer"

EDITOR'S NOTE—As noted on the front cover, this issue contains more than the usual number of articles for the "average engineer"—the man who is concerned not so much with large or costly works like the Miami Districts' flood protection works, the Hell Gate Bridge or the Catskill Aqueduct, but rather with details of design and construction and the daily routine encountered in the smaller engineering or contracting organization. ENGINEERING NEWS-RECORD *must give adequate treatment to the big projects, but at the same time it recognizes the needs of the "average engineer" and endeavors to give him the kind of material which he will find useful in his own work.*

Every now and then we receive a letter from one of our readers suggesting that more space in the paper be devoted to small job articles. Good material of this sort is not easy to secure. Many men, apparently, feel a certain hesitancy in sending articles to the technical press unless they deal with work the cost of which runs well into six figures. It is true that much of the small work is commonplace, but it frequently develops one or more details of striking interest. A case in point is that of the alternate sewer sections at Lynn, Mass., described by Mr. Wentworth on this page. If our friends who urge the publication of more material for the "average engineer" would tell us briefly how some one feature of their own work was handled in an effective or novel way, or how some useful, time-saving kink was developed in the drafting-room or in the field, it would be easier for the editors of this journal to publish a greater volume of material for the "average engineer."

Sewer Cost Lowered by Increasing Concrete Yardage in Section

Simplification of Form Work at Lynn, Mass., Cuts Contractor's Bid $2 per Linear Foot and Saves $1,000

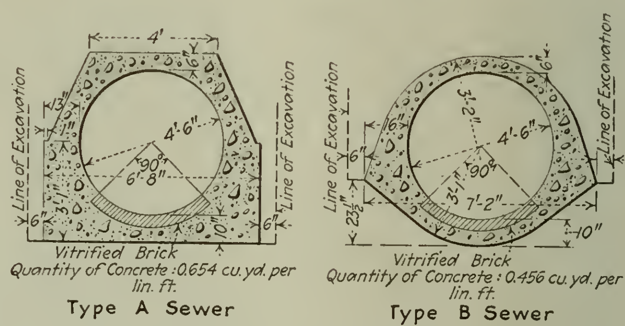
BY JOHN P. WENTWORTH
Assistant Engineer, Metcalf & Eddy, Consulting Engineers, Boston, Mass.

THE lowest bid received on June 15, at Lynn, Mass., for a concrete sewer affords an opportunity to secure a contractor's views upon the cost of furnishing and placing concrete in a section accurately proportioned to meet loading and other conditions, and in another section adequate for the same conditions but more generously proportioned and for which curved outside forms or "jackets" are not required. The contract drawings showed two-cross sections, Types A and B, either of which was acceptable. The object of offering two types was to give an opportunity for the city to adopt the cheaper section.

As shown by the accompanying drawing, Type A requires a flat bottom, whereas Type B requires a curved trench bottom. In the case of Type A, below the springing line, the contractor will be permitted to place the concrete directly against the sides of the trench, if in firm ground, otherwise he must use outside forms or place the concrete against the sheeting. If the concrete is placed against the sheeting the contractor must either draw the sheeting, or leave it in at his own expense. Above the springing line he must use outside forms, but as these will be plane surfaces no shop work will be required.

In the case of Type B, outside forms will be necessary from bottom to top. These forms will be curved, requiring a small amount of shopwork for getting out the ribs.

In each case the quantity of excavation to be paid for will be computed to lines of excavation 6 in. outside the concrete. In the case of Type A, however, the contractor, if he chooses, may excavate his trench 12 in. narrower than indicated by the "lines of excavation" and thus save about 0.5 cu.yd. of excavation per linear foot of trench. This cannot be done in the case of Type B because of the space required for the outside forms, although possibly some saving might be made by very careful and well planned work. Furthermore, the



TYPE A SEWER, ALTHOUGH REQUIRING MORE CONCRETE, DREW LOWER BID THAN TYPE B

narrower trench for Type A will simplify and cheapen the cost of bracing.

The prices bid for concrete in the two cases are as follows: Type A, $25 per cu.yd.; Type B, $40 per cu.yd.

These prices are for 1:2:4 concrete; the contractor furnishes the cement. For a short length of the sewer steel reinforcement is required, but the contractor receives an extra price for furnishing and placing the steel.

The resulting costs per linear foot of sewer for concrete are: Type A, $16.35; Type B, $18.24.

The total difference in cost of concrete for the entire sewer (650 ft. of two sizes) is $1,000 in favor of Type A. The quantity of earth excavation paid for in the case of Type A sewer is slightly greater than in the case of Type B, so that the difference in cost in favor of Type A will be offset to the extent of $400, thus reducing the net difference to $600 in favor of Type A.

Among the possible reasons for the lower bid in the case of Type A the following have occurred to the writer:

(1) It affords opportunity for material saving in cost of excavation and bracing.

(2) It saves time in shaping the bottom of the trench.

(3) It permits the omission of lower outside forms.

(4) It avoids the use of curved outside forms.

(5) It permits of using cheaper labor for placing forms.

(6) It reduces time required for placing forms.

The proposal upon which this article is based may not fairly represent the general opinion of contractors, although it is in line with contractors' comments which have come to the notice of the writer on a number of occasions.

This sewer is to be built under the direction of William L. Vennard, city engineer of Lynn, Mass., Metcalf & Eddy acting as consulting engineers. The contract has been awarded to Anthony Baruffaldi of Somerville, Mass.

Load Tests of End Joints in Maple Flooring

By C. A. Petry

Structural Engineer, University of Illinois, Urbana

The strength of the joints of dressed and matched flooring is seldom a factor in determining the type of flooring to be used. However, when a single-ply floor is considered which may be subjected to occasional heavy loads, information on the strength of the joints is essential. Some limited data were obtained recently from a test of this kind made by the Materials Testing Laboratory of the University of Illinois, at the request of the Supervising Architect's office of the university.

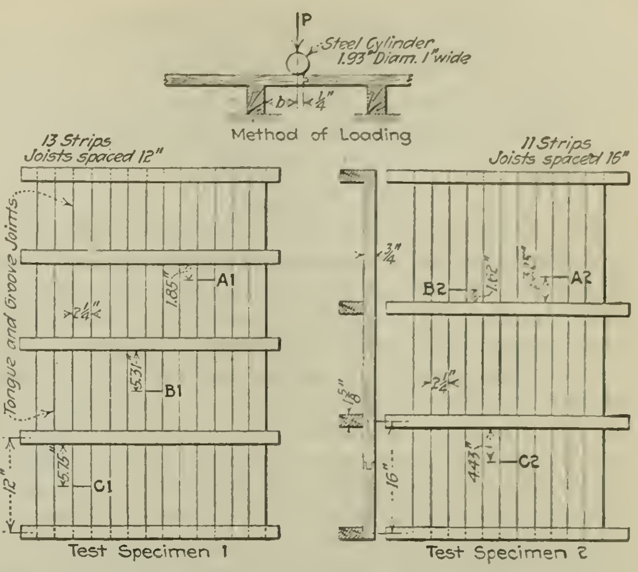


FIG. 1. MAPLE FLOOR PANELS FOR TEST

Two panels of 1⅜-in. maple flooring nailed to transverse sleepers were made up with sleepers spaced respectively 12 in. and 16 in. on centers; end joists were located as shown in Fig. 1. Load was applied to the specimens near transverse joints as shown. As the investigation was for the purpose of determining the effect of the weight of a grand piano, the load was applied by a steel cylinder approximately the size of a piano caster, and deflection readings taken.

At the left in Fig. 2 is a graphical representation of the relation of the deflection to the load; the maximum loads are noted. No attempt was made to secure deflection readings when nearing the ultimate load. The fracture was in most cases in the floor strip itself, not in the tongue. The toughness and elasticity of maple was strikingly demonstrated in the large deflections obtained before failure; in some instances the strip sprang back to its original position when the load was removed, after rupture.

The curves at the right in Fig. 2 give the relation between the maximum load and the distance of the load to the near edge of the support. The few points obtained indicate the relation to be represented by a straight line.

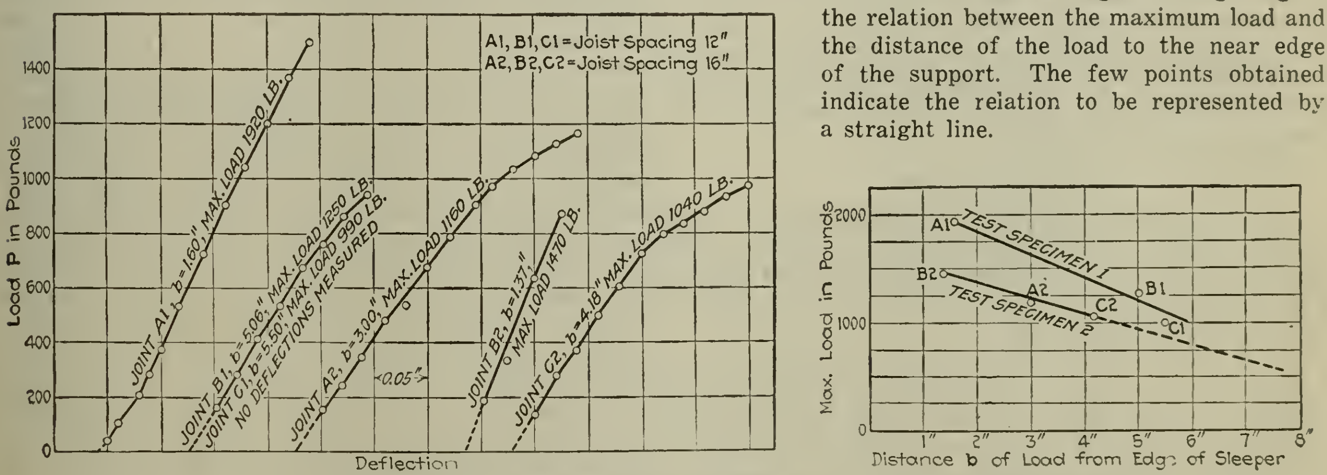


FIG. 2. ELASTIC ACTION OF FLOOR STRIPS SHOWN BY CURVES OF TEST RESULTS

Electrolytic Iron for Engineering Purposes

Studies of defects in electro-deposited iron carried out by W. E. Hughes and reported in a paper before the Iron and Steel Institute at its annual meeting on May 6, 1920, show that extensive structural irregularity, presence of pinholes, inclusion of foreign matter, and cracking or seaminess may occur in iron galvanically deposited. During the war, electrolytic iron was used in many instances for repair purposes and in parts for airplanes. Mr. Hughes concludes from his studies that the defects of electrolytic iron may render its use dangerous in engineering service unless it is heat-treated, but that these defects can be largely eliminated by skill in the deposition process. He also says that the common view that electrolytic iron is hard and brittle may need revision, as he has found such iron in many cases to be quite malleable.

The quantity of stone sold in the United States in 1919, according to a recent bulletin published by the U. S. Geological Survey, amounted to 71,380,000 tons.

Rapid Progress Made on Topographic Survey

Plane Table Party of Three Men Located 871 Shots in 7 Hr. 50 Min. for Topographic Map of Akron

By R. H. Randall
R. H. Randall & Co., Topographic Engineers, Toledo, Ohio

IN the making of a topographic survey of the City of Akron, Ohio, an incident occurred recently which may be of interest and worthy of record. A plane table party composed of three men located 871 shots in 7 hr. and 50 min., and upon these as control constructed a complete map, covering 75 acres, on a scale of 1:2400 and with a contour interval of 1 and 2 ft., the latter varying with the steepness of the slope. This map shows street lines and the outlines of wooded areas in addition to the topography. G. D. Whitmore, of this company, was the topographer in charge of the party.

These figures may not seem remarkable to the casual observer, but to the engineer familiar with field procedure in this work they are significant. They are evidence, upon the part of the topographer, of unusual efficiency in the handling of the instrument and of extreme rapidity and sureness in plotting and contour sketching. They further indicate an almost balance of effort of each man in the party with every other man; for to attain such speed the party chief must so direct the labors of himself and party that each man may be busy all the time with the thing that will most advance progress, and no man may be kept waiting and idle until another's work is completed.

Equipment Used

The instrumental equipment used by this party consisted of a regular Bausch & Lomb plane table outfit, the tripod having the Johnson movement, a 12-ft. rod having for a face a Keuffel & Esser flexible rod No. 6,332, a stadia slide rule, tape, etc.

On this day's work, as is customary when working upon this scale, distances were read and plotted to the nearest foot, elevations on side shots were read to tenths, and vertical angles to minutes. Elevations on turning points were read to hundredths of a foot. In reading vertical angles it is, of course, necessary to read an index or level angle. Thus the topographer for a level shot observes the level reading upon the rod, the stadia distance, plots the position of the new point, and writes the elevation to the nearest tenth upon the sheet, the recorder meanwhile giving him the plotting distance corrected for stadia factor and the computed elevation. For an angle shot the reading of "point sighted" and a "level angle" with the consequent increase in computation is added to this procedure.

As a basis of comparison it may be stated that the field records of the survey of Flint, Mich., (see *Engineering News-Record* of April 8, 1920, p. 700) show that an average day's field work for an experienced topographer runs from 200 to 500 shots, depending upon the type of country encountered and the efficiency of the topographer and the party as a whole. The previous high mark of which this company has record was made by C. S. Elicker in 1917. Upon the same scale and with the same size party as described here, 626 shots were read in 8 hours, controlling about 30 acres of extremely detailed, glacial topography near Jackson, Mich.

To read a total of 871 shots in the 7 hr. and 50 min. Mr. Whitmore averaged a trifle better than 108 shots per hour. In one period of 20 min. he read and plotted a total of 75 shots. At another instrument station the total time elapsed was 18 min., during which time 48 shots were read and plotted and the contours completely sketched. The cost per square mile, as computed from this day's work, would be about $159 for the map complete in pencil. This of course includes no allowances for primary control or overhead charges. The accuracy of this topographer's work has been amply proven by various test profiles, similar to that described in *Engineering News-Record* of April 8.

Other Records

It might be pertinent here to call attention to other remarkable records published in *Engineering Record* of June 6, p. 639, July 18, p. 84, and Oct. 10, p. 415, 1914, which at the time occasioned some discussion. The best day's work recorded was 1,023 shots, using a transit party of 5 men. The best hour's work, with the same party was 212 shots.

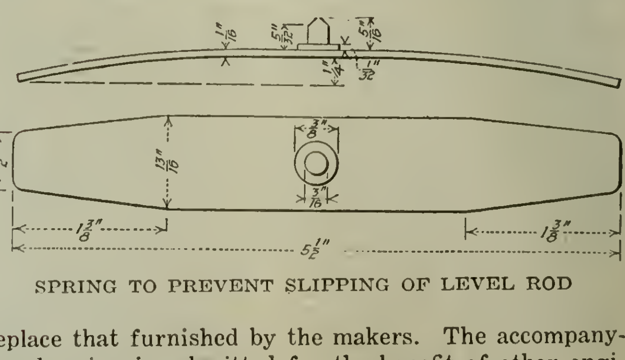
At the risk of being considered controversial and of reopening an old discussion, the writer cannot resist comparing the relative advantages of the plane table and transit methods. The essence of the plane table method, as distinguished from the transit, is the obtaining of direction by direct sighting and the sketching of the topographic details in the field. In all classes of work and under all ordinary conditions, the plane table equals the transit. In all except three specific classes of work the plane table patently excels any other topographic method of making accurate, large-scale maps, *when in the hands of a competent, experienced operator.* A plane-table topographer to a certain extent must be "born." Given certain natural qualifications his subsequent training must be long and thorough. When finally proficient, he is able to make a better map, and with a smaller expenditure of effort, than it is possible to obtain by any other method. It is the purpose of this article to show some of the things it is possible for him to do.

A Dozen Articles for

Anti-Slip Spring for Level Rod

By John Orth Cook
Engineer, Allegheny County (Pa.) Planning Commission

HAVING had considerable trouble with my high level-rod slipping, I designed and had made a spring to replace that furnished by the makers. The accompanying drawing is submitted for the benefit of other engineers who meet with the same difficulty.



SPRING TO PREVENT SLIPPING OF LEVEL ROD

the "Average Engineer"

Storm Water Run-Off Diagram for Rational Method

By George C. D. Lenth
Assistant Chief Sewer Engineer, City of Chicago

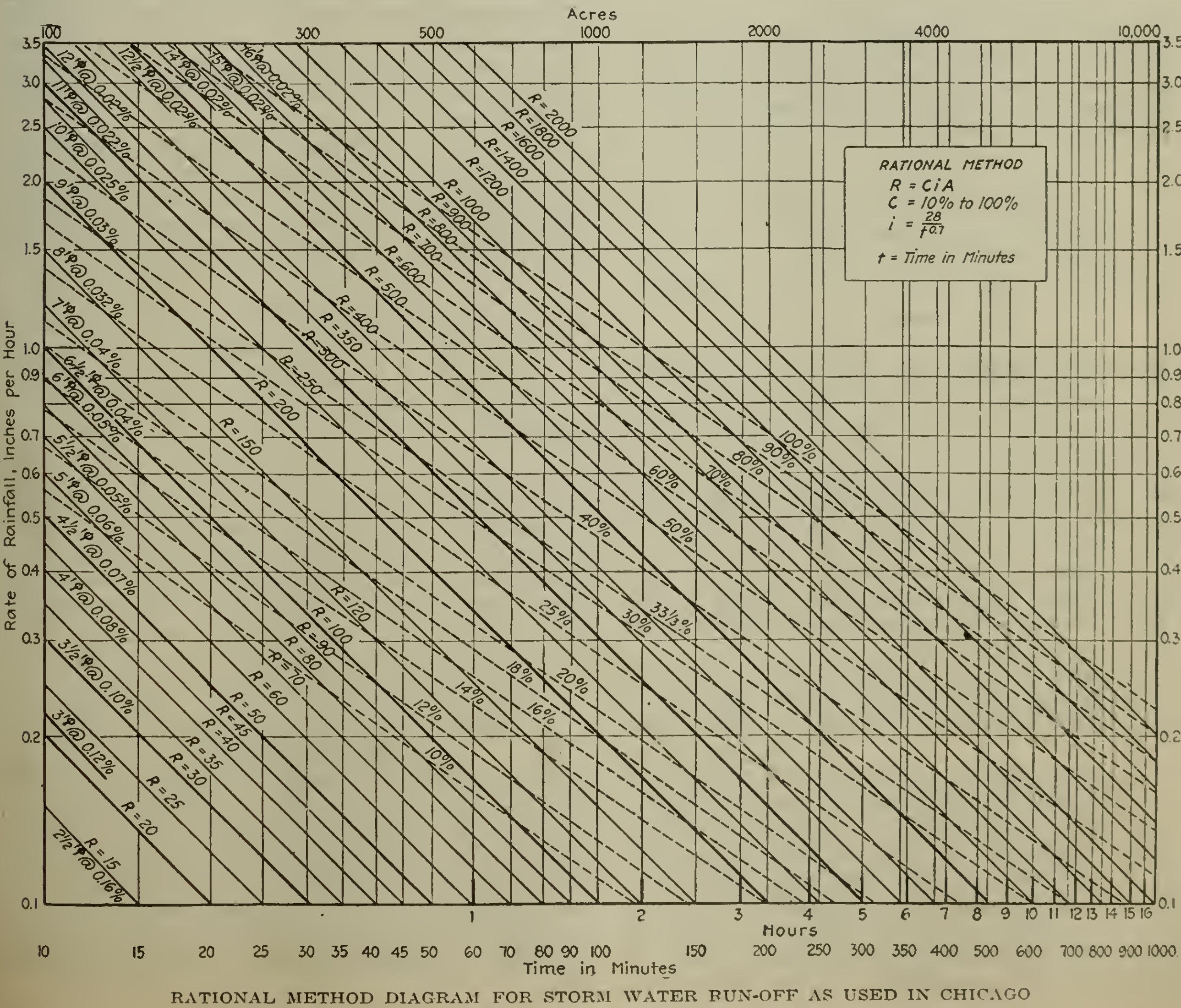
The calculations of run-off by use of the rational method in the design of storm water sewers is somewhat tedious. With the idea of eliminating the labor of multiplication in solving this problem, the diagram herewith was made to give the run-off of a given area in second-feet, when the time of concentration, the area, and the ratio of run-off to rainfall has been determined. The volume of the storm water as determined by the rational method is dependent upon the intensity of rainfall, the duration of the storm and the character, slope and area of the drainage district under consideration.

The relation between intensity of precipitation and duration of the storm has been established for Chicago by the formula $i = 28/t^{0.7}$. The time "t" in minutes is the time required for the water to reach the sewer, known as the inlet time, plus the time due to the storage capacity of the sewer, plus the time of flow from the most distant point to the point under consideration, coefficient to run-off, or the run-off factor, may vary which is usually taken as the time of concentration. The from 100 per cent to 10 per cent, in accordance with the judgment of the designing engineer. It is predicated upon the character, the surface of the drainage area as regards imperviousness and slope.

Referring to the diagram, the rate of rainfall in inches per hour and the corresponding rate of run-off in second-feet per acre is platted vertically on a logarithmic scale and indicated along the right and left margins. The time in minutes is platted logarithmically and indicated along the upper and lower margins. The dotted diagonal lines indicate the intensity of rainfall corresponding to the time of concentration affected by coefficients of run-off varying from 10 per cent to 100 per cent, so that for a given time by means of the diagram the rate of run-off is obtainable.

Imposed upon the diagram is a second series of full diagonal lines indicating the total run-off in second-feet from any area indicated in acres along the lower margin with any rate of run-off indicated on the side margin. At the upper ends of the diagonal lines are indicated the size of circular sewers that would have the required capacity when flowing full at a velocity of approximately 3 ft. per second.

To illustrate the use of the diagram, let it be assumed that the drainage area is 500 acres, that the inlet time is 15 minutes, that the time of flow in the sewer 50



RATIONAL METHOD DIAGRAM FOR STORM WATER RUN-OFF AS USED IN CHICAGO

minutes, and the time due to storage capacity 25 minutes, so that the total time will be 90 minutes. The character, slope and local conditions require a run-off of 25 per cent of the rainfall. Following the vertical line indicating "90 minutes" to the intersection of the dotted diagonal line showing the intensity of rainfall as 25 per cent, we find the rate of rainfall is at their intersection and read along the right margin, or 0.3 in. per hour, or 0.3 sec. ft. per acre. Passing along the horizontal line "0.3 in. per hour" to the vertical line indicating 500 acres, we find the full diagonal line marked 150 sec. ft.

Computing Cross-Section Areas by the Method of Co-ordinates

By J. A. MacDonald
Provincial Land Surveyor, Souris, Prince Edward Island

The co-ordinate method of computing cross-section areas here described is little practised by engineers and surveyors for the very good reason that it is not taught in technical schools nor is it given in the manner here shown in textbooks. Something, after the manner of computing land areas by double meridian distances, is given in many textbooks, but this simple and concise method is considerably different and for rough and broken sections there is no other known method so simple.

The cross-section is considered an area all of whose co-ordinates are known. The cuts or fills are represented as ordinates and expressed in terms of y, while the distance out from the center becomes abscissæ, and are expressed in terms of x.

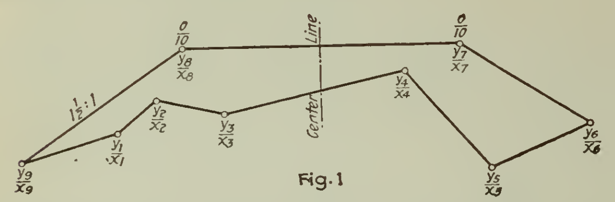


Fig. 1

The field notes of the section (Fig. 1), would be written thus: $\frac{-8}{22}\ \frac{-6}{15}\ \frac{-4}{12}\ \frac{-5}{7}\ \frac{-2}{6}\ \frac{-9}{12}\ \frac{-6}{19}$, the minus sign indicating a fill.

The general formula for any possible shape of cross-section whose area is A would be (Fig. 1) $y_1\ (x_9 - x_2) + y_2(x_1 - x_3) + y_3(x_2 - x_4) + y_4(x_3 - x_5) + y_5(x_4 - x_6) + y_6(x_5 - x_7) + y_7(x_6 - x_8) + y_8(x_7 - x_9)$.

The application of this formula is not at all as difficult as its formidable appearance would indicate to the reader.

In making use of this formula it will be advisable at first to draw a rough sketch of the section (Fig. 2) indicating the data from the field book in their proper positions.

A very little practice will enable the engineer to compute the areas directly from his cross-section notes. The formula is not an approximation as are the slope and other formulas, but is mathematically correct. Begin at any point on the section and proceed with the sun or hands of the watch, or counterwise, as one may elect, multiplying each cut or fill in its order by its horizontal distance between the point just preceding and the point just succeeding. In the above rough sketch I begin at $\frac{y_1}{x_1}$ or $\frac{6}{15}$ and I multiply the ordinate y_1 or 6 by the horizontal distance between $\frac{8}{22}$ or $\frac{y_9}{x_9}$ and $\frac{9}{12}$ or $\frac{y_2}{x_2}$ —the preceding and the succeeding. Thus

$$
\begin{array}{lcrcrl}
y_1(x_9 - x_2) = 6 \times 10 = & 60 & \\
y_2(x_1 - x_3) = 4 \times 8 = & 32 & \\
y_3(x_2 - x_4) = 5 \times 18 = & 90 & \\
y_4(x_3 - x_5) = 2 \times 19 = & 38 & \\
y_5(x_4 - x_6) = 9 \times 13 = & 117 & \\
y_6(x_5 - x_7) = 6 \times 2 = & \ldots & -12 \\
y_7(x_6 - x_8) = 0 = & — & \\
y_8(x_7 - x_9) = 0 = & — & \\
y_9(x_8 - x_1) = 8 \times 5 = & \ldots & -40 \\
\hline
 & 337 & -52
\end{array}
$$

$$\frac{337 - 52}{2} = \frac{285}{2} = 142.5 \text{ sq.ft.}$$

In cases where one passes to the left (as I did at $\frac{6}{19}$ or $\frac{y_6}{x_6}$ in measuring the horizontal distance from the point just preceding to the point just succeeding, the product obtained by multiplying this distance by the cut or fill, at the intermediate point, is of one sign, and in cases where one passes to the right it is of the opposite sign.

Take one-half the difference between the sums of the products of opposite signs, and the result is the area of the section.

Thus in a side-cut where only the slope stake reading and the intersection of the earth surface with the grade-line are taken, the area is a simple triangle, and the application of the formula to the computation of the area would seem to require three multiplications. Two

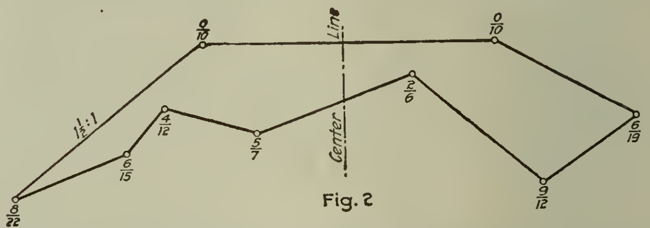


Fig. 2

of the points, however, are on the grade-line and the cut, or fill, is zero; hence the product is zero. The formula, therefore, results in a single multiplication and taking one-half the product of the fill (or cut) and width. In the "three level" case, two multiplications are eliminated. Many useful and interesting uses of the formula appear as its application is extended.

Shipping Board Has Nine Million Tons of Merchant Vessels

According to its latest statistical compilcation the U. S. Shipping Board owns and controls a total gross tonnage of vessels amounting to 9,243,464. This comprises 1493 ships, of which 1388 are cargo, 28 cargo and passenger, 59 tank, 15 refrigerator, and 3 transport vessels. About one-ninth of the total consists of wood, composite and concrete ships, including 271 wood and composite, of 997,854 tons, and 4 concrete, of 13,500 tons.

A Dozen Articles for

the "Average Engineer"

Estimation of Conduit Capacity in Relation to Storage

By Frederic H. Hapgood
With Hazen, Whipple & Fuller, Consulting Engineers, New York City

ONE of the problems encountered in connection with studies for a new water supply for New Britain, Conn., was finding the most economical combination of capacities of a retarding reservoir and a pipe line to provide a sufficiently complete development of the drainage area selected. The computations for this purpose here given were made by the writer in the office of Hazen, Whipple & Fuller, New York City.

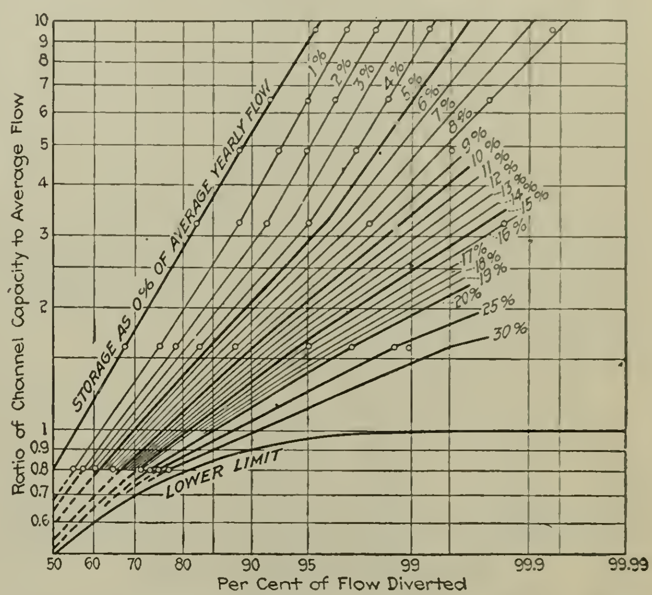
The areas from which it is proposed to take water to New Britain are about ten miles away. Upon investigation it was found that it would be impracticable to build a storage reservoir of sufficient size on the watersheds themselves, because at points where storage might be provided the extent and coarseness of the materials underneath the dam sites made a tight dam impracticable and at the point where it was practicable to build a fairly tight dam the contour of the country was such that sufficient storage could not be provided. Near the city, however, there is a favorable site for a sufficiently large storage reservoir. It would require too expensive a pipe line to bring the flood flows of the stream to the reservoir, but by providing a retarding reservoir at the inlet end of the pipe line a smaller pipe will serve. The larger the reservoir, the smaller the capacity of the pipe line may be.

Since the records of flow from the area covered too short a period, search was made for a reliable, long-term record taken on some similar area. The records of the daily flow of the Manhan River in Southampton, Mass., from 1897 to 1915 inclusive, started under the direction of James L. Tighe, formerly city engineer of Holyoke, Mass., were chosen. Therefore, the following calculations apply directly only to watersheds similar to that of the Manhan River.

The capacity of a diverting conduit depends upon three variables: (1) The size of the stream measured by its average annual flow; (2) the portion of the total flow of a stream that it is desired to divert, and (3) the size of the retarding reservoir that it is convenient to build at the inlet end of the conduit. The best method of finding out the relations existing between several variables is by means of a diagram, and consequently a diagram was constructed. Points on this diagram were found by computing the amount of water that would run to waste if an assumed rate of draft drew water from an assumed retarding reservoir that was being filled by the flows recorded for the Manhan River. The quantity of water diverted would be the difference between the total flow and this computed waste.

In these computations the following assumptions were made: (1) It was assumed that the conduit was always wide open. (2) The retarding reservoir was considered large enough to take care of the hourly fluctuations in flow. (3) If any water was left in the retarding reservoir at the end of the 19-year period, it was assumed that the period would repeat itself and the computations were continued by starting again with the earliest year, but with the reservoir containing the water left in it at the end of the last year, and by computing the amount wasted until the reservoir was emptied, thus starting and ending with an empty reservoir.

With these assumptions, computations of the amount of water that would run to waste were made for several rates of draft and for several sizes of retarding reservoir sufficient to cover the entire desired range. These computations were more tedious than difficult. For instance, take the lowest draft assumed, which was 1,000,000 gal. per day per square mile. To find the waste at this rate it was necessary to go through the records of each day's flow for the whole 19 years and set down the amount by which that day's flow exceeded or was less than 1,000,000 gal. The sum of all the excesses gave the waste if there were no storage. But, with a retarding reservoir of a certain size the first



RELATION BETWEEN CAPACITIES OF CONDUIT AND STORAGE RESERVOIR

water above the assumed 1,000,000-gal. draft was held until the pipe took it or until the retarding reservoir had been filled. After the retarding reservoir had been filled, if the flow continued above the pipe capacity the excesses mentioned above could be estimated as going to waste. When the flow became less than the 1,000,000-gal. draft, the reservoir would begin to empty and there would be no waste. In working out the waste at one rate of draft and with several assumed reservoir capacities, a table was arranged by which it was unnecessary to repeat the entire calculation and much repetition of work was avoided. The resulting quantities of waste were figured as percentages of the total flow for the whole period. The differences between these and 100 per cent gave the portions of the flow that could have been diverted.

By expressing conduit and reservoir capacities in terms of average flows, the results were reduced to a common basis and became generally applicable to similar watersheds. From these results the curves shown herewith were plotted. Logarithmic probability paper was used because the lines appear straighter on it than on any other. The line on the diagram labeled "lower limit" simply shows that where the conduit capacity is

less than the average flow of the stream it is impossible to divert the whole stream through that conduit, the largest amount of course being equal to the capacity of the conduit. As this approaches the average flow of the stream, the sizes of the retarding reservoir necessary to make diversion equal to conduit capacity becomes very large.

The following example will serve to show how the curves may be applied to watersheds similar to that of the Manhan River:

Suppose: Area of watershed, 2.5 sq.mi.; average flow, 455,770,000 gal. per sq.mi.; maximum storage that can be provided in diversion reservoir, 15,000,000 gal.; daily draft required, 2,500,000 gal.

Maximum Storage = 15,000,000 gal. or

$$\frac{15,000,000}{2.5 \times 455,770,000}$$

= 1.32 per cent of average yearly flow.

Average daily draft = 2,500,000 gal. or

$$\frac{2,500,000 \times 365}{2.5 \times 455,770,000}$$

= 80 per cent of flow to be diverted.

From the curves: To divert 80 per cent of the flow by the use of a diverting reservoir whose capacity is 1.32 per cent of the average yearly flow requires a diversion channel whose capacity is 1.9 times the average flow of the stream or

$$\frac{455,770,000}{1.9 \times 365 \times 24 \times 60 \times 60 \times 7.48} = 3.68 \text{ cu.ft.}$$

per second.

Simple Accounting System for an Engineering Office

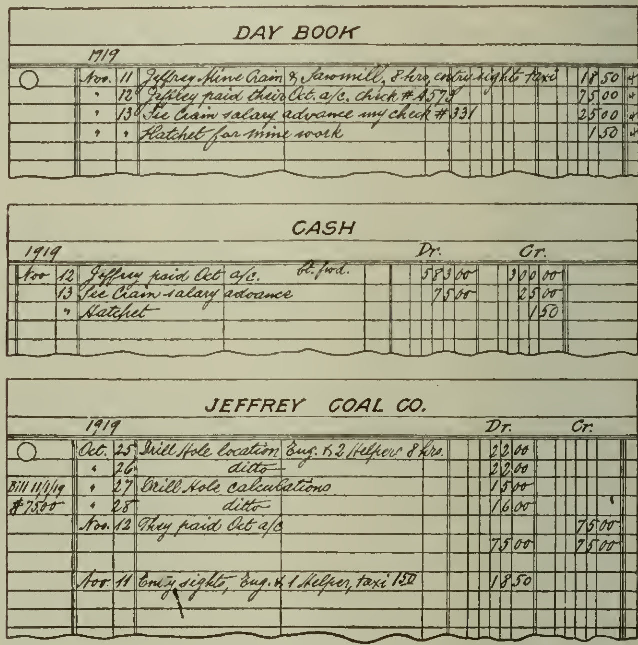
By G. N. Pfeiffer
Consulting Engineer, Herrin, Ill.

WHEN I opened an engineering office one of my problems was to provide a proper system of account keeping. I am not a bookkeeper. At the start I could not afford to employ an experienced man to take care of the books although it was very probable I would do so later on. After a day's work in the field I did not care to spend much time on the books in the evening.

After due consideration I decided that any system, to be adopted, must meet the following conditions: (1) It must be simple. (2) The books must be kept by myself for a time. (3) It must be possible to determine, at any time and in a very short time, the amount due me from any client. (4) The system must permit of expansion with the business. (5) Daily work records must be made by chiefs of parties, and incorporated in the permanent office record. (6) The date and amount of the last statement to any client must be evident at a glance.

Since an engineer with a party is often away from the office for a week or more I decided on a letter-size loose-leaf system, using for simplicity the same form and size of sheet for day book, cash book and ledger. At a local store I bought a holder and some loose leaves already punched and ruled. Part of a page from each of the three books is shown in the illustration.

The posting took but a few minutes two or three times a week. It was only when sending out statements at the end of the month that more time was needed. None of the engineers or helpers had access to the books, except in the case of the one sheet containing the daily work records. At the end of the month, or when full, this one sheet was filed with any other records.



TOPS OF DAY BOOK, CASH BOOK AND LEDGER PAGES SHOWING ENTRIES AND NOTATIONS

An entry in the day book, when posted on the credit side of the cash book or ledger, had a check mark placed after it; when posted on the debit side it was followed by a cross-check mark; and it was followed by the latter superimposing the former when posted to credit in one book and debit in the other. From these marks I could tell whether I had posted all the items I cared to post. Another notation for convenience was to write in the left margin the date and amount of statement rendered. The notations are shown in the sample sheets illustrated.

The foregoing system worked out successfully for me, and later, when the business expanded and a firm was formed, it was easily modified to suit.

Results of Cleaning Water Mains

The distribution mains in the southern section of the city were laid during the eighties, and therefore after thirty-five years of service their carrying capacity, due to tubercles, have been reduced to less than 40 per cent of that of new pipe. Upon authority, the Department cleaned a total of six miles of 6-in. mains throughout the older portions of the city during the summer and fall. A test to determine the loss of head or friction before and after cleaning showed that on an average the carrying capacity of the mains for the same loss of head had been increased to 2.6 times the capacity before cleaning. The total cost of the work, including labor, materials and royalties, was $3,267.84 or 10.32 cents per foot.—J. E. Gibson, Manager and Engineer Water-Works, Charleston, S. C., in annual report for 1919

the "Average Engineer"

Table for Use in Converting Stations to Miles

By R. T. Brown
Chief of Surveys, State Highway Department of South Carolina

The table given herewith will be of service to engineers who frequently have occasion to convert stations to miles and vice versa. This applies especially to highway engineers. When such a table is not on hand, and one does not wish to go to the refinement of actually dividing out the stations to convert to miles, the following method will be found convenient and correct to within one tenth mile up to twenty miles:

Place decimal point between tens and hundreds in the number of stations. Multiply by two. From result subtract number of stations with decimal point to left of hundreds.

Example—Convert 317 + 00 to miles. 3.17 × 2 = 6.34, 6.34 — 0.317 = 6.02 miles. Actual distance is 6.004 miles. With the table given below as a basis this computation can very easily be performed mentally when looking at a map or driving along the road.

CONVERSION TABLE—STATIONS TO MILES
TENTHS OF MILES

Mi.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0+00	5+28	10+56	15+84	21+12	26+40	31+68	36+96	42+24	47+52
1	52+80	58+08	63+36	68+64	73+92	79+20	84+48	89+76	95+04	100+32
2	105+60	110+88	116+16	121+44	126+72	138+00	137+28	142+56	147+84	153+12
3	158+40	163+68	168+96	174+24	179+52	184+80	190+08	195+36	200+64	205+92
4	211+20	216+48	221+76	227+04	232+32	237+60	242+88	248+16	253+44	258+72
5	264+00	269+28	274+56	279+84	285+12	290+40	295+68	300+96	306+24	311+52
6	316+80	322+08	327+36	332+64	337+92	343+20	348+48	353+76	359+04	364+32
7	369+60	374+88	380+16	385+44	390+72	396+00	401+28	406+56	411+84	417+12
8	422+40	427+68	432+96	438+24	443+52	448+80	454+08	459+36	464+64	469+92
9	475+20	480+48	485+76	491+04	496+32	501+60	506+88	512+16	517+44	522+72
10	528+00	533+28	538+56	543+84	549+12	554+40	559+68	564+96	570+24	575+52
11	580+80	586+08	591+36	596+64	601+92	607+20	612+48	617+76	623+04	628+32
12	633+60	638+88	644+16	649+44	654+72	660+00	665+28	670+56	675+84	681+12
13	686+40	691+68	696+96	702+24	707+52	712+80	718+08	723+36	728+64	733+92
14	739+20	744+48	749+76	755+04	760+32	765+60	770+88	776+16	781+44	786+72
15	792+00	797+28	802+56	807+84	813+12	818+40	823+68	828+96	834+24	839+52
16	844+80	850+08	855+36	860+64	865+92	871+20	876+48	881+76	887+04	892+32
17	897+60	902+88	908+16	913+44	918+72	924+00	929+26	934+56	939+84	945+12
18	950+40	955+68	960+96	966+24	971+52	976+80	982+08	987+36	992+64	997+92
19	1003+20	1008+48	1013+76	1019+04	1024+32	1029+60	1034+88	1040+16	1045+44	1050+72
20	1056+00	1061+28	1066+56	1071+84	1077+12	1082+40	1087+68	1092+96	1098+24	1103+52
21	1108+80	1114+08	1119+36	1124+64	1129+92	1135+20	1140+48	1145+76	1151+04	1156+32
22	1161+60	1166+88	1172+16	1177+44	1182+72	1188+00	1193+28	1198+56	1203+84	1209+12
23	1214+40	1219+68	1224+96	1230+24	1235+52	1240+80	1246+08	1251+36	1256+64	1261+92
24	1267+20	1272+48	1277+76	1283+04	1288+32	1293+60	1298+88	1304+16	1309+44	1314+72
25	1320+00	1325+28	1330+56	1335+84	1341+12	1346+40	1351+68	1356+96	1362+24	1367+52
26	1372+80	1378+08	1383+36	1388+64	1393+92	1399+20	1404+48	1409+76	1415+04	1420+32
27	1425+60	1430+88	1436+16	1441+44	1446+72	1452+00	1457+28	1462+56	1467+84	1473+12
28	1478+40	1483+68	1488+96	1494+24	1499+52	1504+80	1510+08	1515+36	1520+64	1525+92
29	1531+20	1536+48	1541+76	1547+04	1552+32	1557+60	1562+98	1568+16	1573+44	1578+72
30	1584+00	1589+28	1594+56	1599+84	1605+12	1610+40	1613+68	1620+96	1626+24	1631+52
31	1636+80	1642+08	1647+36	1652+64	1657+92	1663+20	1668+48	1673+76	1679+04	1684+32
32	1689+60	1694+88	1700+16	1705+44	1710+72	1716+00	1721+28	1726+56	1731+84	1737+12
33	1742+40	1747+68	1752+96	1758+24	1763+52	1768+80	1774+08	1779+36	1784+64	1789+92
34	1795+20	1800+48	1805+76	1811+04	1816+32	1821+60	1826+88	1832+16	1837+44	1842+72
35	1848+00	1853+28	1858+56	1863+84	1869+12	1874+40	1879+68	1884+96	1890+24	1895+52
36	1900+80	1906+08	1911+36	1916+64	1921+92	1927+20	1932+48	1937+76	1943+04	1948+32
37	1953+60	1958+88	1964+16	1969+44	1974+72	1980+00	1985+28	1990+56	1995+84	2001+12
38	2006+40	2011+68	2016+96	2022+24	2027+52	2032+80	2038+08	2043+36	2048+64	2053+92
39	2059+20	2064+48	2069+76	2073+04	2080+32	2085+60	2090+88	2096+16	2101+44	2106+72
40	2112+00	2117+28	2122+56	2127+84	2133+12	2138+40	2143+68	2148+96	2154+24	2159+52
Hundredths of mile.		0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
Equals in feet		52.8	105.6	158.4	211.2	264.0	316.8	369.6	422.4	475.2

A Simple System of Indexing Notes and Plans

Filing by Location Preferred to Other Methods—Key Map Has Numbered Areas—Loose Leaf Ledger Used

By F. Deane Avery
Engineer and Architect, Greenfield, Mass.

From time to time there have appeared various articles describing indexes for notes and plans but most of them seem to me to be more complex than necessary for an ordinary engineering and surveying office. In planning such an index we should keep in mind the essentials which I believe are three in number: Speed in indexing; speed in finding; and positive action.

First, to make an index which can be maintained in the least time: The systems most in favor seem to be some form of card index with cross indexes, but a cross index takes time. About the simplest have two cards—one for the owner's name and one for the subject—while a system which gives also the adjoining owners and the location will require eight cards for the survey of an ordinary city lot. It takes twice as long to write two cards as it does for one, so that a one-card system saves on the cost of indexing, which is the first object on our list.

Second, to make an index which will save time in

searching for things: Before deciding this let us consider under what conditions we start our search, as for example, for field notes of John Jones' lot on North St. We may know that a survey was made for him a few years ago and in that case the ordinary name index will find the data promptly. If, as is usually the case, we do not know whether there are any notes of a previous survey, we are all at sea.

The average man will look up Jones and finding nothing will address a question to the office in general as to whether anyone knows of such a survey. That usually ties up the whole office and finally after looking up several names which might be near there it is decided that probably there are no old notes.

Third, to make an index that will be positive in action so that we can *either find what we want or prove that there is no such thing!* As shown above the greatest trouble is to prove that there are notes or maps of the territory or structure in question. Any index of names is of use only to the man who remembers what name to look for. Any index by subjects is usually too large to be efficient. Any index by location requires areas small enough so that it can be quickly gone over.

Index by Location Preferred

Filing by location, in my opinion, is the whole secret of successful indexing of surveying notes. It is difficult to imagine wanting notes or a map of any spot without knowing where the spot is located. My own index is based on that principal and I will outline it briefly for the benefit of any who care to use it.

I have divided my territory small enough so that a page will be sufficient for indexing everything within that area. These areas are indicated on maps (two in my case) and a number assigned to each area. In this city it means that practically each block has a number, but in the outside districts one number is still sufficient for an entire town. I have one book for plans and one for notes and all notes or plans for any block are indexed on the page corresponding to the number of the block. That is if block 60 is bounded by north, east, south and west streets, all notes and maps for that block will be indexed on page 60 of the proper index book.

A map would appear on the index as "John Jones, Lot Survey, Lot 83, North Street near East—Date, Scale, Kind, File number." The brief description fixes it so that one seldom has to go beyond the index to find out whether it is the plan wanted.

In addition to the numbers showing locations on the map I have assigned one number for general maps of the city, one for maps outside the territory covered by the key map, and one for buildings. The last is because I do certain kinds of architectural work and in addition to the location index I keep a list of buildings separated according to kinds. Street plans, which are few in number, take the numbers to south or east, except that long plans may be under the general map of the city.

Subdivision plans are indexed under every block covered.

Tables are not indexed as maps but are listed in a card index with other miscellaneous data. A page could be added for these if desired.

This system takes less time to maintain or use than any other index I ever saw. Most items require one entry only, and as there is no question where to index there is also no question where to look for it later.

A Dozen Articles for

I use a loose leaf ledger although the system would be the same if one preferred cards. After experience in charge of four different offices—two of which had card indexes—I will say that in my opinion the loose leaf is far superior for this purpose. The chances for error are less than with a card index. Cards may be misplaced or lost or overlooked, but pages that are numbered and in order can always be found, and it is much simpler to glance over twenty items on one page than to look over twenty cards one by one. The only advantage of loose leaf over a bound book is that pages can be rewritten if soiled, or if one wants to further divide the territory.

Abstracts of deeds, and descriptions written for deeds with accompanying correspondence are put in bundles, numbered according to the key, and kept in numerical order, in drawers. These could be indexed but I have not thought it worth while in my case.

I believe that the majority of plans are best filed flat but whether flat or rolled use standard sizes and do not put two sizes in a drawer or pigeon hole. If one cares to do so it is easy to subdivide by subject on each page but I prefer to keep the areas so small that it is not necessary. I use two colors of ink—green for notes and maps made before I came into the office, and black for those since. Maps which are referred to frequently are often indicated by a red mark on the margin.

It costs something to make a good index but after that it is a time saver and a constant source of satisfaction. In my opinion a location index is the only one of any value to any one except the one who makes it, and for that reason most of the old survey notes are lost to future generations.

Permit me to repeat the essentials. Divide your territory into areas, assign a number to each area, and have a corresponding page in the index book. Put plans of a size together and describe locations as fully as possible in the index. As time permits get the old notes into the new index, and then get your competitors to use the same system—perhaps the same key map. If surveyors could easily find old records and would consult with each other there would be fewer discrepancies and their reputations would be enhanced.

Weight of Rail in Tons

By George W. White
Assistant Engineer Southern Railway

WEIGHT of rail in gross tons (2240 lbs.) for various sizes from 45 lb. to 100 lb. per yard and from one to nine feet in length, figured to nine decimal places for one foot and to eight places for other lengths may be readily calculated by use of the accompanying table. By shifting the decimal point, the weight to three decimals for any length up to two million feet will be given.

To use the table, select from the column of tons, under the proper weight of rail, the figures opposite the number of feet desired, using each digit of the number separately, and moving the decimal point to correspond with the position of that digit Then add these figures together. Use only the number of decimal places desired in the result, and notice the fraction added or discarded

the "Average Engineer"

in each case so as to adjust the total to the nearest figure.

These tables are especially serviceable if an adding machine is available for use in connection with them. They will be found to be great time savers, where there is much figuring of this sort to be done.

WEIGHT OF RAIL IN TONS PER FOOT OF LENGTH — 45 LB. TO 100 LB. SECTIONS

Ft.	Tons 45 Lb. Rail	Ft.	Tons 50 Lb. Rail	Ft.	Tons 56 Lb. Rail	Ft.	Tons 60 Lb. Rail
1	006 696 429	1	007 440 476	1	008 333 333	1	008 929 571
2	013 392 86	2	014 880 95	2	016 666 67	2	017 857 14
3	020 089 29	3	022 321 43	3	025 000 00	3	026 785 71
4	026 785 71	4	029 761 90	4	033 333 33	4	035 714 29
5	033 482 14	5	037 202 38	5	041 666 67	5	044 642 86
6	040 178 57	6	044 642 86	6	050 000 00	6	053 751 43
7	046 875 00	7	052 083 33	7	058 333 33	7	062 500 00
8	053 571 43	8	059 523 81	8	066 666 67	8	071 428 57
9	060 267 86	9	066 964 29	9	075 000 00	9	080 357 14
	65 Lb. Rail		70 Lb. Rail		75 Lb. Rail		80 Lb. Rail
1	009 672 619	1	010 416 667	1	011 160 714	1	011 904 762
2	019 345 24	2	020 833 33	2	022 321 43	2	023 809 52
3	029 017 86	3	031 250 00	3	033 482 14	3	033 714 29
4	038 690 48	4	041 666 67	4	044 642 86	4	047 619 05
5	048 363 10	5	052 083 33	5	055 803 57	5	059 523 81
6	058 035 71	6	062 500 00	6	066 964 29	6	071 428 57
7	067 708 33	7	072 916 67	7	078 125 00	7	083 333 33
8	077 380 95	8	083 333 33	8	089 285 71	8	095 238 10
9	087 053 57	9	093 750 00	9	100 446 43	9	107 142 86
	85 Lb. Rail		90 Lb. Rail		95 Lb. Rail		100 Lb. Rail
1	012 648 810	1	013 392 857	1	014 136 905	1	014 880 952
2	025 297 62	2	026 785 71	2	028 273 81	2	029 761 90
3	037 946 43	3	040 178 57	3	042 410 71	3	044 642 86
4	050 595 24	4	053 571 43	4	056 547 62	4	059 523 81
5	063 244 05	5	066 964 29	5	070 684 52	5	074 404 76
6	075 892 86	6	080 357 14	6	084 821 43	6	089 285 71
7	088 541 67	7	093 750 00	7	098 958 33	7	104 166 67
8	101 190 48	8	107 142 86	8	113 095 24	8	119 047 62
9	113 839 29	9	120 535 71	9	127 232 14	9	133 928 57

Finding Rivet Pitch in Plate Girders Quickly

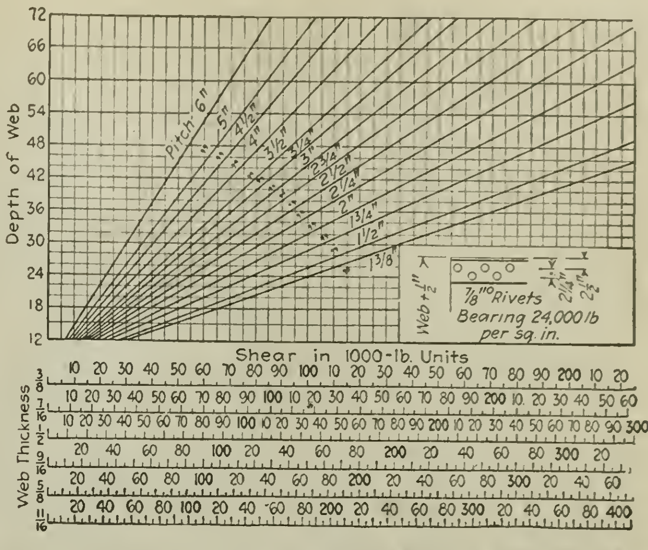
By Ralph Smillie
New York City

In the accompanying diagram for the rapid determination of rivet pitch in plate girders, two lines of ⅞-in. rivets are used as basis of calculation, so that the diagram applies to 6 x 6-in. flange angles. It is based on a bearing value of 24,000 lb. per square inch.

The diagram solves the equation $p = \frac{dV}{S}$ in which p is the rivet pitch in inches, d the depth between centers of gravity of flange rivet lines in inches, V the value of one rivet, and S the shear, the latter two being in the same unit (pounds or thousands of pounds). The value of V obviously varies with the web thickness, but it is convenient to remember that the double shear value of a ⅞-in. rivet is substantially the same as its value in bearing on an 11/16-in. web.

To illustrate the use of the diagram, suppose a girder with 48 x ⅜-in. web carries a shear of 100,000 lb. In the lower scales, for web thickness, select the line marked ⅜, and go vertically from the value 100 (representing 100,000 lb.) on this line to the horizontal line representing 48-in. depth of web. The intersection lies between the sloping lines 3 and 3¼, and the required pitch therefore is 3 in.

When only one rivet line is used the depth for entering the diagram may be taken 2 in. greater than the actual depth and the result will be very close to correct. If the above girder, for example, had 6 x 4 flange angles. 50 in. may be used for the depth, and the pitch will be found to be 3¼ in.



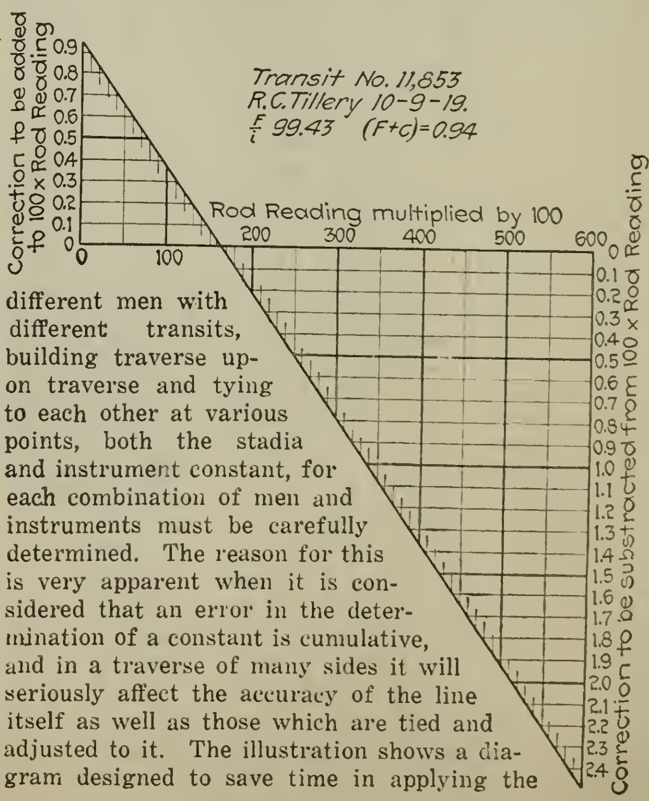
Rivet Pitch Diagram for Plate Girder Flanges, with Two Lines of ⅞-in. Rivets.
For bearing value 24,000 lb. per square inch

Obviously, the diagram is not applicable to railway deck girders or others that carry concentrated loads directly on the flanges.

Practical Method of Applying Stadia Constants

By W. J. Nuebling
Badin, N. C.

For many purposes the stadia constants as determined by the instrument maker are practical, but as these constants vary with the seasons of the year, the age of the instrument, the man, and other factors, very close attention must be given to individual constants when accurate results are required. In a system of surveys wherein lines are run by a number of different men with different transits, building traverse upon traverse and tying to each other at various points, both the stadia and instrument constant, for each combination of men and instruments must be carefully determined. The reason for this is very apparent when it is considered that an error in the determination of a constant is cumulative, and in a traverse of many sides it will seriously affect the accuracy of the line itself as well as those which are tied and adjusted to it. The illustration shows a diagram designed to save time in applying the



stadia and instrument constant to the different rod readings. As these diagrams are easily and quickly made it is handy to have one for each instrument and instrument man. To construct this diagram the constant $(F + C)$ is first laid off to a convenient scale to a point above the line. Next the correction is figured for the maximum sight length, the point is platted either above or below the base line, depending upon whether it is positive or negative, and the points are connected by a straight line. Corrections for the rod readings are indicated on the connecting line where it is intersected by perpendicular lines from the base.

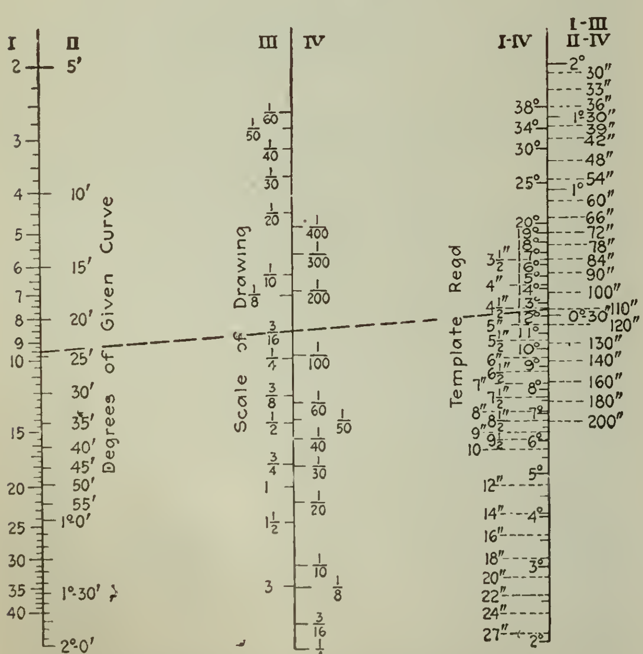
After the correction has been applied to the rod reading the correction for the vertical angle is made by multiplying the corrected rod reading by $cos^2 A$. This method, although not theoretically exact, will check the theoretic formula within a few hundredths of a foot for small angles and one or two-tenths for large angles and distances. Good results can also be obtained in figuring the vertical differences by multiplying the corrected rod reading by $\frac{1}{2}$ *sin.* 2 *A*.

Chart Showing Template for a Given Degree of Curve to Any Scale

By Donald P. Maxwell
Aluminum Company of America

In the *Engineering News-Record*, March 4, 1920, p. 486, there was given a conversion table for plotting curves. This problem is solved particularly well by means of a chart of the alignment type. One devised by the writer and adapted to the curves used in this office, namely, one set marked in degrees to 100 scale, the other marked in inches radius, is submitted herewith.

By doubling the scales the chart is made very compact and no difficulty will be found in reading the chart if attention be paid to the Roman numerals designating the several scales. Thus, if the given curve be found on scale II and the scale of the drawing on scale IV read the required template on scale marked II-IV.



Example: What template must be used for a 9°-30′ curve on $\frac{3}{16}$″ = 1′-0″ Connect 9°-30′ (I) to $\frac{3}{16}$″ (III) and read 110 lb on (I-III) (0°-30′ may be used)

An Auto-Trailer That Carries a 28-Ton Load

In order to move heavy transformers for supplying emergency demands the Southern California Edison Company of Los Angeles designed and built an automobile trailer suitable for carrying 24 tons. This was done when it was found that shipping transformers by rail often required a week or more and left unsolved the problem of getting the heavy equipment from the railroad siding to the exact location desired. Having the equipment out of service even for such a period was a serious loss during times of limited power supply.

The company, therefore, built a trailer, shown in the accompanying illustration, which has successfully handled 28-ton loads. Since it has been used there has seldom been a delay of more than 24 hr. in moving heavy equipment over distances up to 100 mi. wherever destination could be reached over good roads, such being the case in most of the communities served by the company.

HEAVY DUTY TRAILER DESIGNED BY CALIFORNIA CONCERN

Two features of the trailer design are that it is without springs, and the forward axle is arched so that the bed is suspended by king-pin and links. The bed is 18 ft. long and the overall width is 8 ft. 3 in. The diameter of the front wheels is 36 in. and of the rear wheels 42 in. Wheels are equipped with solid rubber tires, the rear tires being 14 in. wide. The lift to the top of the bed is 25 in. and the clearance is 15 in. When handling capacity loads the trailer is usually drawn by a 6-ton. truck with 5 tons of ballast.

The first truck built by the company at a cost of about $2,300 was in constant demand and was found to be so useful that a second one was constructed, the only change in design in the second trailer being the addition of band brakes operated by an 8-ft. level to which a rope from the driver's feet was attached. The design has been copied by three trucking companies.

P. H. Ducker is superintendent of transportation for the Southern California Edison Co.

Qualifications of the Teacher of English for Engineers

VIEWS of older engineers on the subject of teaching English to the undergraduate are unanimously in favor of giving more and better courses. The type of teacher required is a vital point since the student generally is not attracted to English. These are the conclusions reached in a paper presented recently to the Society for the Promotion of Engineering Education by Miss S. A. Harbarger, department of English, Ohio State University. The paper was based on a questionnaire to deans of engineering schools, interested instructors in English, heads of departments and special teachers. Miss Harbarger has had 12 years' experience teaching engineers. Extracts from her paper follow:

The experience of the most successful teachers in English to engineering students seems to have demonstrated convincingly that the college course should start with the students' interest in engineering and should make plain to them that they need English (1) to amplify, reinforce, make clear and extend the range of ideas expressed through drawings and mathematical symbols, (2) to become articulate for the purpose of rendering, through their profession, effective and constructive service to the world, and (3) to be able to take their rightful place among men of other professions as progressive leaders in their communities.

The pronounced characteristics of the engineering student are definiteness, practicality, eagerness and youthfulness. These have a direct bearing upon the English teacher. His own characteristics must be complementary and supplementary if he is to recognize and capitalize these traits and to give his students, through training in the effective communication of ideas, orientation, reach, restraint, balance and power.

First of all, the teacher of English must realize that the engineer needs English as a powerful tool, capable of a variety of uses that will bring financial returns and advance professional prestige. Though he may, before the course is completed, lead out into some of the cultural aspects of English, by subtle references and appropriate comparisons, yet he never loses sight of the fact that engineers need English as a tool. He associates English, therefore, with reality and finds an objective for his students' thoughts, as they express them in speech and in writing, that is within their range and that leads toward their goal. He attempts to guide constructively their imaginations, through system, clearness and accuracy to a fine, honest sense of proportion and relative values and independent thinking. He trains for remorseless and scientific efficiency in the use of words for the purpose of getting tangible results.

Only a few think that the teacher of English should have an engineering degree. But unquestionably he must have an interest in science and some engineering aptitude, whereby he will intuitively understand and sympathize with the problems and ambitions of his students. He must be sincerely interested in the whole aim and trend of engineering education; respect and be stimulated by engineering projects, vast and small; be a good listener and get men to talk enthusiastically of their work. He must have enough knowledge of the hardships and the difficulties that are encountered in an engineering undertaking to appreciate, not only the cost in dollars and cents but in energy and spirit, and to understand the justifiable glow of elation and victory that every engineer has when his work is complete, safe and useful.

The instructor in English must be able to write articles that are acceptable to technical journals and magazines. Definite results of theory wherever they appear always impress engineering students. If in their perusal of technical periodicals—for every good teacher of English will turn the attention of his students early to the current literature of his profession—they come upon articles written by the instructor, the prestige of English and of the instructor rises.

A wide acquaintance with practicing engineers through their writings and through personal friendship is a peculiar asset of the teacher of English. This acquaintanceship is vital if the instructor is to keep his teaching rich, full, forward-looking and telling. He learns from both sources the tendencies of modern engineering thought.

Another qualification in the instructor of English is a phase of personality that gains from the faculty of the engineering college the confidence, the active cooperation, the constructive criticism and the further stressing as a part of every course, of the need and the value of good English for the engineer.

Finally, the vocational guidance instinct should be present in every good instructor of technical students, but the English teacher is likely to have the most accurate and extended information. He deals generally with the first-year men; he has the best source of any instructor of freshmen from which to obtain an intimate knowledge of their aims and aspirations, their previous experience, their immediate difficulties and shortcomings. The instructor in English, through the personal conference with each student, which is a necessary part of the teaching, and through the weekly themes which are written on assigned topics, acquires a very detailed and definite knowledge of his students. To the experienced teacher the themes have much significance, for they indicate the student's state of rest or unrest. The personal conference checks the impression gathered from the themes; consequently the instructor can make some very reliable assumptions. The fatalities among first-year men are great; the unrest and often open dissatisfaction among fourth-year men are too wide spread. Until the data of intelligence tests can be given extended study-application and until colleges can give more time to the study of each individual, there is need for someone somewhere along the line to apply the rudiments of vocational guidance in order to save everyone time and effort.

If engineering faculties and engineering societies would state definitely what they need, take active steps toward recognizing English as a subject fundamental to successful engineering practice, and ask for the teacher with the special qualification, they could raise the standard of English teaching in all engineering colleges.

Moisture Content of Wood Is Not Dependent on Density

Even after long exposure to the same atmospheric conditions, different pieces of wood do not have exactly the same moisture content. Variations of 2 per cent were recently found in red oak blocks stored under carefully fixed humidity conditions at the Forest Products Laboratory. These moisture differences, unlike variations in strength, are apparently independent of the density of the pieces. In the laboratory experiments, the variation proved to be as great in blocks of the same density as it was throughout the lot of specimens. Moreover, the range in moisture content was the same in wood of low density as in wood of medium density or high density.

Data on a few representative specimens are given in the accompanying table:

Density of specimen	Average moisture content in percentage of weight oven-dry. Relative humidty at 80 deg. F.		
	38%	61%	88%
Low			
0.519	7.6	11 2	19.4
0.527	6 0	10.0	17.4
0.536	6.5	11 0	18 2
Medium			
0.630	7.7	11.3	18.9
0.639	5.8	10.7	18.3
0.643	6.8	11.3	19 5
High			
0.720	6 4	11.2	19.3
0.724	7.4	11.4	19.6
0.753	6.1	10 8	18 8
Total average	6 7	11 0	18 8

New Steamship Piers on Staten Island Are Too Narrow

Consensus of Engineering Opinion Is That New York's New Development Is Being Made With Too Great Regard for Present Conditions and Not Enough for Engineering Principles

In "Engineering News-Record," May 27, 1920, p. 107, under the title "New York to Build Steamship Piers on Staten Island," there was published a description of the new Stapleton development now under construction by the city.

The fundamental principle in the design of these piers is that the steamship interests who lease them should dictate the type to be adopted. On this basis eight of the piers are 125 ft. wide with one-story sheds completely covering them; two are 130 ft. wide with complete two-story sheds; and two are 209 ft. wide with two-story sheds 131 ft. wide and with railway tracks and freight-handling equipment on the piers outside the sheds. The latter will also have central railroad tracks but the other piers are not to have tracks though structural provision for such tracks is made in the substructure.

Much discussion has been aroused in engineering circles regarding the inadequacy of these piers, particularly in respect to width and machinery equipment. As stated in the earlier article, the Department of Docks has denied that the body of competent engineering opinion is in opposition to the design. "Engineering News-Record" has thought it worth while to ask the opinion of some of the leading port and terminal engineers as to this particular phase of the Stapleton development. These opinions are printed below; comment upon them appears in the editorial pages.—EDITOR.

Narrow Piers Generally Obsolete

By John Meigs
Consulting Engineer, Philadelphia, Pa.

The recently announced plan of the Department of Docks of the City of New York for the construction of a series of twelve piers in the Stapleton section of Staten Island is perhaps the most extensive and costly project of port development yet undertaken at one time by any American community, if we bar the several marine terminal constructions of the United States Government during the recent war. As such, and because of the national character of the port of New York, the importance of this projected improvement far exceeds mere local dimensions and becomes so widespread in scope that the entire country can legitimately participate in the consideration of its details. It is evident, therefore, that no excuse is needed for comments concerning it on the part of non-residents of the New York district.

That the Dock Department authorities are proceeding in the right general direction in locating this pier group on Staten Island—the only portion of New York City on the continental side of the harbor of New York—is beyond dispute; as additional development of the westerly side of the harbor has been advocated for many years by practically all engineers who have given any study whatever to the problem of the proper future development of the port of New York. The location on the easterly, or European, side of the harbor of the principal trans-shipment piers for freight destined for transfer between the American continent and overseas, or vice versa, has been recognized for many years as being in defiance of the most elementary laws of economics in freight handling.

No legitimate excuse can be offered for the continuance of the absurd practice, in vogue so many years in this port, of transferring overseas freight of continental origin from the railroad termini on the New Jersey shore, by a crude and expensive lighterage system, to the opposite side of the harbor for reloading at that point into ships, when the transfer between the rail carriers and the water carriers could be made with equal facility and a fractional part of the cost at piers on the New Jersey side. For these reasons the department can be heartily commended for its announcement of a policy involving the development of the westerly side of the harbor rather than in the exclusive spending of city funds in further improvement of the easterly side of the harbor for general cargo transference purposes.

Of course, the piers of New York and Brooklyn will continue to be of use for the handling of cargoes intended mainly for distribution within the limits of the boroughs of Manhattan and Queens, and for southern New England generally, and for cargoes made up from these sections for trans-shipment abroad, but for the vast bulk of freight destined for distribution to points south of the Hudson and westwardly through the range of states bordering the Great Lakes, and for freight originating in these sections for trans-shipment abroad, these movements will in future be handled very largely on the New Jersey side of the harbor, or in other ports geographically and hydrographically better situated for this purpose than are Manhattan Island and Long Island, notably the ports of Philadelphia, Baltimore and Norfolk.

Piers Extremely Narrow

Considering the extraordinary importance of the precedent which is now being set by the New York Dock Department, the problems involved in the design of these piers should have had the most careful and even prayerful consideration by the best authorities obtainable on these subjects. Presumably they have been given this consideration, but the result of the careful studies of the Dock Department's authorities is, on the face of the returns, somewhat disconcerting to the average port engineer who is familiar with the modern trend in the design of piers—which is, first, toward a radical increase in their width; second, toward the providing of them with direct railroad connections wherever possible; and, third, toward the equipment of them with modern freight handling machinery for facilitating the loading and discharge of cargo.

The most striking feature of the layout of the Stapleton piers is their extreme narrowness compared with modern piers in other ports. All of the Stapleton piers except two, it is noted, are but 125 or 130 ft. wide,

and this element of the design appears to have been decided mainly by the current practice for generations past in New York City, rather than by any reference to the actual needs of present-day marine cargo handling and storage facilities.

It is generally considered, among port designers, that the transfer sheds for the handling of cargo to and from ships should be planned of sufficient width to accommodate approximately the total bulk of cargo carried by the average vessel, in a length of shed approximately the same as that of the vessel itself. This restriction as to the length of storage area allotted per cargo is in order that the transfer of cargo from its place of deposit on the pier to the vessel, and vice versa, should be through the shortest possible horizontal distance; and as to width, on the theory that properly to take care of both the inbound and outbound cargo, storage space for the equivalent of one complete cargo should be provided on the pier itself opposite each ship berthing thereat.

It is held that the proper place for the assembly of a ship's cargo is on the pier, at the ship's side, and not in railroad cars in holding yards, as is the current practice in the New York district; the piers 125 ft. wide are simply not capable of performing this function. Recent piers in Montreal, Boston, Philadelphia, Baltimore, Norfolk, Seattle and other modern ports range from 200 to 400 ft. in width, and are found to be admirably suited to their purposes and are none too large for economy of operation.

It is argued by the narrow-pier cult that it is foolish for pier owners to provide extra width on piers for the purpose of assembling cargo when the railroad companies are entirely willing to furnish from 20 to 30 days free storage of export freight in cars which are held by them in their terminal yards for delivery to the steamship companies on demand. The economic fallacy of this is perfectly apparent when we consider the relative cost of accommodations for the storage of freight in railroad cars and in pier sheds or warehouses adjacent to the piers. On the basis of present-day freight-car prices, the cost of storage space in cars, including the value of the tracks upon which they stand in the holding yards, is from $8 to $10 per square foot; and, notwithstanding the present tremendously inflated costs of piers and warehouses, similar accommodations can be provided in such structures for not more than one-third to one-half of what car-storage space would cost.

Shortage of Railroad Equipment

The present paralysis of railroad business throughout the country is not ascribable to any one particular cause, being due to many co-ordinate ones, but among these contributory causes none is more important than the unnecessary placing out of commission of cars held in terminal yards, diverted from their proper purpose as mediums of transportation and converted into improper use as portable warehouses for the time-storage of freight. With the crying shortage of railroad equipment that the railroads have labored under for years past, and the tremendous financial difficulties under which they will be compelled to struggle for years to come, it is of primary importance that every means possible be utilized to introduce proper economies in railroad operation. One of the most obvious means of accomplishing this end is by providing facilities at the marine terminals for the immediate discharge of freight cars upon arrival thereat and their prompt reloading and return to the railroads for legitimate use as transportation equipment, instead of holding them indefinitely as mere warehouses, in accordance with present practice.

Naturally, as long as steamship owners and operators are permitted to take advantage of the laxity of the railroads, and the good nature of the American public which is paying the bills, this practice may be expected to continue, but eventually, either now or later—when sane business principles are permitted to govern such matters—this source of lost motion and wasteful expenditure will inevitably be eliminated.

When this time comes, it will be found that the operators of piers of insufficient width to properly take care of the distribution and assembling of ships' cargo thereon will be most seriously handicapped in competition with better equipped terminals, and will then be forced to provide additional pier accommodations or to continue to do business at tremendously greater cost to themselves than their competitors are subjected to.

Another noteworthy feature of the Stapleton pier layout is the failure on most of the piers to take advantage of the opportunity afforded by the proximity of the Baltimore & Ohio R.R. tracks in their rear to make direct rail connection between them and this important trunk-line railroad. When we consider that perhaps 75 per cent of the import freight arriving in New York harbor is destined for transfer into the interior of the country by rail, and that an equal proportion of the export freight arrives by rail, this lack of pier tracks would seem to be an extraordinary omission on the part of the designers.

This apparent mental lapse is, of course, explained by the prevailing and uneconomic system of railroad rates in the New York district. Under this system—which, although it has been in vogue for generations past, cannot continue in defiance of proper economic laws indefinitely—car transfer service by floating equipment is furnished by the railroads free of cost between their terminal yards and all points in the harbor within predetermined lighterage limits. Under this paternal custom it is, of course, more economical for the pier owners to load freight into railroad cars placed, at no expense to themselves, alongside of their piers or ships on car floats kindly furnished by the railroads, than it would be to load the same cars situated on running tracks located on their own piers—which tracks, and the deck area occupied by them, would have to be provided at their own expense.

The argument of the New York Dock Department that piers without tracks are satisfactory to their tenants and are therefore justifiable, is valid only so long as the system of free lighterage of railroad cars continues. The moment this inherently vicious practice is abolished—as it is bound to be in time, in the distant if not in the near future—from that time forward the absolute necessity for railroad connections on piers will be manifest. Piers not so provided, and therefore subjected to the additional cost of car transfer by water between the ship and some distant railroad yard, will be so severely handicapped in the competitive handling of freight that the owners will be found to suffer financial losses therefrom.

As to the mechanical equipment of these piers, or lack

of it, as mentioned in their published description, it would be quite impossible to form any proper conception of the necessities of the case without knowing at least to some extent for what purpose it is anticipated the piers will be used. Sufficeth to say that in these days of increased cost and decreased efficiency of manual labor, the wise pier operator will see to it that every advantage is taken of the opportunity afforded by the output of our ingenious freight handling machinery manufacturers to perform as much as possible of the labor of handling and rehandling freight mechanically, and as little as may be manually.

Defects in Design

Without intending personal criticism of the authorities in charge of this public improvement, I am forced to the belief that this pier group has been planned with no thought of the opportunity presented by it of linking these extensive marine terminals directly to the tracks of the thirteen great trunk-line railroads which now cross the Jersey meadows immediately in rear of Staten Island; too little in accordance with the best modern conceptions of port design, and too much along the lines of former practice on Manhattan Island.

Manifestly the radically improved methods of cargo handling possible on the Staten Island shore, located on the continental side of the harbor, have been entirely overlooked in the hurry and pressure under which the Department presumably has had to provide these piers to comply with the feverish demands for additional space from intending tenants of these structures.

It may now be too late to consider the foregoing principles of design in connection with the present pier project, but for the City of New York to proceed indefinitely along these archaic lines, without reference to the keen and intelligent competition which it is meeting from other and more progressive ports on the Atlantic seaboard, would be not only incredibly stupid business policy for the municipality, but eventually will become suicidal so far as its hope of maintaining its long-continued port supremacy is concerned.

Controlling Principles Indicate Need For Wider Piers

By William S. Wilgus
Consulting Engineer, New York City

It seems to the writer that the fundamental cause for the difference of opinion as to how the Stapleton improvement should be planned lies in the conception of the purpose of the pier. In your issue of May 27, it is stated that the Dock Department "considers that the elemental function of a pier is to furnish shelter to a ship." The writer is among those who believe that its primary purpose is the affording of safe means for the economical interchange of freight between land and water carriers, and that to accomplish that object in the best manner there should be, (1) exterior tracks on the pier for the direct transfer of certain commodities (including war supplies) between ship and car, (2) ample contiguous "transit area," shedded in whole or part, for the sorting and temporary storage of cargo, and (3) interior tracks and driveways for direct interchange between the transit area, railroad cars and motor trucks.

In piers as long as those at Stapleton, 1,000 ft., later to be extended to upward of 1,300 ft., there should be two exterior tracks adjacent to each stringpiece, and not less than four interior tracks, all arranged so that the working of ship and transit areas may be uninterrupted while loaded and empty cars are being shifted.

Piers Should Be 340 Ft. Wide

The transit area on each side of the pier should be sufficiently wide to accommodate modern vessels with cargoes equivalent to from 10 to 15 tons per linear foot of stringpiece, requiring from 80 to 120 ft. in width of transit area on each side of the pier, to which should be added ample driveway space for motor trucks.

To meet these obvious requirements the pier should be *not less* than 340 ft. wide.

That such a width is by no means unusual, or confined to the practice of the northwestern Pacific coast, is shown by the dimensions adopted at many Eastern ports such as Montreal, Halifax and Philadelphia, as well as at the leading European and South American ports.

Were Stapleton like Manhattan, completely severed from direct contact with the trunk lines in New Jersey, and hampered like that island with cramped quarters and congested surroundings which deny to it the promise of future relief in that respect, there would be some excuse for the modeling of the improvements at Stapleton after those in vogue in Manhattan, namely, narrow trackless piers served by lighters.

However, the circumstances are not similar. At Stapleton the waterfront, with its roomy surroundings and deep channel, is already directly in touch by rail with five of the trunk lines that serve the port, and ultimately will be connected with all of them by means of a projected outer belt line.

To ignore this difference in circumstance simply fastens on the port a continuance of the use of the "lighterage proposition," which is so largely responsible for the deserved stigmatizing of this port as "the terminal sore spot of the Nation." Whatever is done here will have a large influence on future planning at Jamaica Bay and other points on Long Island, where the opportunities for direct rail connection with the trunk lines and plenty of elbow room for expansion will be equal to those at Stapleton.

That lighterage is an evil to be avoided to the fullest possible extent is self-evident when we realize that it involves the expense and delay of two additional handlings and intermediate floatage of all freight transshipped in that manner between rail and water carriers, coupled with the enforced use of costly waterfront railroad yards and other waterfront facilities for the transferring of freight between the rail termini and the lighters. To the extent that direct contact can be established between the water and rail carriers at piers on which those agencies may meet without the interposition of lighterage, to just that extent will the port of New York be freed from the shackles which are retarding its progress.

It will therefore be seen that the wide pier with direct rail connections, ample space for sorting and temporarily storing cargo, and suitable facilities for motor trucks, will have a compelling influence on the reduction of costs and delays—a condition which must be brought about if New York is to hold its pre-eminence as the leading port of the world.

As regards mechanical equipment on the piers, it is true that there are differences of opinion, as illustrated at Stapleton itself, where one steamship interest favors the adoption of gantry cranes and another opposes their installation. Does not this conflict of judgment prove the necessity for the consideration of the matter from a broad and *disinterested* standpoint with a view to reaching a decision that will be beneficial to the port as a whole? Eventually, these piers are to revert to the city, and when that time arrives they should be adapted to the widest possible use rather than restricted to a narrow purpose.

Then, too, war necessities may arise which will impose upon these piers a duty not now contemplated by the prospective lessees. Our experience in the World War, both in this country and in France, proved the necessity for modern cranes for the speedy handling of miscellaneous cargoes direct between car and ship. In fact the experience of the army brought out very clearly the great advantage of mechanical equipment for the prompt release of vessels—a consideration of the first importance from both commercial and military standpoints. Nor should sight be lost of the need for mechanical equipment for the transferring of freight between the piers and water craft unequipped with self-handling devices, as is the case for instance with canal barges. The State of New York is spending many millions to equip its canal terminals with freight-handling devices; does it not seem curious that the City of New York should create modern water terminals and in large degree ignore that feature?

All this leads up to the point that in the designing of the piers at Stapleton, the conflicting views of the prospective lessees should not be permitted to dominate. This is a function that should be jealously retained by the city authorities whose broad knowledge of the subject, wide vision as to the future, and strength of purpose should be sufficient to plan these improvements as they should be planned, along logical lines and in recognition of the fact that the conditions which have thwarted modern development on Manhattan Island are, fortunately, absent in the case of Staten Island. That is the one borough in the city which lies west of the Hudson channel and therefore contiguous to the mainland, and which therefore is in touch with the trunk lines that connect the port with the Nation at large.

Wider Piers Necessary For Economy

By Frank G. White
Chief Engineer, Board of State Harbor Commissioners, San Francisco, California

The Staten Island harbor improvement project is of great interest to all engineers who are connected in any way with terminal development. It comes somewhat as a surprise, however, to learn that in planning "the largest steamship pier project in the history" of the city, advantage was not taken of the opportunity to develop a modern, fully co-ordinated steamship and rail terminal. Undoubtedly local conditions and local customs governing the delivery and handling of freight influenced the decision as to the plans, but it seems possible that the construction of a well-planned, fully-equipped terminal might assist in bringing about changes in these customs and a reduction in the terminal handling costs.

It would appear that piers as narrow as 125 to 130 ft. would be entirely inadequate to permit of the economical handling of cargo between ship and car, truck or lighter if the full berthing capacity of the pier is utilized. As these piers are to be from 1,030 to 1,137 ft. in length, each will berth four cargo ships having a capacity of at least 10,000 tons. At least 32 ft. of the width of the pier will be occupied by the two railroad tracks and the necessary runways for loading and unloading cars. There remains inside the shed, with no allowance for driveways, a width of not more than 82 ft. which means that the available space on the pier for handling each 10,000 tons cargo is approximately 41 x 550 ft. or 22,550 sq.ft. With a proper allowance for trucking aisles not more than 20,000 sq.ft. will be available for stacking cargo. Theoretically, this area will hold 5,000 tons of dead-weight cargo or 5,000 tons of measurement cargo stacked 10 ft. high, but practically it is very unlikely that more than one-third of a mixed cargo of 10,000 tons can be accommodated within the space available This means that during the period of loading or discharging at least two-thirds of the cargo must be brought to, or removed from, the pier by car, truck or lighter. If adequate storage were available immediately adjacent to the pier this movement would be greatly facilitated, but the plans do not indicate that warehouses are contemplated to operate in conjunction with the pier.

In the event of railroad congestion or delays from other causes such a movement of cargo during loading or discharging would materially retard operations and delay the dispatch of the ship. Of course a large part of the cargoes are handled by lighter and will continue to be so handled but obviously rail shipments can be transferred much more economically and expeditiously by rail than by lighter. This naturally brings up the question of the proper location and arrangement of tracks on the pier.

San Francisco's Experience

Experience in the operation of the harbor of San Francisco, where practically all of the piers have direct rail connections, has proved the great disadvantage of center tracks inside the sheds. On two piers so constructed the congestion caused by cars, teams, motor trucks and hand-trucks all operating in a center driveway so detracted from their efficient operation that the inside flush tracks were removed and one depressed track was constructed along the side of each pier. Furthermore, the location of tracks along the edge of the pier permits of the direct interchange of cargo between ship and car which in many cases is a distinct advantage. Also it has been found that there is considerable economy both as regards expense and space required for the movement of freight if the tracks are depressed so as to permit of trucking into cars on the level.

The development of mechanical equipment for the handling of miscellaneous cargoes is in its infancy and the problem is not easy of solution. Many types of machines have been used and any such installation is a step in the right direction. Perhaps the most satisfactory equipment has not yet been designed but it would seem to be good judgment to construct a modern terminal so as to permit of the installation of mechanical equipment for the handling of cargo between ship and pier, on the pier itself and between pier and warehouse.

In connection with the development of a new section

of the San Francisco waterfront we are making studies which contemplate piers from 315 to 330 ft. in width. Each pier will have two separate sheds with depressed tracks between the sheds, flush tracks adjacent to the slips and provision for mechanical equipment. Ample railroad yard and warehouse facilities will also be provided.

In my opinion the two Staten Island piers which are to be 209 ft. in width, with outside depressed tracks and semi-portal cranes, will permit of greater economy in the handling of cargo and greater speed in dispatching the ship than the narrower piers with inside tracks and no mechanical equipment.

Lighterage Should Not Control New Development

By Fay, Spofford & Thorndike
Consulting Engineers, Boston, Mass.

Of the twelve new piers designed for Stapleton, ten are narrow, either 125 or 130 ft. in width, and the other two are 209 ft. in width. It is understood that the width of these piers was determined by the Department of Docks from the requirements of the lessee in each case. Since the method of handling cargoes from and to ships in New York harbor is at present largely by means of lighters, it has been customary to build narrow piers which serve principally as structures to which ships can tie up while loading and unloading to and from lighters, only a relatively small amount of space being available on the pier for the storage of incoming and outgoing cargoes. These narrow sheds are entirely inadequate for the storage of incoming and outgoing cargoes for ships berthed simultaneously on both sides of the piers.

The Stapleton piers differ from the Manhattan piers in that they have direct connection with a railroad, the Baltimore & Ohio, which in turn connects with all the Jersey railroads. We would expect that less freight would be handled by lighters from and to ships here than is the case with the Manhattan piers, and, therefore, more space should be devoted to the storage of cargo, to tracks and mechanical handling devices.

The narrow piers at Stapleton have no mechanical equipment for the handling of freight from and to ships other than simple cargo beams and the accompanying cargo hoists. If the greater portion of the ships docking here are unloaded and loaded to and from lighters, mechanical equipment is perhaps not so essential, as the cargo can and probably will be handled by the equipment of the lighters or of the ships themselves.

Up to the present time, it apparently has been found in New York harbor that the operating com panies prefer to use the ship's tackle rather than mechanical equipment installed on the piers. The question of the use of such equipment is a matter of dollars and cents; that is, whether it costs more to pay the charges for mechanical equipment and to operate it with the resulting saving of the time the ships are in port, or to use the ships' own tackle which otherwise would be idle, and thereby lose a greater or less amount of time due to the slower loading and unloading.

With the continued improvement of mechanical handling devices and the increasing cost of labor, we expect the use of mechanical equipment for piers having ample railroad connections will materially increase in the near future.

These piers have been designed for a floor load of 500 lb. per sq.ft. and, with general package freight, would allow tiering to a height of 15 ft. more or less. This can be done economically only by the utilization of mechanical tiering equipment.

Wider Piers Needed

The New York Dock Department may be warranted, in view of the present requirements of the lessees, in building these piers substantially in accordance with the present plan. We believe, however, that where in New York harbor piers are provided with adequate rail connections, as we understand is to be the case with these piers, they will, as time goes on, obtain more and more of their freight from railroads and less from lighters and that. therefore, wider piers will be needed.

We further believe that shipping interests do not appreciate the great rapidity and convenience possible by the proper utilization of adequate equipment for the mechanical handling of freight.

In these days of high prices, inadequate and inefficient labor and frequent strikes, it would seem to be to the advantage of ship agents and operators at the port of New York to give the most thorough and scientific study possible to the utilization of mechanical equipment before determining upon the width of piers.

The question at issue appears to be whether it is best to build piers only to meet present conditions under the special requirements of particular lessees without regard to their effect on the future development of the port, or whether the problem should be attacked from the other side and piers designed as part of a permanent and comprehensive plan. The latter, we believe, to be the proper procedure.

Wider Piers Are Necessary To Handle Traffic

By Frederick W. Cowie
Chief Engineer, Harbor Commissioners of Montreal, Montreal, Que.

In the course of the modernization of the port of New York, the logical, if not the only way is to bring economy of time and movement within the harbor and terminals. Lighterage in the past was developed to an unusual degree and, owing to its physical location and intense concentration on the Manhattan peninsula waterfront, lighterage was essential. The unique requirements of the Manhattan waterfront require unique facilities. Why New York design and practice, developed for its Manhattan water front and for the Long Island waterfront, where lighterage is essential, should be considered in connection with the design and practice to be adopted at the new ocean terminals at Staten Island, is incredible.

The Staten Island unit of the port of New York will be a modernized combination of ocean transportation and transcontinental railway terminals. Concentration beyond logical economic practice is not required. Twelve piers, having berths for 48 cargo ships, should result in a comprehensive self-contained port.

To be successful, this comprehensive port should be so designed that ships may arrive and clear in the shortest possible time. Even if steamship agents are

willing to lease a pier for their own exclusive use, so as to have an independent berth, it is not sound port economy to provide more berths than can be used in a more or less continuous manner.

It must be admitted that the Staten Island ocean terminals should fundamentally be designed to meet the requirements of the trade and commerce of the United States. Interior bulk of freights, inward and outward, will not or should not be handled in New York City.

To solve the transportation problem of America, railway cars must be promptly released, ships must not be detained in ports and freights must be handled economically. A pier, therefore, built for four ocean berths, should be so designed as to permit of the speedy unloading and loading of at least three ships—not one or two ships. The upper story may be used for assembling cargo; the lower deck or floor must be clear when a ship arrives.

Each berth should have an average capacity of at least 5,000 tons inward and 8,000 tons outward per week. At least 75 per cent of this may be expected to be handled by railway.

It is a demonstrated fact that in order to handle this quantity of freight, the transit sheds at each berth must have ample floor space, as it is not economical to stack freights which are to be promptly removed, to any great height. Each berth would therefore require a double-story transit shed about 500 ft. long and 100 ft. wide. With this shed accommodation, a right smart terminal railway organization must be on the job to handle cars in and out promptly. In fact the railway organization will make a good showing if they can take care of three ships instead of four, per pier per week.

Summing the matter up, a dock engineer advising on port economics will naturally insist on port facilities which should be used to at least two-thirds of capacity, while a steamship agent, whose revenues are based on a percentage of costs may not be of the same opinion. One would expect an easy decision!

250 Ft. Should Be Minimum Width

BY GEORGE F. NICHOLSON
Chief Engineer, Port of Seattle, Seattle, Wash.

After an inspection and study of the Atlantic, Pacific and Gulf ports of North America and fully realizing the present method of freight handling necessitated by local conditions in the port of New York, I earnestly believe that the port authorities are making a grave mistake in building such narrow piers as are planned.

It is unfortunate that in so many of our ports, piers have been built the same width as quay wharves when, as a matter of fact, a pier with double the berthing space should be twice the width. The pier should be considered two quay wharfs back to back.

Although freight is transferred largely by lighters in the port of New York, why should new permanent piers be built with the view that this condition will always continue? And would not wide, commodious piers with a great amount of railroad trackage and mechanical handling equipment encourage the handling of freight direct between ship and railroad car? And even if the more modern method of freight handling does not materialize in New York for a number of years why build permanent piers now of such width that will make them obsolete when a direct-to ship-and-car movement is finally perfected?

If the absorption of port lighterage by the railroad shall be permanently prohibited by the Government, in what an unsatisfactory position will it leave the New York side of the port. Although the Baltimore & Ohio R.R. has heretofore enjoyed a monopoly of the best opportunities on Staten Island, this will not always prevail and the final solution of the problem is railroad tunnels connecting the New York and New Jersey sides of the harbor, so that eventually there will be direct-to-rail and direct-to-ship freight movement.

In my opinion the Stapleton piers should not be less than 250 ft. wide, equipped with two 2-story transit sheds and two shipside tracks on either side of pier and at least three depressed tracks in the center, this area to be paved for motor truck and team traffic.

In Seattle we are just completing the largest commercial pier in the world, it being 365 ft. wide and 2,580 ft. long, equipped with two 2-story transit sheds 130 ft. wide and on this pier alone there is 4½ miles of railroad trackage that will accommodate over 400 railroad cars at one time. This trackage consists of two shipside tracks on either side of pier and four depressed tracks in center with cross-overs approximately every 400 ft. This enormous amount of railroad trackage was decided upon after seven years' operation of a similar pier equipped with 3½ miles of railroad trackage.

Attention is also called to the fact that the Lehigh Valley R.R. is contemplating the construction of three large piers at the tide flats in the Greenville section of Jersey City on New York harbor, these piers to vary from 330 ft. to 550 ft. wide, and approximately 7,000 ft. long. The first unit of the terminal for which a 35-ft. channel is now being dredged to deep water is to be a 3,000-ft. wharf. All of these piers will have extensive railroad trackage, warehouses, and modern mechanical freight-handling equipment, and other such modern facilities.

Although conditions of freight handling vary considerably between New York and the Pacific Northwest, there is no question that New York should strive hard to bring about the direct to and from ship and to and from car movement of freight and the first step to bring that about is to build piers of adequate width and equipped with modern two-story transit sheds and sufficient railroad trackage and mechanical handling equipment in order to put into actual operation the more modern method of freight handling in connection with the operation of their marine terminal facilities.

Asphalt Production in United States

A preliminary estimate of the production and sales of asphalt and paving bitumens and allied substances in the United States in 1919, has just been made public by the U. S. Geological Survey. Asphalt produced from domestic petroleum amounted to 600,000 short tons, valued at $9,000,000, an apparent increase over 1918 of 72,425 tons and of $1,564,796, respectively. Asphalt produced from Mexican petroleum amounted to 572,000 short tons valued at $7,917,000, an increase from 1918 of 21,756, tons in quantity and a decrease of $2,407,020 in value. About 115,000 short tons of native bitumen and allied substances valued at $1,000,000 were produced in 1919, and an apparent increase over 1918 of 54,966 tons and of $219,192.

Special Impellers for Pumps in Dredging Stumpy Ground

Centrifugals on New Orleans Industrial Canal Were Rebuilt Like Wood Sewage Trash Pumps and Efficiency Increased

By Walter J. White

Formerly Superintendent of Dredging, Board of Commissioners of the Port of New Orleans; now at Covina, Cal.

About 80 per cent of the area to be excavated for the New Orleans Inner Harbor-Navigation Canal was underlaid with large cypress stumps, while for several miles there was a heavy surface growth of cypress and other timber with its accompanying roots. Notwithstanding the obvious difficulties of using a hydraulic dredge in this ground, such machines were decided upon because of the necessity of utilizing the excavated material along the banks at such a distance back as to preclude the use of dipper dredges or scow disposal. How the hydraulic dredge pumps were revamped so as to carry efficiently the matted cypress stumps and roots along with the spoil is told in thé accompanying abstract of a paper presented at the last annual meeting of the American Society of Mechanical Engineers. Some changes and additions to the article as originally printed are herein incorporated by the author.—Editor.

NOTWITHSTANDING the great number and character of stumps and roots in the main section of Inner Harbor Navigation Canal at New Orleans, La. [the *Engineering News-Record*, April 22, 1920, p. 808, for description and progress report] it was decided that the work could best be done by hydraulic pipe-line dredge of the cutter type and contractors were asked to submit bids on the work. On account of the difficulties of the site, however, contract prices could not be secured and arrangements were made to charter dredges, the Board of Commissioners accepting all responsibility for output. Four 20-in. dredges and one 22-in. dredge, the "Texas," were accordingly secured and work was commenced on May 15, 1918. The dredges were powerful machines of good design in all respects, but it was fully realized that much trouble was to be expected on account of stumps and roots (Fig. 2).

By utilizing a bayou, four of the dredges were brought in to a point on the canal where one was placed in operation headed toward Lake Ponchartrain and three were started toward the Mississippi River; one dredge was also started south from Lake Ponchartrain. On account of large areas in suction and discharge pipes and pumps, the 22-in. dredge "Texas" was placed in the most difficult section. After allowing a reasonable time for dredge and crew to become adjusted to conditions, it became evident that progress would be slow and the work would be expensive, due entirely to delays and decreased capacity occasioned by stumps and roots clogging pump throat and suction. The soil itself was easily handled by a hydraulic dredge and the pipeline conditions were not difficult, but the amount and character of roots encountered and later successfully handled is beyond description. Fig. 1 shows the character of the material actu-

FIG. 1. KIND OF MATERIAL PUMPED BY DREDGE "TEXAS"

FIG. 2. CANAL BEFORE DREDGING

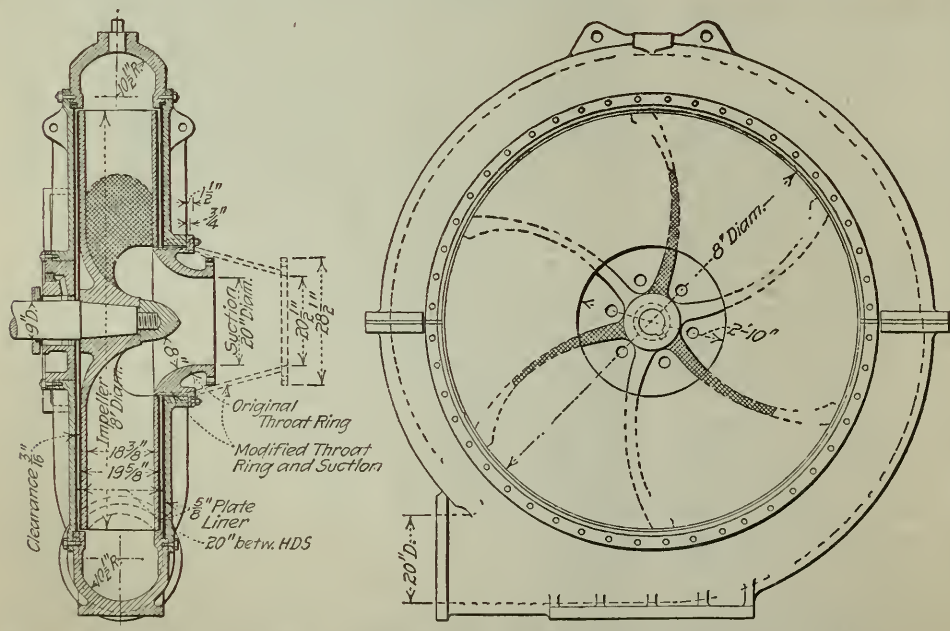


FIG. 3. DETAILS OF PUMP ON DREDGE "CAPTAIN HUSTON" SHOWING MODIFIED THROAT AND IMPELLER

ally pumped through the dredge "Texas." It was thought that the solution of this difficulty would be found in a pump impeller designed with large and easy passage areas and having no projection webs on vanes or hub. The writer learned that A. B. Wood, mechanical engineer for the Sewerage and Water Board of New Orleans, had designed and patented a centrifugal-pump impeller for handling sewage containing trash. An impeller for a 12-in. pump was inspected, and while none had heretofore been used on dredges of the cutter type it was believed that the root problem was solved and Mr. Wood was engaged to design an impeller for the 22-in. dredge "Texas." All costs in connection with the manufacture of the impeller were to be borne by the Board of Port Commissioners regardless of whether or not it proved a success.

From the first the results obtained with the new impeller were remarkable, the increase in output being between two and three hundred per cent. The increased yardage excavated by the dredge "Texas" is shown by the following comparative statement, covering thirty days' operation immediately before and immediately after substituting Mr. Wood's impeller for the old type:

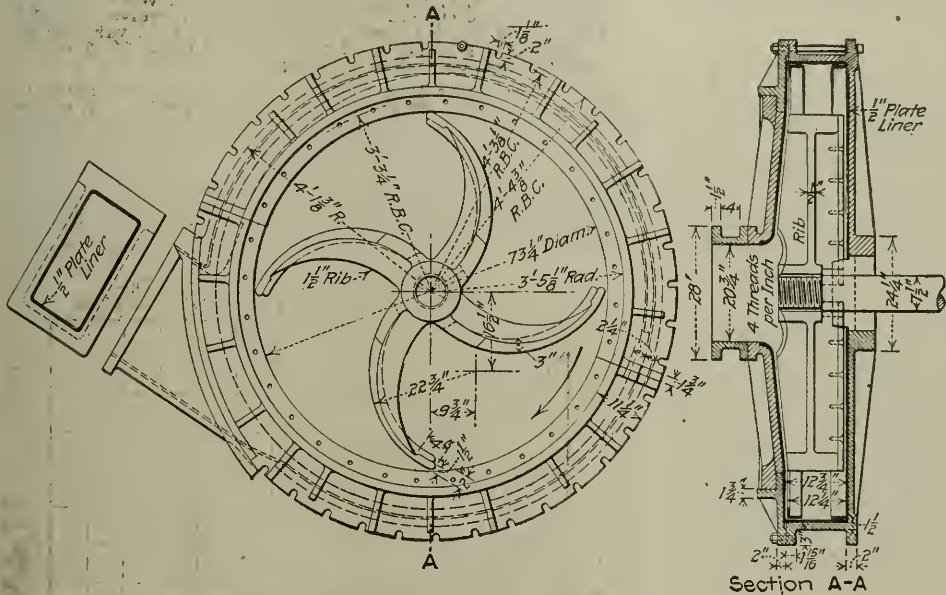


FIG. 4. DETAILS OF PUMP ON DREDGE "PELICAN" WITH IMPELLER IN PROPER POSITION

	Old Impeller	New Impeller
Excavating, hours	482.43	394.00
Clogged suction delay, hours	130.75	71.50
All other delay, hours	106.82	254.50
Advance, feet	873	2,901
Excavated material, cubic yard	73,472	175,460
Average yardage per excavating hour	152	445

The large number of delay hours after installation of new impeller was due to time lost cleaning boilers and raising a sunken fuel barge. For the period covered in the tabulation it will be seen that although the installation of new impeller decreased the number of excavating hours, the average advance and yardage was much greater. From observations of the dredge in operation it was seen that the ability of the impeller to pass stumps and roots insured the maintenance of a satisfactory output.

The operation and output of the 20-in. dredges "Captain Huston" and "Dixie" were very greatly facilitated and increased by certain modifications made in pump casings and impellers. Area in pump throat was increased by changing the shape of the throat ring and fitting a new piece of suction pipe. As previously mentioned, it was recognized that in order to secure maximum output in material of this character, it would be necessary to provide as large passages through pump and impeller as possible, and it was therefore determined that two-thirds of each alternate vein should be cut out of the impellers in these dredges, as shown in Fig. 3. The outer one-third of the vanes was left to preserve structural strength, but after observing the performance of the pumps it is the opinion of the writer that every alternate vane could have been entirely removed.

During the first three days that the dredge "Captain Huston" was in operation and prior to making alterations to the pump the yardage output of the dredge was practically nothing. This was due to the fact that the pump suction throat was continuously clogged with stringy roots and stumps, which it was impossible for the pump to handle. Conditions could not have been worse and it was felt that any method whereby the pump throat and impeller could be opened up would result in increased output. It is admitted that some uneasiness was felt as to how these alterations might affect the performance of the pumps, but results have more than justified what at first seemed to be a drastic and hazardous measure. Pump and engine tests have shown that these alterations did not affect the capacity or efficiency of the pump, other than by greatly facilitating the passage of roots, etc., through the pump. While the writer understands that radical alterations should not be made without careful consideration, it is undoubtedly true that the performance of a dredge is to be judged largely, if not solely, by the unit cost of output, and where

FIG. 6. SIDE VIEW OF SPECIAL IMPELLER FOR DREDGE "TEXAS"

FIG. 5. BACK OF TWO VANED IMPELLER DESIGNED BY A. B. WOOD FOR 22-IN. DREDGE "TEXAS"
Foot measure alongside. Dotted lines show shape of vanes.

TABLE I. DATA AND RESULTS OF TESTS OF CENTRIFUGAL DREDGING PUMPS

Test Number	Steam Pressure, Lb. Sq.In. Gage	R.P.M.	Suction, Ft. of Water	Discharge, Ft. of Water	Total, Including Difference of Velocity Heads	Flow in Ft. per Sec. by Venturi Meter	Indicated Hp.	Water, Hp.	Combined Efficiency, Engine and Pump	Peripheral Speed, Ft. per Sec.
					Texas					
					Feb. 14, 1919					
1	175	201	— 0.94a	76.02	77.03	20.16	423.4	175.8	41.5	70.16
2	175	201	+ 0.86a	99.34	98 48	0 0	254.45	0.0	0.0	70.16
3	173	202	—12.94	57.57	71 18	58.37	742.5	471 0	63.3	70.51
4	170	240	— 1.34a	112 04	113.47	22.86	681.9	293.0	43.0	83.78
5	175	244	+ 0.86a	145.29	144.43	0.0	403.4	0.0	0.0	85.18
					Captain Huston					
					Feb. 23, 1919					
1	200	141	—30.20	25.82	54 26	52.38	657.9	322.1	49.0	59.06
2	198	161	—15.23	85.11	99.56	35.17	706.7	397.8	56.3	67.44
3	200	165	—12 74	93.65	105.69	33 05	729.5	396.0	54.1	69.12
4	200	166	+ 0.28a	99.89	99.61	0.0	292.7	0.0	0.0	69.54
5	191	168	—10.06	98.96	108 49	28.87	682.8	355.8	52.1	70.38
6	200	174	—10.97	104.97	115.33	30 78	742 8	403.0	54.3	72.95
7	200	182.5	— 6.56	123.67	129.88	23.47	756.8	346.0	45.7	76.48
8	200	184	— 6.40	122.22	128.27	23 47	759.6	341.7	45 0	77.0
9	200	221.5	+ 0.28a	186.94	186.66	0.0	426.0	0.0	0.0	92.78
					Dixie					
					Mar. 11, 1919					
1	158	158	—25.99	28.52	54.70	49.55	559.55	307.50	55.0	57.91
2	155	160	—22.98b	34.27	57.42	46.62	568.83	303 71	53.4	58.64
3	150	163	— 7 68	58.36	66.10	27.29	446 78	204.66	45.8	59.74
4	156	163.5	—18.48b	44.22	62.85	42.0	551.42	299.56	54.3	59.92
5	145	166	— 8.16	60.21	68.44	27.81	471.47	215 94	45 8	60.84
6	152	174.75	—9.32	66.68	76.08	30 35	545.4	261.8	48 0	64.05
7	155.7	175.5	—10.74	64.71	75.54	32.33	577.42	277.25	48.0	64.32
8	154.5	176	— 2.68a	76.37	79.08	17.85	479 15	160.15	33.5	64.50
9	156	176	— 0.03	78.91	78.95	8.95	407.72	80 11	19.65	64.50
10	156	176.5	+ 0.92a	82.61	81 79	0.0	310.24	0.0	0.0	64.68
11	151	186	— 3.60	83.76	87.40	19.47	547.96	193.06	35.3	68 17
12	150	197	— 0.38a	99.46	99.85	10.21	552.39	115.66	20.95	72.20
13	154	219	+ 0.82a	127.17	126.35	0.0	578.31	0.0	0.0	80.26
					Pelican					
					May 28, 1919					
1	174.5	119.5	+ 3.99	8.93	23.16	30.06	139.95	78.9	56.3	38.06
2	175	132	—17.40	10.58	28.26	32.90	184.33	105.2	57.2	42.04
3	175	145	—21.96	11.78	34.10	37.04	246.10	143.0	58.1	46.18
4	182.5	145	+ 0.88a	41.45	40.57	0.0	75.66	0.0	0.0	46.18
5	175	146.5	—10.96	16.63	35.90	34.58	231.32	140.3	60.7	46.65
6	180	148	— 3.87a	36.38	40.32	16.61	162.82	76.0	46.6	47.14
7	175	149	+ 0.28a	42.88	42.61	5.74	117.93	27.7	23.5	47 46
8	180	150.5	— 1.57a	40.06	41.67	11.99	147.15	56.6	38.5	47.93
9	182.5	159	—11.34	34.03	45.55	25.96	236.30	133.8	56.7	50.64
10	182.5	164	—12.91	35.03	48.14	28.01	249.94	152.8	61.2	52.23
11	182.5	177	— 7.66	51.68	59.45	20.93	272.30	140.8	51.75	56.37
12	177.5	184	— 4.0	60.61	64.69	15.97	276.22	117.0	42.4	58.60
13	175	186	— 2.82a	63.63	66.51	14.65	286.53	110.2	38.5	59.24
14	175	199	+ 0.08a	76.78	76.71	6.79	283.2	59.0	20.75	63.38
15	177.5	217	+ 0.88a	99.41	98.53	0.0	295.22	0.0	0.0	69.11
					Pelican					
					May 31, 1919					
					During this test the runner was reversed					
1	175	118	—13.49	7.98	21.69	28.85	151.78	70.9	46.75	37.58
2	176	137	—19.67	10.53	30.52	35.1	255.12	121.3	47.6	43.63
3	189	141	—21.75	11.28	33.39	36.9	288.57	139.3	48.35	44.91
4	172.5	142	—17.53	15.08	32.89	32.85	256.88	122.3	47.7	45.23
5	177.5	146	— 3.93a	31.88	35.88	16.65	154.56	67.70	43 8	46.50
6	175	146	+ 0.88a	37.98	37.10	0.0	75.85	0.0	0.0	46.50
7	175.5	147	— 1.13a	36.68	37.84	10.60	138.93	45.5	32.7	46.82
8	172.5	148	+ 0.88a	38.18	37.30	0.0	79.48	0.0	0.0	47.14
9	172.5	150	+ 0.64a	40.08	39.44	3 76	106.66	16.78	15.73	47.78
10	181	152	—10.63	28.58	39.38	25.90	233.58	115.3	49.4	48.41
11	181	159	—11.84	31.18	43.22	27.54	266.79	134.7	40.55	50.64
12	177.5	182	— 7.14	56.18	57.44	21.38	307.91	139.0	45.2	57.97
13	187.5	199	— 3.88a	64.88	68.83	16.49	321.50	128.5	40.0	63.38
14	181	209.5	+ 0.88a	79.68	78.80	0.0	194.58	0.0	0.0	66.73
15	180	218	+ 0.88a	87.83	86.95	0.0	227.89	0.0	0.0	69.43
16	170	221.5	— 0.43	88.78	89.23	8.17	327.96	82.50	25.18	70.55
17	185	224	+ 0.88a	90.58	89.70	0.0	243.34	0.0	0.0	71.34
18	185	244.5	+ 0.88a	109.78	108.90	0.0	334.57	0.0	0.0	77.87
19	185	249	+ 0.88a	113.58	112.70	0.0	354.46	0.0	0.0	79.31

a Readings of suction gage incorrect because of whirl set up in pipe by pump mpeller.

b Suction readings incorrect, due either to pet cock being throttled down too much or getting temporarily choked up.

DISCHARGE-PIPE-LINE CONDITIONS FOR TESTS OF DREDGING PUMPS GIVEN IN TABLE I

Texas: Tests 1 and 4, 8-in. valve on end of discharge pipe wide open. Tests 2 and 5, 8-in. valve on end of discharge pipe cut off. Test 3, pipe line 570 ft. pontoon and shore pipe.

Captain Huston: Test 1, Pipe full opening. Test 2, Iron plate bolted on discharge pipe. Tests 3, 7, and 8, 8-in. valve on end of discharge pipe wide open. Tests 4 and 9, 8-in. valve on end of discharge pipe cut off. Tests 5 and 6, Pipe line 3,538 ft. pontoon and shore line.

Dixie: Test 1, Pipe full opening. Test 2, Wooden piece bolted on discharge pipe. Tests 3, 5, and 6, Pipe line 1,583 ft. pontoon and shore pipe. Test 4, 2 pieces of wood bolted on end of discharge pipe. Test 7, Iron plate bolted on end of discharge pipe. Tests 8 and 11, 8-in. valve on end of discharge pipe wide open. Tests 9 and 12, 8-in. valve on end of discharge pipe partly closed. Tests 10 and 13, 8-in. valve on end of discharge pipe cut off.

Pelican: Tests 1, 2, and 3, Pipe full opening. Tests 4 and 15, 8-in. valve on end of discharge pipe cut off. Tests 5 and 10, Wooden piece bolted on end of discharge pipe. Tests 6 and 11, 3 wooden pieces bolted on end of discharge pipe. Tests 7 and 14, 8-in. valve on end of discharge pipe partly closed. Tests 8, 12 and 13, 8-in. valve on end of discharge pipe wide open. Test 9, 2 wooden pieces bolted on end of discharge pipe.

Pelican (with reversed runner): Tests 1, 2, and 3, Pipe full opening. Test 4, Wooden piece bolted on end of discharge pipe. Tests 5 and 12, 3 wooden pieces bolted on end of discharge pipe. Tests 6, 8, 14, 15, 17, 18 and 19, 8-in. valve on end of discharge pipe cut off. Tests 7 and 8 8-in. valve on end of discharge pipe wide open. Tests 9 and 16, 8-in. valve on end of discharge pipe partly closed. Tests 10 and 11, 2 wooden pieces bolted on end of discharge pipe.

In all cases where length of discharge pipe is not given the length was less than 100 ft. from the stern of dredge. In general figures in Table I are a mean of a number of readings recorded during tests, which explains why the figures are worked out to two decimal places. The venturi meter had an inlet diameter of $22\frac{5}{16}$ in. and a throat diameter of 18 in. For readings at cut off, the elevation of water at rest in suction pipe was taken as suction head and for other readings of low quantity the suction head was taken from loss pressure curve plotted from high quantity readings.

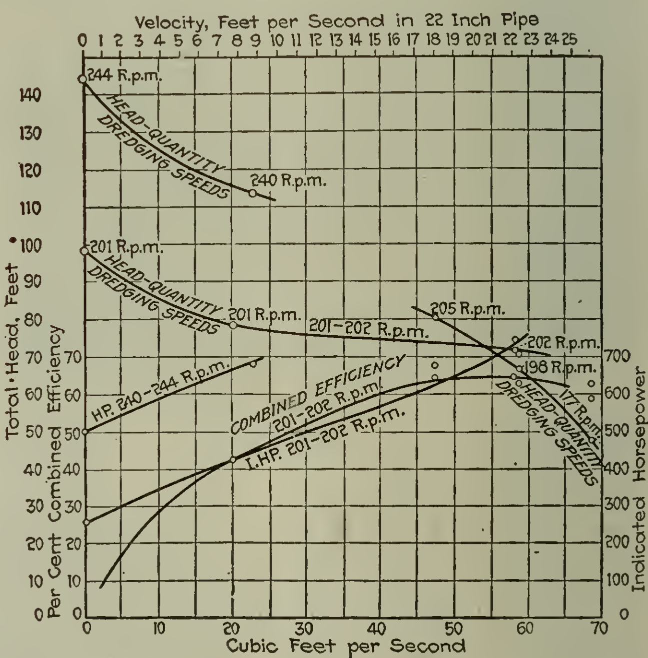


FIG. 7. PERFORMANCE CURVES OF DREDGE "TEXAS" EQUIPPED WITH PUMP IMPELLER DESIGNED BY A. B. WOOD

TABLE II. DATA ON CENTRIFUGAL DREDGING PUMPS

	Texas	Capt. Huston	Dixie	Pelican	Pelican †
Diam. of impeller, in.	80	96	84	73	73
Number of vanes	2	3*	3*	4	4
Diam. of suction pipe at suction gage, in.	$23\frac{3}{8}$	$19\frac{23}{32}$	$20\frac{5}{16}$	$20\frac{3}{4}$	$20\frac{3}{4}$
Diam. of discharge pipe at discharge gage, in.	$22\frac{11}{16}$	$20\frac{25}{32}$	$20\frac{3}{16}$	$25\frac{1}{2}$x$12\frac{11}{16}$	$25\frac{1}{4}$x$12\frac{11}{16}$
Triple expans. engine, in.	14x$21\frac{1}{2}$x35	$14\frac{3}{8}$x$22\frac{1}{2}$x40	$14\frac{3}{8}$x$22\frac{1}{2}$x36	$11\frac{1}{16}$x18x29	$11\frac{1}{8}$x18x29
Length of stroke, in.	18	20	18	18	18
Water at rest in canal above center-line of pump, in.	$10\frac{3}{8}$	$3\frac{3}{8}$	$9\frac{7}{8}$	......	......
Water in river above center-line of pump, in.	....	......	......	$10\frac{1}{2}$	$10\frac{1}{2}$
Zero of suctiongage below center-line of pump, in.	19	20	16.68	1.68	At center line of pump
Zero of discharge gage above center-line of pump, in.	20	......	......	7	7
Zero of discharge gage below center-line of pump, in.	....	$53\frac{13}{16}$	47.66	......	......

* Originally 6, parts of 3 vanes removed. † This test made with impeller reversed.

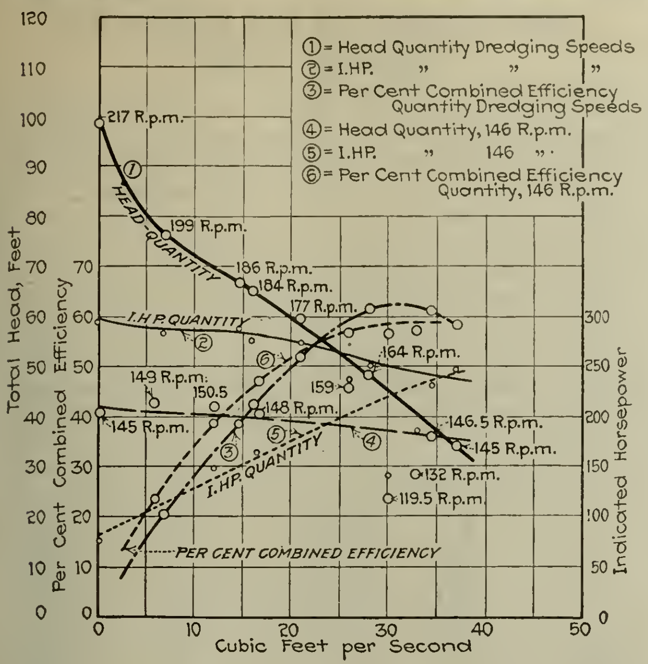


FIG. 8. PERFORMANCE CURVES OF PUMP OR DREDGE "PELICAN"

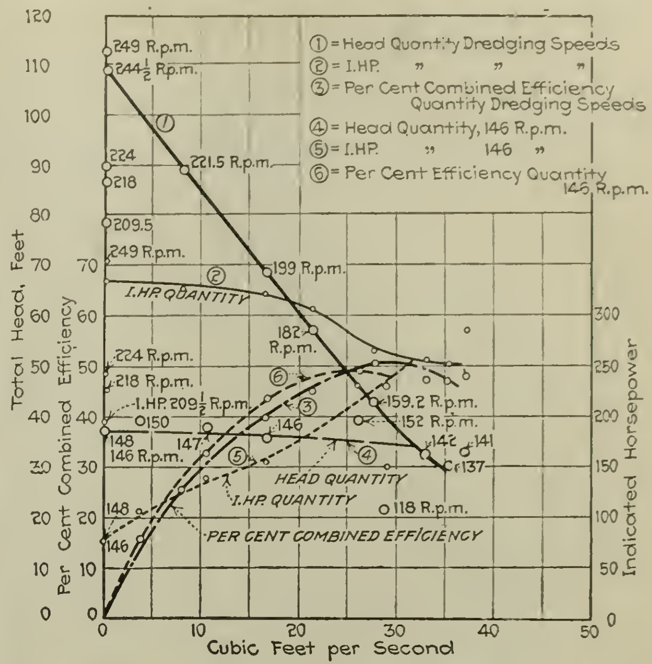


FIG. 9. PERFORMANCE CURVES OF "PELICAN" WITH REVERSED IMPELLER

for any reason output is not being secured any modifications of plant are justified, provided that the unit cost of output is controlled. In this particular instance there was involved the difference between failure and success. Assuming the same general character of excavation, a further modification along the lines indicated would, it is believed, result in a further increase in output.

The impeller designed for the 22-in. dredge "Texas" was of same diameter (80-in.) as that of the old impeller, but it had two instead of four vanes. An examination of Figs. 5 and 6 will show that due to the peculiar shape of vane, the lodging or collection of roots or other material is made difficult, if not impossible, every encouragement being given by shape of vane and throat of impeller to the continuous flow of water containing irregular shape roots or other objects. The writer does not wish to convey the impression, however, that all of the large cypress stumps and roots were cut up by the cutters and handled through a 20- or 22-in. dredging pump. While suction ladders were built for heavy service and cutters were of good design and powerful, a great many of the stumps were undercut and allowed to sink to the bottom, where they were deposited below grade.

In general the operation and maintenance of the dredges followed the usual procedure for dredges of this type. The 22-in. dredge "Texas" was equipped to use ball joints as connections between sections of pontoon pipe, and it is believed that the passage of roots was made easier than if rubber sleeves had been used.

Pump impellers having two, three, four, six, and seven vanes and varying in diameter from 68-in. to 96-in. were used in the different dredges engaged on this work. Tests to determine certain centrifugal dredge-pump characteristics while pumping water were carefully made. The results of these tests are given in Tables I and II. Observers were selected and were rehearsed several times to make sure that they understood just what was required of them. All practicable precautions were taken so that accurate results would be secured. Readings were recorded as observed, the object being to eliminate any intention to interpret or analyze readings while test was in progress. A study of the readings does not reveal any wide range in any set of readings for a given condition. All the figures in Table I are a mean of a number of readings and the writer has confidence in the correctness of all observations and computations, and it is believed that the data presented will be of value in analyzing and studying the design and performance of centrifugal dredging pumps. At the time tests were made, the dredges were in good operating condition, but no special preparation of machinery was made. All of the pumps tested were of the single suction type and all impellers, with one exception, were shrouded on both sides. The pumps were directly connected to vertical triple-expansion engines.

Upon the completion of the tests made on the dredges "Captain Huston" and "Dixie" both of which were equipped with pumps having modified propellers, it was decided to test the pumps of the dredge "Pelican" which was fitted

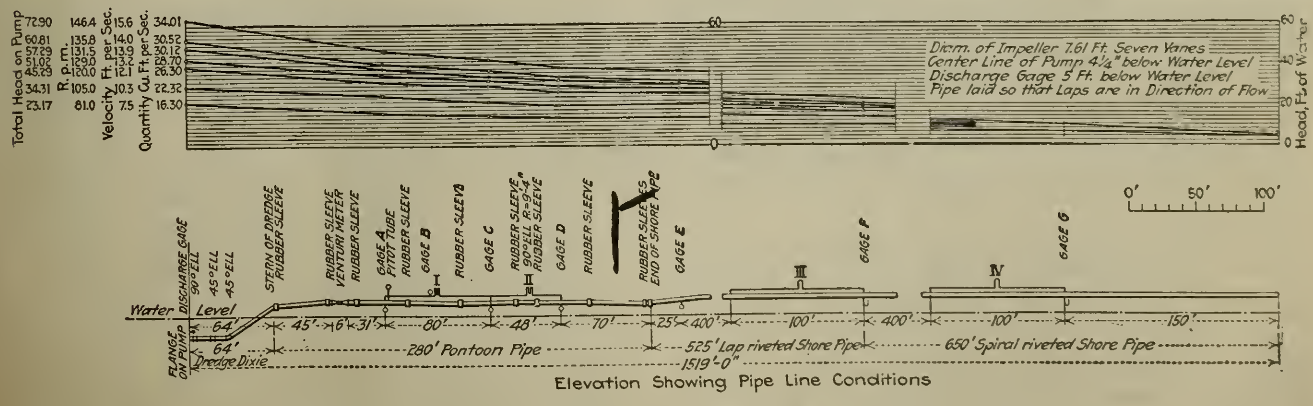


FIG. 10. LOSS OF PRESSURE TEST ON 20-IN. DREDGE "DIXIE"

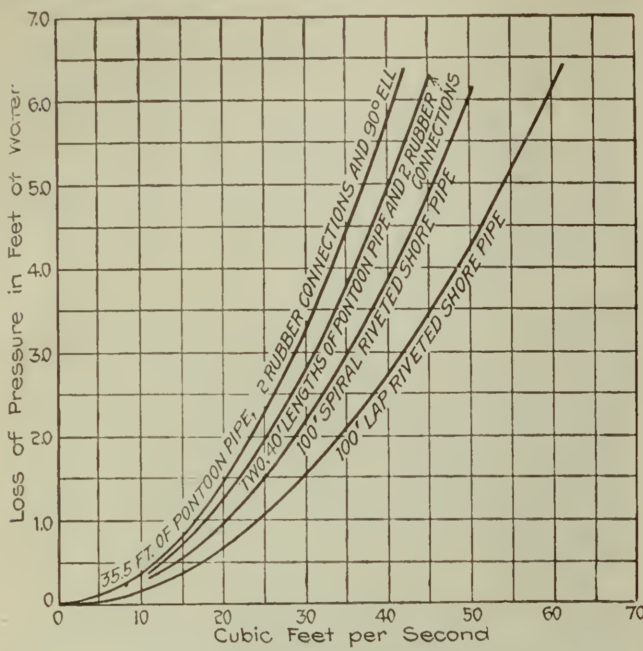


FIG. 11. LOSS OF PRESSURE PLOTTED TO DISCHARGE ON "DIXIE"

with an open impeller. This pump, shown in Fig. 4, was tested with impeller in the pump in the normal manner with the vanes curved backward and also with the impeller reversed, i.e., with the vanes curved in the direction of rotation. The results were surprising and are shown in detail in Table I and the curves of Fig. 8 and 9. So far as the operation of the dredge was concerned, both while pumping water and also while dredging, there was nothing to indicate to the closest observer that the pump was not assembled in the usual manner. After completion of tests it was found by comparison that there was a 10 per cent loss of efficiency due to increased consumption of power with the reversed impeller. As a matter of interest it might be stated that the dredge "Pelican" was operated from June 1 to June 14, 1919, with the reserved impeller, nothing unusual being noticed in operation and no diminution in yardage being apparent.

Pressure Drop Tests

In the tests of dredges "Texas" and "Captain Huston" the quantity of water discharged by the pump was measured by pitot tube and venturi meter. While testing the dredge "Captain Huston" the pitot tube was bent and was not used in the tests of the other dredges. During tests the venturi meter was located just astern of the dredge in a straight section of pipe, where it would not be influenced by elbows. Suitable arrangements were made so that the discharge pipe could be throttled, or closed off entirely, and in this way a variation in head and quantity was created. Piezometers were ¼-in. tee-handled pet cocks, which were screwed into the pipe. Indicators were not calibrated, but are believed to have been in excellent condition. Cards were taken simultaneously on the three-engine cylinders.

It was unfortunate that during the drop in pressure test (shown in Figs. 10 and 11) made on the dredge "Dixie" it was impossible to obtain comparable peripheral speeds due to valve of intermediate cylinder being improperly set.

In a hydraulic pipe-line dredge of the cutter type it is believed that all passages through pipes and pump should be designed so that clogging at any point by more or less irregularly shaped solids will be reduced to a minimum. As a result of tests and also based on observation of the dredges in operation, it is the conclusion of the writer that the modifications described did not decrease the efficiency or capacity of the main engines and pumps, but did greatly increase the output of the dredges as excavating machines.

States Absorb All 1920 Federal-Aid Highway Funds

On June 16 the last plans and estimates needed to insure that every cent of Federal-aid funds which had to be taken up prior to July 1 would be taken up, were received and approved by the chief engineer of the Bureau of Public Roads. Not only have all the funds available during the fiscal year of 1920 been obligated by the various states, but eight states have applied for their share of Federal-aid which must be applied for by July 1, 1921. The Bureau of Public Roads is now giving attention to the construction of more than 18,000 miles of improved highways included in 1,800 projects.

Following is the status of Federal aid as of June 16, 1920:

STATUS OF FEDERAL AID FUNDS ON JUNE 16, 1920

State	Funds Which Must Be Taken Up Prior to July 1, 1920	Funds Obligated by Plans and Estimates Approved by Chief Engineer of the Bureau of Public Roads	Balance to Be Taken up Prior to July 1, 1920	Funds Which Must Be Taken up Prior to July 1, 1921	Balance Which Remains of Funds to Be Taken up Prior to July 1, 1921
Alabama	1,676,167.27	1,714,967.74	0	3,671,669.07	1,956,701.33
Arizona	959,097.68	970,074.38	0	2,397,707.53	1,427,633.15
Arkansas	1,338,315.29	1,301,127.53	0	2,934,751.38	1,633,623.85
California	2,433,607.29	3,060,552.46	0	5,329,679.06	2,269,126.60
Colorado	1,375,920.25	1,450,904.21	0	3,024,304.97	1,573,400.76
Connecticut	492,552.43	981,823.05	0	1,075,975.27	94,152.22
Delaware	130,349.56	284,980.01	0	284,980.02	.01
Florida	912,449.89	1,476,917.40	0	2,002,664.56	525,747.16
Georgia	2,152,942.64	4,067,844.55	0	4,710,427.66	642,583.11
Idaho	974,371.32	1,003,107.46	0	2,134,338.93	1,131,231.47
Illinois	3,506,652.82	10,484,154.61	0	7,659,199.06	.00
Indiana	2,163,392.46	2,330,279.49	0	4,728,239.34	2,397,959.85
Iowa	2,316,226.61	5,318,649.70	0	5,058,014.40	.00
Kansas	2,2[illegible]5,068.00	4,888,460.41	0	5,024,064.45	135,604.04
Kentucky	1,562,265.53	1,614,538.20	0	3,418,309.36	1,803,771.16
Louisiana	1,086,908.29	1,918,464.93	0	2,380,293.44	461,828.51
Maine	771,393.47	1,056,827.77	0	1,685,733.41	628,905.64
Maryland	697,750.11	1,691,116.43	0	1,523,750.46	.00
Massachusetts	1,179,698.00	1,600,470.81	0	2,579,776.26	979,305.45
Michigan	2,319,921.34	3,309,422.02	0	5,069,627.58	1,760,205.56
Minnesota	2,273,822.10	3,662,728.41	0	4,973,293.69	1,310,565.28
Mississippi	1,434,957.40	1,590,182.62	0	3,143,985.12	1,553,802.50
Missouri	2,713,079.31	3,049,093.49	0	5,934,176.11	2,885,082.62
Montana	1,592,849.60	1,508,854.18	0	3,491,837.18	1,982,983.00
Nebraska	1,706,399.75	3,451,947.98	0	3,733,019.68	281,071.70
Nevada	1,029,358.18	1,081,665.09	0	2,250,931.75	1,169,266.66
New Hampshire	333,410.35	790,690.56	0	728,250.06	.00
New Jersey	949,046.06	1,454,849.23	0	2,077,742.57	622,893.34
New Mexico	1,273,633.77	1,307,676.17	0	2,791,326.76	1,483,650.59
New York	3,989,791.41	4,213,480.30	0	8,716,908.56	4,503,428.26
North Carolina	1,825,679.69	3,127,560.01	0	3,991,636.88	864,076.87
North Dakota	1,226,375.37	1,256,560.95	0	2,686,259.90	1,429,698.95
Ohio	2,973,222.17	5,446,803.36	0	6,496,700.90	1,049,897.54
Oklahoma	1,844,961.83	1,889,799.50	0	4,035,767.27	2,145,967.77
Oregon	1,259,853.95	3,320,163.83	0	2,756,026.23	.00
Pennsylvania	3,678,154.13	9,624,353.12	0	8,040,698.24	.00
Rhode Island	186,500.46	403,834.79	0	407,909.26	4,074.47
South Carolina	1,147,734.06	1,538,526.76	0	2,510,598.46	972,071.70
South Dakota	1,134,842.29	1,155,215.65	0	2,837,103.60	1,681,887.95
Tennessee	1,815,227.44	2,683,406.00	0	3,966,224.08	1,282,818.08
Texas	4,095,133.88	4,162,884.20	0	10,238,806.31	6,075,922.11
Utah	909,205.72	985,775.02	0	1,987,630.72	1,001,855.70
Vermont	362,650.02	476,240.16	0	792,026.64	315,786.48
Virginia	1,589,155.85	2,250,133.01	0	3,474,056.45	1,223,923.44
Washington	1,154,550.27	3,365,604.27	0	2,527,048.04	.00
West Virginia	851,534.38	2,008,040.76	0	1,862,351.68	.00
Wisconsin	2,040,736.93	2,208,988.16	0	4,459,335.32	2,250,347.00
Wyoming	980,308.68	1,447,678.68	0	2,144,842.33	697,163.65

Cost of Railroad Stationery

Vice-President T. C. Powell has recently compiled some figures on the Erie's expenditures for rails and stationery from 1915 to 1919, inclusive, as follows:

Year	Stationery	Rail	Rail Price Per Ton
1915	$403,125.20	$660,386.00	$30.00
1916	395,980.10	872,410.00	31.50
1917	560,565.83	658,839.00	31.50
1918	497,933.36	889,292.00	40.80
1919	541,474.55	781,143.00	40.80

It will surprise many employees to know, as these figures demonstrate, that stationery calls for such enormous outlay; and it will help to justify the efforts we have been making to convince employees who use paper and other articles included under the heading of stationery, that the subject is deserving of all the attention it is receiving.—*Erie Railroad Magazine.*

Motor Operation Costs as Affected by Highway Location and Grade Design—Part II

Value of Eliminating Rise and Fall by Cut and Fill Construction Discussed — Simple Case of Farm Wagon Trailer Train Explained

By Wilson G. Harger
Former Senior Highway Engineer, U. S. Bureau of Public Roads

A CLOSE analysis of the effects of distance, rise and time on the cost of motor operation is desirable but hardly possible yet. With the great variety of cars, trucks, and other vehicles operating under different degrees of efficiency it is hopeless to arrive at very definite conclusions. General principles based on the laws of mechanics can be derived, but actual definite costs are another matter and the author frankly leaves their determination to someone in the future. Long alternate routes can be advantageously compared in value for the elements of distance, rise and time, but the value of a close operating cost analysis of grade line design has a very limited application as previously discussed. The time element has not much practical value on short trips as we all waste considerable time during the day, but on commercial hauling routes it plays a noticeable part in the cost and for this reason we have analyzed some of the problems in two ways. As a matter of general interest the following approximate data are included. These data have been used by the author personally for some time, but merely as a basis for judgment.

We all have heard the cost of tires, repairs, gas, etc. talked by the hour for the ordinary pleasure car. Each reader probably has his own data but we will assume that the total operating cost on hard surfaced roads in 1919 for the ordinary passenger car, including interest on investment, depreciation, insurance, repairs, gas, oil, storage, etc., runs from 5c. to 12c. per mile. Assume 8c. as an average, and that of this amount gas and oil cost 2½c., assuming 14 mi. per gallon.

We will assume that 5-ton trucks cost about $28 per day to operate; that the total cost of operation will run from 30c. to 50c. per mile. These trucks get about 3 to 5 mi. on a gallon of gas and the cost of fuel will be assumed at 8c. per mile. Two-ton trucks under similar conditions probably cost about $20 per day to operate or about 30c. per mile with a fuel cost of say, 5c. per mile.

It can be seen that the cost of fuel is only a small percentage of the operation of a truck.

Value of Distance Saved

Traffic counts, or the general character of territory served by the road in question, can be used as a rough guide as to the probable proportion of horse traffic, passenger cars and trucks. Taking the ratios of traffic for the main roads of Massachusetts we get the following average saving in operation cost per vehicle for a saving of 1 mi. of distance:

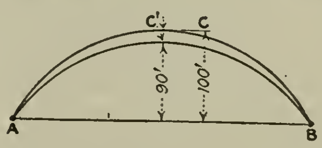
Horse traffic	6% of total	6 x 3c. per mile	= $1.80
Light cars	87% of total	87 x 8c. per mile	= 6,96
Trucks	7% of total	7 x 35c. per mile	= 2.45
	100%		$11.21

Then, $\frac{11.21}{100} = 0.11$, or 11c. However we will assume the financial saving to be 10c. per vehicle on a saving of 1 mi. in distance for main traveled roads.

These data agree with the assumptions of A. R. Hirst given in Part I of this article. Table No. I in Part I of this article assumes average going and does not consider various rates of grade. It includes the time factor and is intended for the comparison of long routes or special service commercial roads. If used as a basis for estimating the value of saving distance on a local service road it is just as well to divide the figures by two. The figures previously given may be summarized by the statement that the capitalized value of saving 1 foot of distance amounts to approximately $14 for a volume of traffic of 100 vehicles per day.

Value of Rise Saved

The elimination of needless rise and fall between terminals providing the distance is not increased is evidently valuable. There are so many indeterminate factors that in this discussion we will take refuge in simple theoretical mechanics using the simplest data available and then modify the results arbitrarily. The tabular results given (Table II) have been used by the author in the absence of reliable data as a rough guide in comparing cut and fill grade reductions. The time factor is not considered as it does not have much real practical value for short grade changes. Time is, however, very noticeable on long steep climbs. For comparing total rise and fall on long routes it is better to use Table III as this considers the time factor.



If a car started at A from rest and there was no rolling resistance, no air resistance, no friction of any kind, no loss of energy from the engine running while coasting down the grade from C to B or from the application of brakes while descending from C to B, the potential energy of the vehicle at the top of the hill C would be equal to the energy in ft. lb. required to

TABLE II. CAPITALIZED VALUE OF SAVING 1 FT. OF RISE AND FALL WITHOUT INCREASING DISTANCE

(Based on fuel cost of 2.7c. per mile on the level)

(Time factor not considered)

Average No. of Vehicles per Day	Yearly Saving 10% Grade	6% Grade	2% or Less	5 Per Cent Capitalized Value 10% Grade	6% Grade	2% or Less
100	$7.55	$5.10	$1.10	$151	$102	$22
250	18.90	12.75	2.75	378	255	55
500	37.75	25.50	5.50	755	510	110
750	56.65	38.25	8.25	1,133	765	165
1,000	75.50	51.00	11.00	1,510	1,020	220
2,000	151.00	102.00	22.00	3,020	2,040	440
3,000	226.50	153.00	33.00	4,530	3,060	660
4,000	302.00	204.00	44.00	6,040	4,080	880
5,000	377.50	255.00	55.00	7,550	5,100	1,100
10,000	755.00	510.00	110.00	15,100	10,200	2,200

NOTE.—This table can be used as the extreme basis of cut and fill reductions on local service roads.

TABLE III. CAPITALIZED VALUE OF SAVING 1 FT. OF RISE AND FALL WITHOUT INCREASING DISTANCE

(Based on a car-mile operating cost of 11c. on average grades)

(Time factor included)

Average No. of Vehicles	Yearly Saving — Grades			5 per Cent Capitalized Yearly Saving — Grades		
per Day	10%	6%	2% or Less	10%	6%	Less than 2%
100	$21	$14	$3	$427	$275	$60
250	52	35	7	1,067	687	150
500	105	70	15	2,135	1,375	300
750	158	105	23	3,202	2,062	450
1,000	210	140	30	4,270	2,750	600
2,000	420	280	60	8,540	5,500	1,200
3,000	630	420	90	12,810	8,250	1,800
4,000	840	560	120	17,080	11,000	2,400
5,000	1,050	700	150	21,350	13,750	3,000
10,000	2,100	1,400	300	42,700	27,500	6,000

NOTE:—This table can be used for the comparison of long routes or indicates about the maximum allowable expenditure for cut and fill reduction on special service commercial roads. Considering the fact that extra fuel and gas means very little to most raod traffic ¼ of these values would be a liberal expenditure at the present time for such refinements.

haul it up the hill from A to C and the kinetic energy at B would be the same due to its speed developed by coasting. Under these theoretically perfect conditions no energy is required to move the load from A to B on the level. The energy in ft. lb. per ton of load would be $2{,}000 \times 100 = 200{,}000$. If the car was stopped at B by braking, this energy would be lost and the total energy expended would have been 200,000 ft. lb.

In a similar way the energy expended over the same hill cut down 10 ft. to C' would have been $2{,}000 \times 90 = 180{,}000$, or number of foot pounds. The saving in energy resulting from cutting down the hill 10 ft. is 20,000 ft. lb. or 2,000 ft. lb. per ton of load per foot of rise saved provided the car is stopped at B. In case the car is not stopped at B and the coasting cars partially climb another hill beyond B on their own momentum there is no saving at all accomplished by cutting down the hill shown from C to C' as the car having a kinetic energy of 200,000 ft. lb. will go farther on its own momentum than the one having a kinetic energy of 180,000 ft. lb.

The introduction of friction and rolling resistance merely adds a constant loss of energy in the normal grade direction which is practically the same in amount no matter how much the hill is cut down as the difference in the distances $A\ C\ B$, $A\ C'\ B$ and $A\ B$ is not appreciable for ordinary road grades.

As a matter of fact the cars are rarely stopped at the bottom of each hill and it is evident that the saving in expended energy due to grading down a knoll depends on how much of the potential energy at C or C' is lost in descending the grades $C\ B$ or $C'\ B$. That is, if half the potential energy is lost through braking, an actual saving of 1,000 ft. lb. per ton of load results from cutting down the hill one foot. If three-fourths of the potential energy is wasted a saving of 1,500 ft. lb. results, etc.

Simple Case Explained

Suppose we carry through a simple case of a farm wagon trailer train starting from rest at A. Full power is applied climbing $A\ C$ and the energy used per ton of load is 2,000 lb. $\times$ total rise in feet plus the rolling resistance in pounds per ton of load x distance travelled in feet. The potential energy of the train at C per ton of load equals 200,000 ft. lb. and the energy used in overcoming rolling resistance is a dead loss and equals 40 lb. (rolling resistance per ton of load from table 1) x distance $A\ C$ in feet. In a similar way the potential energy at C' equals 180,000 ft. lb. per ton of load and the energy lost in overcoming the rolling resistance is the same as the first case.

In descending the hill from C to B or C' to B practical wastes of the potential energy occur through keeping the engine running while coasting; through the application of brakes to control the speed on steep grades or through throwing the engine into second or low gear, and keeping it engaged to act as a brake. Rolling resistance also eats up its regular supply of energy. On low grades no shifting of gears occur as a rule nor is the engine thrown out, the driver merely cuts down his gasoline and takes advantage of the gravity help. *That is, there is less potential energy wasted on a light grade than on a heavy grade. This is the principle we wish to develop as it indicates that from a practical standpoint the actual saving in operation cost for eliminating a foot in rise and fall over a hill, is less important on light grades than on heavy grades.* Professor I. O. Baker developed this same general principle in the third edition of his book published in 1918. This adds a certain theoretical strength to the contention that for light intermediate grades there is very little advantage to traffic through cutting the top of every knoll and fiilling every hollow.

For purposes of a rough approximation we will assume that 80 per cent of the potential energy is lost on a 10 per cent grade; 50 per cent on a 6 per cent grade and 10 per cent on grades of 2 per cent and less. This is based on the assumption that on a level the rolling resistance per ton is 40 lb. and that on a 10 per cent grade the rolling resistance plus gravity = 240 lb. per ton. The down hill gravity pull amounts to 200 lb. per ton, 40 lb. of this is effective in overcoming rolling resistance. We probably lose by brake action $200 - 40 = 160$ lb., or $\frac{160}{200} = 80$ per cent plus engine running waste say 2 per cent = 82 per cent. This is arbitrarily reduced to 80 per cent. In a similar way the other two values are derived modified by the probability that less brake action and engine loss occur on the 6 per cent grade. Theoretically, no loss occurs on grades of 2 per cent or less on the basis of a 40-lb. rolling resistance but we have assumed a loss of 10 per cent as a common sense value.

The theoretical potential energy per foot rise per ton is 2,000 ft. lb. The loss on these grades would therefore be for a

10% grade	80% loss of 2,000 ft. lb. =	1,600 ft. lb.
6% grade	50% loss of 2,000 ft. lb. =	1,000 ft. lb.
2% grade or less	10% loss of 2,000 ft. lb. =	200 ft. lb.

If we assume that the rolling resistance of the farm wagon trailer on a level road is 40 lb. per ton we can convert the saving of energy per foot rise into equivalent distance.

$$1 \text{ ft. rise on } 10\% \text{ grade} = \frac{1{,}600 \text{ ft. lb.}}{40 \text{ ft. lb.}} = 40, \text{ number feet of level distance}$$

$$1 \text{ ft. rise on } 6\% \text{ grade} = \frac{1{,}000 \text{ ft. lb.}}{40} = 25, \text{ number feet of level distance}$$

$$1 \text{ ft. rise on } 2\% \text{ grade} = \frac{200}{40} = 5, \text{ number feet of level distance}$$

Assumng an average fuel cost for all classes of traffic on the road at 2.7c. per car per mile on the level the fuel cost per 100 ft. of rise care becomes.

$$\text{On a 10\% grade } \frac{4,000}{5,280} \times 2.7c. = 2c.$$

$$\text{On a 6\% grade } \frac{2,500}{5,280} \times 2.7c. = 1.4c.$$

$$\text{On a 2\% grade } \frac{500}{5,280} \times 2.7c. = 0.3c.$$

Using these figures we can compile a table of capitalized value at 5 per cent for saving 1 ft. of rise without increasing distance. This table has some value as indicating about the extreme expenditure that is justified for the elimination of needless rise and fall by grading down small hills by cut and fill on local service roads. It does not consider the time factor of operation as this has little practical bearing on minorchanges in rise because there is a certain amount of time wasted during the day anyway. However, this factor becomes very noticeable on long, steep climbs and should be considered in comparing long routes, special service hauling roads or in making radically different relocations. (See Table III, p. 172.)

In order not to lose the sense of value of any such figures it is just as well to bear in mind that the American public is not particularly careful of small savings. The average motor car is not kept in a high state of efficiency. If the owner himself does not think it worth while to save gasoline by keeping his car in shape how can we expect the community at large to make heavy appropriations for construction features whose values are based on purely theoretical small additional savings. There is undoubtedly more gasoline wasted from careless upkeep and driving than we could ever save by the refinements of scientific location and the author is not inclined to give such analyses much weight except as they indicate general principles.

(To be Continued.)

Railway Access to Large Ports

Increase of railway facilities at some of the large French ports during the war, in order to provide for prompt handling of the great volume of military material and supplies, included the construction of loop or belt lines to give at least two independent connections with the main lines. This scheme of two-way access to the ports was provided not only to increase the traffic capacity but also to prevent the possible blocking of traffic in the event of a derailment or other accident or the destruction of the tracks by enemy airships. At both Calais and Dunkerque, for example, two or more railways converged upon a line leading into a single terminal station, while branches extended to the docks and waterfront. Any accident on the approach to the station would have stopped all railway traffic. In each case the plan adopted was to connect the dock branches with a new outside line passing around the city and effecting a junction with the several main lines. At Dunkerque four lines were built to complete a connected system. Another advantage of these belt lines was that of keeping much of the traffic clear of the city terminals, the material being moved directly to yards on the belt lines and there held in cars or in storage ready for forwarding when required. These railway auxiliary or relief works, which will form permanent additions to the transportation facilities, are described in the *Revue Generale des Chemins de Fer* by M. Moutier, assistant chief of operation of the Nord.

Chicago Double Deck Street for Congested District

Traffic Separation Is Main Purpose—Automobile Parking Space, Wharfage and Freight House Facilities Included

A WIDE double-deck water-front street extending along the bank of the Chicago River is not only to form a new thoroughfare and relieve traffic congestion, but is also to have the unusual features of providing wharfage for vessels and facilities for handling railway freight. This project is one of the important municipal works for which bonds were authorized by the voters of Chicago last fall, and is an item in the broad scheme of municipal improvement prepared under the direction of the Chicago Plan Commission. The commission submitted the original designs to the Arnold Co., engineers, Chicago, for review, particularly with regard to the transportation features, since the importance of the project lies in its varied relations to the local transportaion problem. The following matter is prepared mainly from an extended report by J. R. Bibbins, supervising engineer of the company.

The South Water St. improvement will extend for seven blocks, or about 3,500 ft., as shown by the sketch and plan, Figs. 1 and 2. It will commence at the east

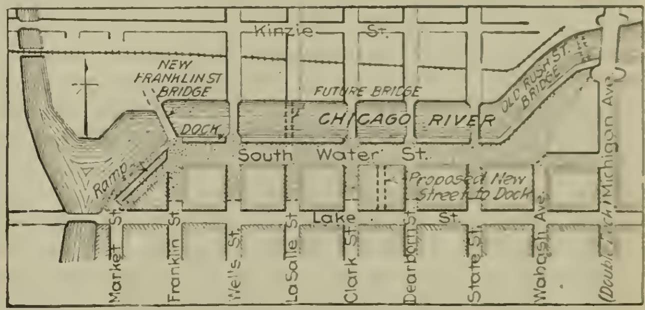


FIG. 2 PLAN OF NEW WATER FRONT STREET

end by a connection with the double deck thoroughfare and bridge completed recently at Michigan Ave., and will terminate at Lake and Market Sts., where an incline is to connect the end of the upper deck with the lower street level. This upper deck will cross the approaches to bridges on six North-and-south main streets serving the central district, and being above the present street level it will permit of giving easier grades upon these approaches.

The improvement will eliminate a congested district which is now occupied by old buildings on both sides of the street and along the river front. This district is utilized as an elongated market for meat, poultry and garden produce. Delevopment of inland navigation, with Chicago as an important gateway, is considered as a possibility and is provided for by the continuous dock front with wharfage and warehouse space. Extension of the marginal street southward along the east bank of the river is recommended, but the double-deck feature might not be required for that future portion of the improvement.

Several purposes will be served by this double deck street. In the first place it will give a new east-and-west thoroughfare of large traffic capacity on the margin of the congested "loop" or central business district, connecting with a number of north-and-south streets, so that it will serve to distribute the traffic at

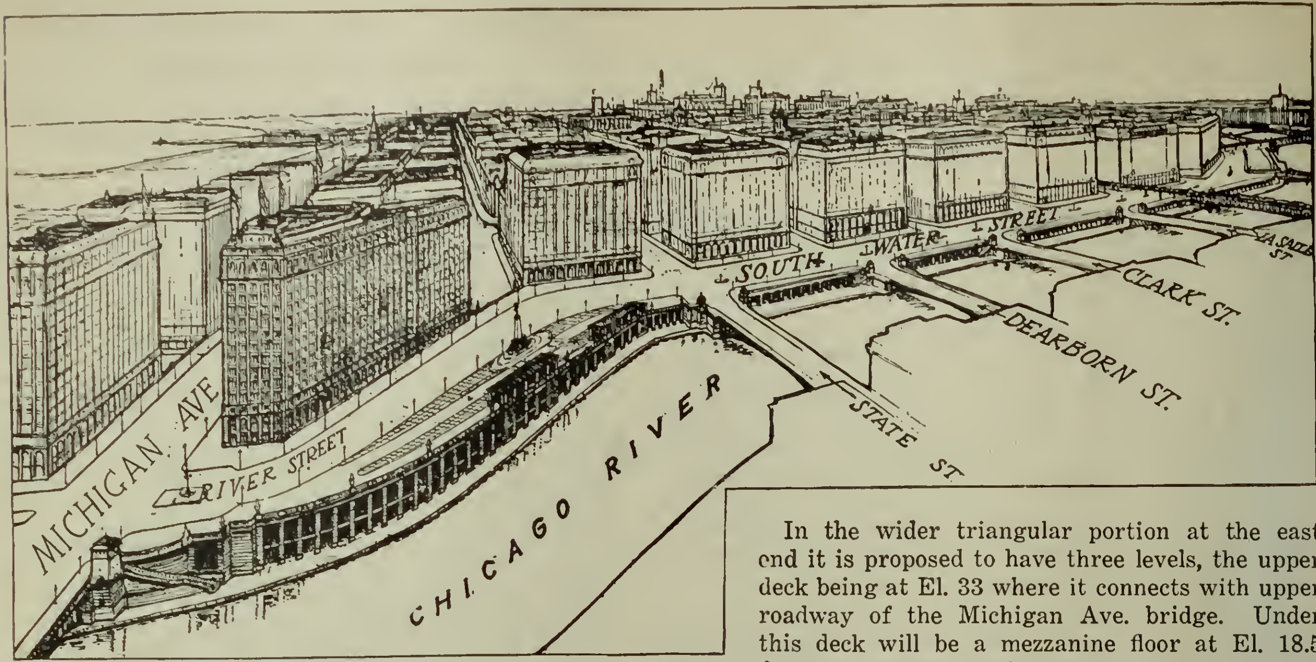


FIG. 1. RIVER FRONT OF SOUTH WATER STREET IMPROVEMENT, CHICAGO

several gateways and will serve also as a needed bypass for much heavy traffic which now has to cross the loop. It will avoid interference of through east-and-west trucking traffic with normal north-and-south traffic over the river bridges. It will also provide extensive freight handing facilities convenient to ships, barges and railway terminals. In addition to increased traffic capacity and the separation of fast and slow traffic, auxiliary advantages include the provision of parking accommodation for automobiles, delivery of freight to buildings on both levels, the increase of local property values and business facilities, the establishment of a continuous line of dock or wharf for water craft, and the removal of the present unsanitary market which blockades a public street.

On the upper level is to be a street 110 ft. wide with a 75-ft. roadway about 21 ft. above the water level of the river (Chicago datum), while the present street elevation is about 14 ft. above datum. This upper deck is for automobiles and through traffic. All intersecting streets will rise to the new elevation by ramps of easy grade on the south side, the north approaches being nearly level with the bridges. The lower level is to be 5 ft. above the water and will project beyond the upper deck so as to form an open wharf or dock space 25 ft. wide, which will be accessible to all abutting property. The typical design is shown by the cross section, Fig. 2.

As the lower deck will be below the street level it will be approached only at the ends, except that near the middle it is proposed to cut a new connection sloping up from the dock level to the normal street level, as shown by the plan. In the covered portion will be four bays forming two roadways for motor truck and wagon traffic, an inner space for wagons backing up to the doors of business houses, and an outer space for parking automobiles or for wharfage. It is estimated that the two roadways will give capacity for 8,000 vehicles each way in an 8-hour day, assuming a speed of 4 m.p.h., or 5,000 vehicles at the slowest vehicle rate of 2½ m.p.h.

In the wider triangular portion at the east end it is proposed to have three levels, the upper deck being at El. 33 where it connects with upper roadway of the Michigan Ave. bridge. Under this deck will be a mezzanine floor at El. 18.5 for storing automobiles and having a central ramp or incline of about 5 per cent grade to connect with the upper roadway. The lower level, at El. 5, will form a municipal dock and warehouse and also a union less-than-carload freight station connected with the existing underground narrow-gage freight transportation system of the Chicago Tunnel Co. A similar station at the west end would be located in the basement of the adjacent building, so as to avoid interference with the through roadways in the event of their extension southward. At each station there are to be elevators and surface tracks for the small tunnel cars, the tracks being on a platform at El. 8.5. The two stations will have a daily capacity for handling 400 and 600 tons respectively. Street cross sections at these stations are shown in Fig. 3.

Ventilation of the lower deck is thought to be necessary owing to the vitiation of air by exhaust gases from motor vehicles and to the fact that this covered portion 110 ft. wide will be closed along the inner side. Gratings in the sidewalk and in safety islands in the roadway are proposed, with an alternative plan for grated openings under the overhanging edge of the sidewalk. On the river side will be arched openings between the columns. The structural design has not been decided upon, but probably concrete piers will form the foundations. Inclined approaches on the south side will be fills with concrete retaining walls, except that they may be utliized partly for storage space. Galleries for the wires, conduits and pipes of public utilities are provided, as shown by the drawings.

Street Traffic Conditions

Improvement of traffic capacity in and around the loop district of Chicago is of particular importance in view of the exceptionally congested and restricted conditions of the district, which has an area of only 0.66 sq. mi. Although this extreme centralization of business is very objectionable, and is detrimental to the proper development of the city, there is little prospect of enlargement of the business center prior to the construction of rapid-transit subways.

Many of the streets in the loop district are narrow and it has only 17 gateways, of which six are on the

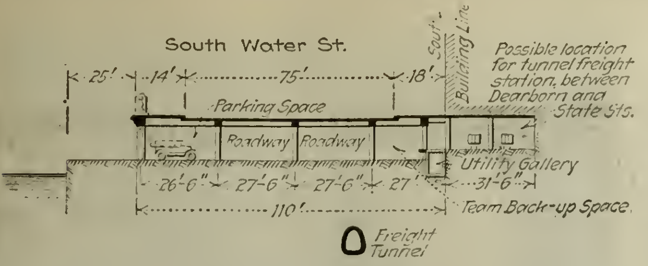


FIG. 3. TYPICAL CROSS-SECTION OF DOUBLE DECK STREET

north side, and most of these routes have the disadvantages of river drawbridges with inclined approaches. Owing to the elevation adopted for the new river-front street, the bridge approach grades will not exceed 3 per cent. It is suggested in the report, however, that each approach should be broken by a short and nearly level stretch on the south side of the new street, even at the expense of lengthening the approach, as this will facilitate the starting of heavy street cars and vehicles when the traffic signal is given.

Nearly 60 per cent of all loop traffic (trucks, teams and automobiles) is to and from the north side, the figures for one day in 1916 showing 15,000 passenger vehicles and 12,000 commercial vehicles. During the same time 5,000 commercial vehicles moved east and west in the first three streets south of the river (South Water St., Lake St. and Randolph St.)

In addition to this heavy and intersecting traffic condition, the loop district is surroundet by steam railways, with freight houses and yards, resulting in an enormous cross traffic of heavy trucking between the various railway and commercial facilities. This condition will be relieved materially by the new street, which will not only enable a large proportion of the traffic to pass around the loop but will keep this by-pass traffic clear of intersecting traffic and out of the path of fast traffic moving in the same direction overhead. It is estimated that without this separation there would be 4,000 freight vehicles crossing the path of 13,000 through vehicles every day.

Of equal importance will be the relief afforded for the automobile traffic, which already is a serious problem in the loop. The main relief will be in distributing the heavy north-side traffic over several gateways, while at present over 75 per cent is handled at one gateway and there is no broad thoroughfare to permit of distribution. Further there will be a route for through movement between the north and west sides of the city without crossing the loop. A traffic census made in 1917 (*Engineering News-Record*, Feb. 17, 1918, p. 254), showed 49,621 automobiles entering and leaving the loop in 12 hours, 15,634 of these being on the north side and 77 per cent of the latter using Michigan Ave.

A large proportion of these automobiles stop in the loop and form a serious hindrance to traffic. From the census noted above it appeared that of 6,000 automobiles coming from the north side in one day, 4,500 were destined to points within the loop and that ?,900 of these were parked at least one hour. A count made by Mr. Bibbins in 1916 showed that over 66 per cent of the parked vehicles in the loop remained over an hour and the majority were on streets having car lines. In spite of city regulations, the parking of cars in the streets is an exceedingly troublesome factor in the municipal transportation problem.

Provision of storage or parking accomodation for automobiles at points closely adjacent to the lop is highly desirable, but it is difficult to find available space. The South Water St. improvement will help to remove this difficulty by providing space for 300 machines on the mezzanine floor at the east end (adjacent to the heaviest traffic gateway) and for 225 machines along the lower level.

Freight Handling Tunnels

For the handling and transfer of local freight Chicago has the unique advtanage of an extensive system of tunnels, although this system has been worked as yet only to a small porportion of its ultimate capacity. It is the utilization of this underground line in connection with the new street, for the double purpose of facilitating the handling of freight and reducing the congestion of street traffic in the business district, that forms one of the important features of the Arnold report. In other words, the street improvement is taken advantage of as an opportunity for improving the entire local freight service of the city.

About 1,800 tons of L. C. L. freight are handled daily by the tunnel system, which serves railway freight houses, large wholesale and retail establishments, warehouses and other points. This tonnage is less than 10 per cent of the total outbound freight traffic of the rail-

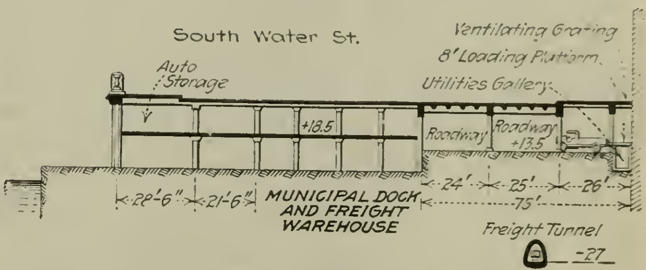


FIG. 4 TRIPLE DECK PLAN GIVES PARKING SPACE

way downtown freight houses, but the report states that with some improvements and with proper co-operation of all interests it could handle probably 10,000 tons daily. Even with 2,000 tons daily the importance of the underground transportation is shown by the fact that this amount would require from 750 to 1,000 trips of motor trucks daily, or 90 to 125 round trips per hour during an 8-hour day. This business would require 250 to 300 more vehicles on the streets, and most of their movements would cross the busy loop district.

Alternatives to the tunnel system for handling the local freight are motor trucks, railway trap cars and river lighters. Trucks will tend to a continual increase in traffic congestion, besides increased cost of street paving and maintenance. Trap cars are a necessary evil, but their use involves delay and expense. Lighters could serve only the relatively small proportion of freight area located along the waterways of the city.

The South Water St. improvement is one feature of the "Plan of Chicago" conceived some years ago by the late Daniel H. Burnham and now supported actively by the Chicago Plan Commission. General designs have been made by Edward H. Bennett, consulting architect for the commission. Detail plans are being prepared by C. D. Hill, engineer of th Board of Local Improvements, which board will carry out all the legal, technical and construction work.

Chart Records of Excavating Machine Operations

TO DISCOVER the rates of speed and the time consumed in the several operations of machine excavators with a view to determining their effectiveness, George B. Massey, consulting engineer, Chicago, has made experiments with autographic apparatus designed by him for the purpose.

The recording instrument, Fig. 1, consists of a series of pens electrically connected to contacts on different parts of the machine and tracing lines or diagrams upon a 5½-in. strip of paper traveling vertically over rollers. The paper is long enough for a record of 90 to 180 minutes and is moved by clockwork at the rate of 6 to 12 in. per minute. Steel fingers on fiber board bases form the contacts with the moving parts, being supported usually on brackets secured to foundation bolts. In this way a rigid attachment can be arranged without difficulty.

For tests on a dipper dredge, six diagrams were drawn recording the performances of: Dipper thrusting engine, swinging engine, direction of swing, hoisting and backing and revolutions of main engine. For a tower type of machine, with a dragline bucket carried by a cable between two towers, the diagrams showed the following: Revolutions of main engine, revolutions of track cable sheave, hauling of loaded bucket, movement of track cable for dumping, backhaul. Samples of these charts are shown in Fig. 2 and 3, the originals being taken with the paper moving at the rate of 8½ in. per minute. Additional pens with automatic or hand operated connections could be used to record coal and water consumption, travel of the machine and the cause of delays.

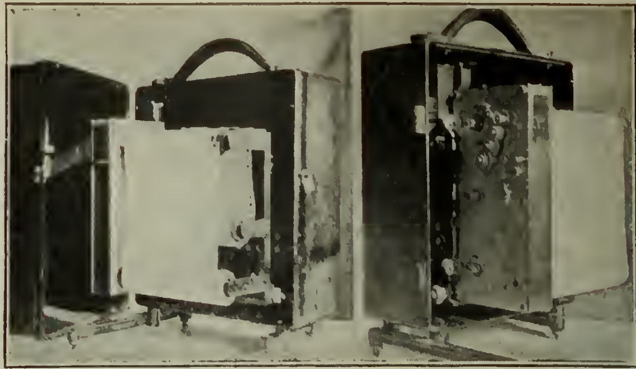


FIG. 1. RECORDING DEVICE FOR EXCAVATING MACHINE

On the dipper dredge, contacts attached to the clutch levers of the hoisting and backing drums indicated when they were operating at the same speeds as their shafts. A contact on the reverse lever of the swinging engine indicated the direction of swing. Thus the position of the boom and the path of the dipper could be plotted and the acceleration of the hoisting, backing and swinging movements could be ascertained. A dipper dredge is apt to roll when the boom swings, especially if the soil makes it difficult to keep the machine pinned up. This may affect the acceleration of boom swinging and could be recorded. It would be desirable also to record the instant when the dipper handle assumed a vertical or horizontal position, as this would give for each cycle a point from which the position of the dipper could be ascertained.

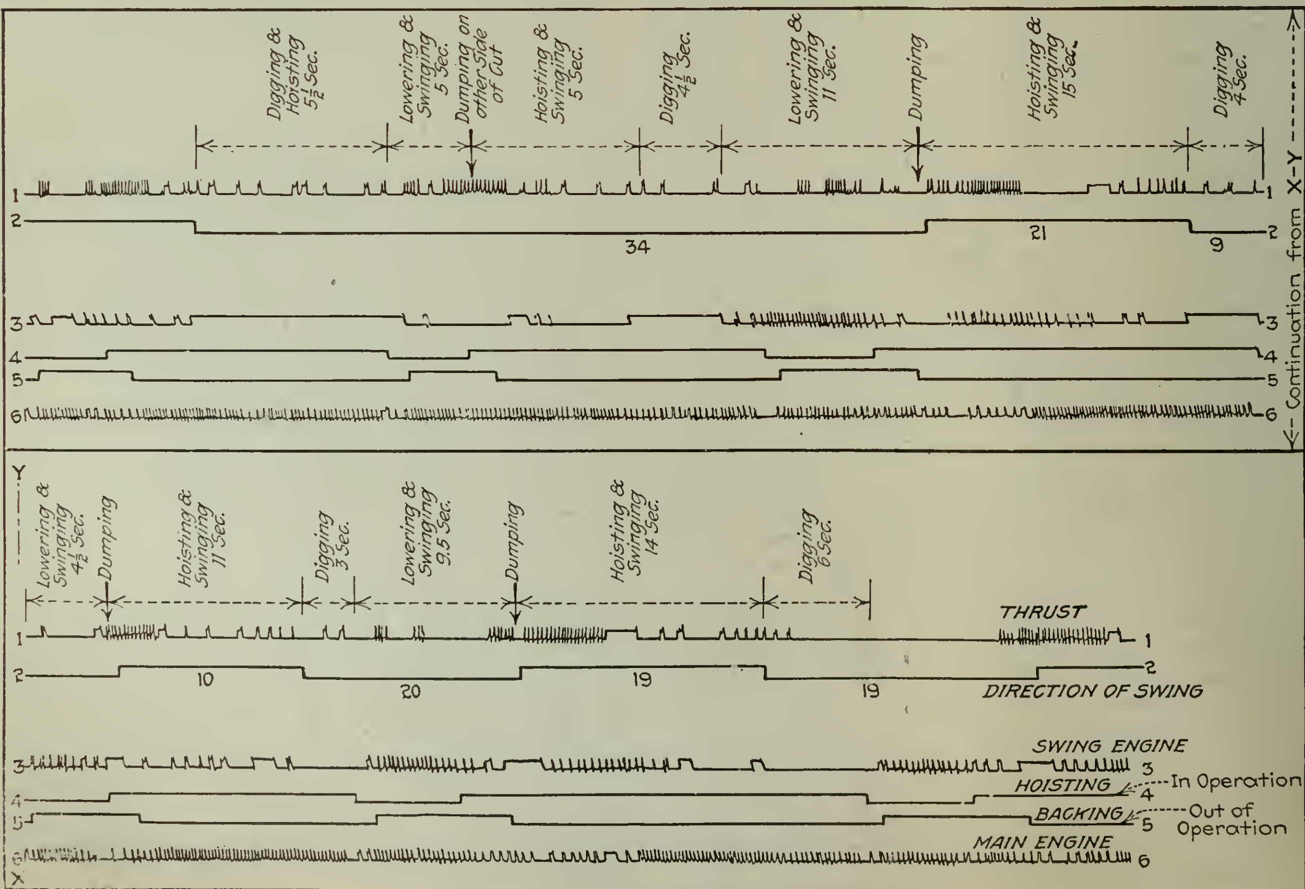


FIG. 2. CHART FROM DIPPER DREDGE

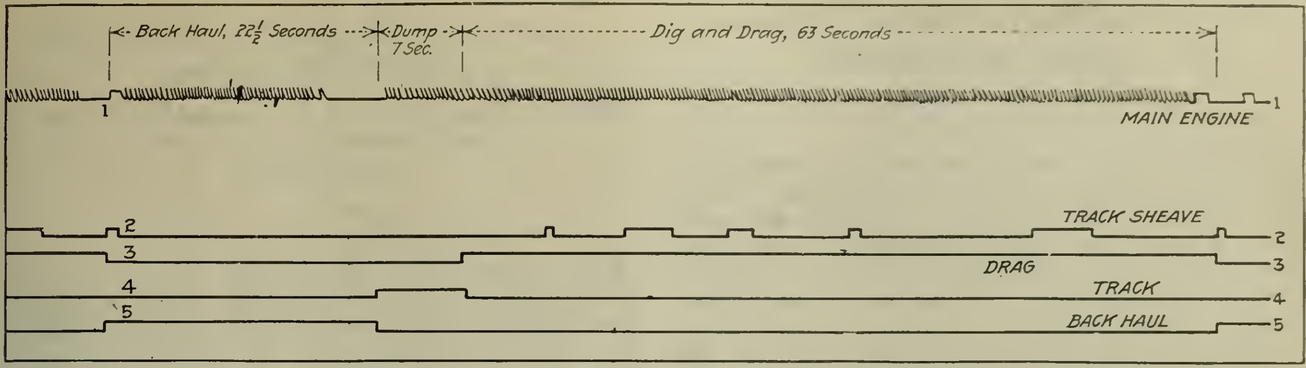


FIG. 3. CHART FROM DRAGLINE EXCAVATOR

An interesting feature in the tests of the dredge was the difference in the records of several operators. With the same yardage one man operated the machinery more smoothly than the others, thus saving in repairs, steam and coal. The only difference in operation was a slightly smaller opening of the throttle valve and the lapse of a little more than a second in throwing the clutches.

In the tower excavator, all the drums were driven by one engine and one contact recorded the revolutions of the crankshaft, the drum speed being determined by the gear ratio between the crankshaft and each drum shaft. A contact on each clutch indicated when the drum was driven and released. To record the speed of paying out the track cable to dump the bucket, a contact was operated by one of the spokes of the sheave when the sheave moved in the paying out direction.

Long Aerial Cable Tramway in the Northern Andes

Country Too Rough for Railway Building Crossed by Line to Mountain City—Maximum Span 3,168 ft.—Steam Power

CONSTRUCTION of a 45-mile aerial cable tramway forming the extension of a mountain railway is being carried out to connect Manizales, Colombia, with the end of the Dorada Railway at Mariquita. The city of Manizales, with a population of 35,000, is the center of a rich agricultural district at an elevation of nearly 7,000 ft. in the northern Andes, but it is accessible only by rough mountain trails. Mule teams can make the 45-mile trip in 2½ to 3½ days in summer, but in the rainy season the trip may take two weeks. As a result the loss and damage to goods in transit is considerable. According to an article in *The Engineer* of London, from which this information is taken, the loss on coffee has amounted to 10 per cent of the total shipments.

Four intermediate villages have to be served by the cable tramway and this condition governed the general route, but surveys for location were hampered seriously by the prevalent and long continued fogs. At one point the line spans a valley only about a mile wide at the top but so steep and precipitous that mule teams take about eight hours for the crossing.

Starting at Mariquita with an elevation of 1,500 ft., the line will rise to a summit of 12,000 ft. in 32 miles, thence descending in 13 miles to an elevation of 6,700 ft. at Manizales. The alignment is fairly straight and includes only five angle stations. The line will be divided into fifteen sections, the longest being 19,000 ft. with a difference in elevation of 787 ft. In the shortest section 8,528 ft., the difference in elevation is nearly 1,312 ft.

For supporting the cables there will be 437 steel towers from 10 to 217 ft. in height, but only two will be of the maximum height and only eight over 130 ft. The longest span between towers is 3,168 ft., but there will be sixteen spans of more than 1,640 ft. Both three-post and four-post towers are used. A wire rope of 2⅝ in. circumference, with a breaking load of 30 tons, forms the track cable and runs over 24 in. sheaves carried by cross arms on the towers. Tension stations are provided to adjust the sag of the track cable to the load carried. The carriers or buckets take normal loads of 670 lb., occasionally as high as 1,120 lb., and travel at a speed of about 400 ft. per minute. The plant is designed for a traffic of 20 tons per hour from Manizales, and 10 tons per hour from Mariquita, but the first installation will be for half this capacity.

Steam plants will be provided in 30-hp. units with boilers adapted for brush fuel and 120-lb. working pressure. At stations where greater power is required, two units will be installed. There will be 20 stations in all, including driving and tension stations. Warehouses into which the carriers will run will be provided at the terminals and at four intermediate points.

Construction was commenced in 1913, the first 10-mile section being opend in 1915, and the adjacent 11-mile section in 1916. War conditions then interfered with the work, but early in 1920 the line had been completed for 23 miles and further construction was in progress. Engines and boilers were shipped in sections of not over 1,120 lb. and most of the cases weighed only about 220 lb. For mule transport the cables were put up in coils of 100 lb. each, with a loose stretch between, each mule carrying two coils. The line is owned by the Dorada Railway Co. (Ropeways Extension), for which Sir Douglas Fox & Partners, London, are the consulting engineers. The Ropeways Co., London, has the contract for equipment and construction.

Water Supply of New Zealand's Capital

The City Council of Wellington, New Zealand, has decided to expend about $500,000 in cutting two tunnels through the hills near the city to bring water from the Orongorongo River, with the additional expenditure of $1,119,295 for extra mains and other expenses to provide a water supply sufficient for a city of 130,000 people. The present population of Wellington and its suburbs is about 95,000.—*Commerce Reports.*

Simple Solution for Finding Center of Gravity of Trapezoid

By Jacob London
New York City

THE problem of finding the center of gravity of a four-sided figure graphically often arises. The solution which I am submitting is simpler than those given in handbooks and especially handy when the shape of the figure is to be determined by a cut-and-dry method, as in the design of buttresses, retaining walls, and small gravity dams.

The principle of construction is briefly this: by means of a diagonal divide the four-sided figure (Fig. 1) into two triangles with centers of gravity at M and N. The center of gravity of the entire figure must lie at a point C somewhere on the line MN. The area of the triangle "N" times MN must equal the area of the entire figure times MC. Call the intersection of MN and the diagonal, A. The triangles have a common base. Their areas are proportional to their altitudes or to the segments MA and AN. The total area is proportional to MN.

Then $AN \times MN = MN \times MC$
and $MC = AN$

In practice the top and rear face of the wall or dam are fixed, arbitrarily. The slope of the front face and

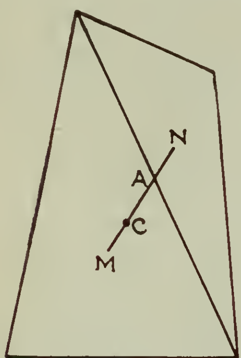


FIG. 1

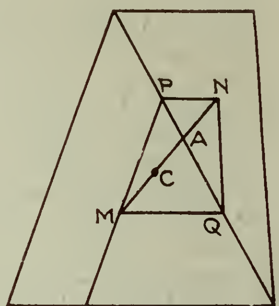


FIG. 2

the width of the base vary with the forces acting. Thus, two adjacent sides are fixed and a diagonal may be drawn. Divide the diagonal into three equal parts (Fig. 2), P being the upper third point and Q the lower. Draw PN parallel to the top and QN parallel to the rear face giving N, the center of gravity of one triangle. Draw a line through Q parallel to the base. All the lines drawn so far are independent of the slope of the front face.

To find the center of gravity of the cross-section for some particular front face draw a line through P parallel to the front face. (The intersection of this line with the base gives the limit of the middle third which is useful.) The intersection of the line with the line through Q, parallel to the base gives M, the center of gravity of the second triangle. Draw MN getting A. Lay off AN along MN from M which gives C, the center of gravity of the cross-section.

If a new front face be tried it is only necessary to draw two new lines PM' and NM' to get the new center of gravity and the diagram is not confused by their addition. Other methods necessitate the erasure of all the old construction lines when a new front face is considered.

Basis of Estimating Allowance for Depreciation

What Is Proper Method of Accounting in Respect to a Valuation for Purposes of Rate-Making?

By William G. Raymond
Dean, College of Applied Science, State University of Iowa

IN A depreciating property furnishing service of any kind, one of the items of cost of service is depreciation allowance, set out from year to year in a depreciation reserve. As valuations are usually made in rate cases the reproduction cost of the property at the time of valuation is estimated, the amount of accrued depreciation is estimated with the reproduction cost as a base, and as an item of the operating expense the annual depreciation allowance is estimated on the same base. The purpose of this paper is to inquire whether or not this is proper practice.

What is it that is chargeable as a cost of service? What is it that the public enjoying that service is under obligation to pay with respect to this item of consumption of capital? Is it the cost of the item in use or the cost of the item that replaces it when it is worn out? Is it the investment that is to be protected by making an allowance for depreciation, or is it the physical thing that was purchased with that investment that is to be protected? That is to say, is it the cost of the item that is to be returned to the owner when the item is worn out, or is it another item of like kind, or for a like purpose that is to be furnished him?

The Wrong Basis

It is thought to be, without question, correct bookkeeping and in accordance with the requirements of public commissions—where these commissions have made requirements—that when an item is discarded its cost is credited to capital, and the cost of the item that replaces it is charged to capital. This seems to be a rational procedure.

But now let it be supposed that instead of charging off the old item at cost, no entry is made in the capital account, but the cost of the new item is treated as an operating expense, which the public is expected to pay, because the public should pay operating expense, and that a valuation of the property to determine fair rates occurs shortly after the replacement. The time since the replacement may be supposed to be so short that in fixing prices of the various items of property the price of the particular item under question will be its actual cost, and let it be supposed that that cost is double the cost of the item that it replaced. Thereafter the public will be expected to pay interest on this double cost after having itself, through its contribution to operating expense, paid half of the cost, that is to say, it will be paying interest on the contribution of the owner and interest on its own contribution as well. Is this right?

But let it be supposed that the cost of the second item is only half the cost of the item that it replaces. The public then will be expected to pay interest on half the cost of the original item, and the owners original investment will have been cut in two. He will henceforth receive interest on only half as much as the invested originally in this item of the plant. Is this right?

It may be said that the results above indicated will have been due to a charge in the value of the dollar and that since the working item is made good in kind the value of the property as a working property is maintained, that the value of the investment is maintained as it was in the beginning, as was required by the U. S. Supreme Court in the Knoxville Water Works decision. But is this true?

Maintaining the Investment

The change in the price of a single item in a large going property may not be due to a change in the purchasing price of a dollar, but may be due to a change in the market price of the particular item. Let it be supposed that an item of presumably long life, purchased and put into service in a going plant, is destroyed by accident shortly after its purchase, but that in the meantime the price of the item, and therefore the cost of replacing it, has changed materially. This is not a violent assumption. Shall the public be expected to pay the additional cost of the new item over the one it replaces, if any, or the owner be expected to lose from his investment the difference between the cost of the old item and that of the new if the new one costs less than the old?

Manifestly either procedure would seem to be unfair, and from this somewhat extreme, but possible example, it would seem to be reasonable to conclude that when a public utility property is created, it is not the physical property items that the public should undertake to maintain, but rather the investment in that property. And if the owner receives a fair return rate on the money that he invests in the various items of a public service property, while these items are in existence, and receives back what he paid for them when they go out of existence, and further receives a fair return on the cost of the items that replace the original items, whether this be less or more than the cost of the original items, is he not receiving his just due, and is not the public paying its fair charge?

If this conclusion is sound, then the annual depreciation allowance that is included in operating expense should be based upon the cost of the depreciating item, and not on the cost of the item that is to replace the depreciating item. As a rule this cost of the replacing item cannot be known in advance of its purchase, so that it is impossible, even if it would be just, to base the depreciation allowance for a given item in use on the cost of the item that is to replace it.

And again, if the conclusion is correct, then it is equally improper to base the depreciation allowance on the cost of reproduction of the property as of the time of a valuation. Rather should the depreciation allowance be based upon the estimated or known original cost to date, and this is true regardless of whether original cost to date or reproduction cost as of the date of valuation, or any other estimate is used for determining the value of the property at a given date.

The position taken by the Committee on Valuation of the American Society of Civil Engineers, appointed to formulate principles and methods for the valuation of railroad property and other public utilities, is strictly in accord with the final conclusion above stated. On page 1857 of the committee's report the following statement is made: "Operating expenses being collected from the public, it is said that the owner is reimbursed when the charge to operating expense is made. Some owners do not charge the cost of the retired item, but rather the cost of the item which replaces it—if such there be—which may be more or less than the cost of the item retired. If it is more, the public is contributing capital to this extent; if less, the owner is losing capital to this extent. This practice is prohibited by the Interstate Commerce Commission for large telephone companies, although permitted for many classes of railroad property."

Railroad ties, which are maintained under what is known as the replacement method of maintenance, are treated much like fuel. It is impracticable to keep track of each tie that is replaced and hence as these ties are wearing out fairly rapidly, the cost of replacement is charged to operating expense, and on a rising cost for ties the public is actually contributing capital to the enterprise; and on a falling cost of ties—a condition that does not exist and is not likely to exist soon to any great extent—the owner is losing capital. But this seems to be an unavoidable difficulty or departure from theoretically correct accounting.

It sometimes occurs that an item of property is not replaced at all when it wears out. Some new method of doing what this item has done has been discovered. The item has become obsolete. The cost of replacing it in kind is zero because it is not replaced. Shall the depreciation allowance be figured on this basis? Manifestly that would be absurd. The owner would have lost his investment.

Does it not seem clear therefore from the statements made, that always the depreciation allowance—when any depreciation allowance is set up in operating expense—should be based on the original cost of the depreciating items rather than on their reproduction cost as of any time or on any estimate that may be made of their future replacement cost?

Wooden Water Mains 130 Years Old

In putting in high-pressure water mains recently, workmen who dug up one of Boston's streets came across about 50 ft. of wooden water mains installed in the city in 1789 and used continually until 1840 for bringing water from Jamaica Pond in Roxbury to Boston. The pipes were installed by a corporation formed at the instance of Gov. Samuel Adams, with authority to hold $33,000 worth of real estate and to issue 100 shares of stock.

In all, 15 miles of these water mains were laid, serving a fairly large section of what is now downtown Boston and was then the whole town. At the height of its prosperity the service supplied 1,500 houses with water. The mains were replaced in 1840 with 10-in. iron pipes, and in 1849 the present municipal system, which now has more than 860 miles of mains, supplying more than 100,000 buildings, was instituted.

The wooden mains are approximately 16 in. in outside diameter, left in their natural condition on the outside, except for removal of the bark, with 4- and 2-in. bores through them. Transversely there are ⅜- and ½-in. openings in which were inserted lead pipe used in conducting the water to the houses. The sections of pipe were cut off at right angles. and lead couplings were used to connect them.

The wood is said to be pitch pine. This was verified by the foreman in charge of the work, although it was first said that the mains were of cedar. The outside surface is rotted but the wood itself is still hard.

Notes from Foreign Fields

ENGINEERING CENTER OF THE BRITISH EMPIRE

BY

E. J. Mehren

EDITOR ENGINEERING NEWS-RECORD

THE "Underground," the name by which the passenger subways of London are generally known, differs radically from our subway construction in the United States in that the tubes, with the exception of those of the District Railway, are at depths varying from 50 to 70 ft. below the surface. We try to keep our rails as near the surface as possible. The American visitor naturally inquires the reason for a design that differs so radically from ours.

A brief acquaintance with London furnishes the answer. In the first place, there are few long straight streets in London, and the direct and economical routes from the business section to the residential districts must lie for their greater length under buildings and private property. Manifestly, the purchase of private rights of way in such a city as London would be prohibitive, while the driving of the tubes close to the surface would involve an amount of under pinning that would again be prohibitive.

In the second place the surface material at London is of a gravelly character, strata ranging from 40 to 60 ft. in thickness. Below is dense, compact clay free from water. By driving through the clay not only can the tubes pass under private property without disturbance of the structures above, but the construction work can go on practically in the dry, while the clay itself is ideal material through which to drive the tubes.

With the exception of the District Railway, the tunnels are built of circular cast-iron rings. The levels rise and fall in accordance with the profile of the top of the clay stratum, care being taken to keep the top of the tunnel about 10 ft. below the top of the clay, so as to exclude the water.

The District Railway was built in the sixties partly by cut-and-cover methods and partly by a double-track tunnel, with segmental arch and flattish floor, timbered during driving. The first of the tube-design lines, the City and South London, built in 1901, has an inside diameter of only 10 ft. 6 in. With these exceptions, the tubes are of a standard design, consisting of cast-iron ring, 11 ft. 8¼ in. in inside diameter. Each tube railway consists of only one pair of tubes, that is, there is no express service such as we know in New York.

Plans have been made for enlarging the City and South London tube to the 11-ft. 8¼-in. standard. The work is to be done during the non-traffic hours and the present cast-iron sections are to be reused, the larger diameter being secured by inserting four key pieces of somewhat greater length than the present keys. The method has already been subjected to experiment with satisfactory results.

The tubes being at so great a depth below the surface are necessarily served by elevators or escalators. As a rule elevators of large capacity are used, two or three to a station. In some of the stations escalators have already been installed and plans for additional installations have been made. They are in pairs, one running down and the other up, with a stationary stairway between. Pairs of escalators of this type have a maximum capacity of about 12,000 passengers per hour and the engineers of the Underground estimate that it would require five to six elevators to do the same work.

The tubes are generally operated with six-car trains, but changes are being made so that eight-car trains can be used. On one of the railways, the District, there are only two guards to a six-car train, the passengers—except during the rush hours—opening and shutting the doors themselves. The rear guard, after assuring himself that all the passengers who so desire have left the train or entered it, blows a whistle as a signal to start. During rush hours guards on the station platforms attend to the loading. At one time there was a guard to every pair of platforms, and the doors were mechanically operated, but this was found to be unpopular with the London public and the present scheme was adopted. However, on the tube routes there is still a guard at every pair of car platforms and the inward-swinging type of door is used. (On the District Railway sliding doors are used.) The reason for this difference in practice is that there is very slight clearance between the cars and the inside of the rings of the circular tube, so that a person getting off while the train is in transit would be crushed to death. In the District tunnels, there is plenty of space on either side, and while there might be serious consequences of alighting, immediate crushing would not result. Experiments are now under way to operate all doors in a train by one guard.

Knowing conditions in New York, one naturally asks whether the London public is satisfied to ride long distances over what must necessarily be a local-stop railroad. From what I could learn there is no dissatisfaction, none of the speed demand that we find in New York. Trains, when they get out of the heart of the business district, do skip stations and thus increase the capacity and speed of the line. It is realized, however, that as present routes become congested additional facilities must be provided and it is planned then to drive additional pairs of tubes at deeper levels and thus, while increasing capacity give an express service.

In an experience of two weeks the service in the Underground impresses one as being very satisfactory; the trains travel at high speed and with remarkable frequency. The engineers have assured me that in the District Railway they put 40 six-car trains through a given station per hour. This equals the theoretical clearance of trains in the New York subways, but I was told here that in actual practice the New York lines do not keep up to this theoretical schedule.

The fares, as I noted in a previous letter, are at the rate of a penny per mile, at which rate, though, the tubes are losing money.

London, May 18, 1920.

Omaha Takes Over Private Gasworks

The privately owned gasworks supplying Omaha, Neb., were taken over on July 1, by the Metropolitan Water District, which already owns and operates waterworks and a municipal ice plant.

Letters to the Editor

The Chicago Drainage Canal Decision

Sir—In your issue of June 24, p. 1274, you have a paragraph headed: "Court Restricts Flow of Lake to Chicago Drainage Canal." You say the draft of lake water into the canal is now limited by the U. S. District Court to 250,000 cu.ft. per minute. The original plan (1887) on which the Chicago drainage canal was designed and built, assumed a diversion of 600,000 cu.ft. As chief engineer of the Drainage Commission which made this recommendation after almost a year's careful observation and thorough investigations, permit me to call your attention to some engineering facts, which are not mentioned in your statement but may be of interest.

The diversion and abstraction from Lake Michigan of a large quantity of water, required for sewage dilution, and its subsequent discharge into the Desplaines, Illinois, and Mississippi Rivers, in addition to their flood flows, demanded studies in hydraulic engineering of unusual magnitude at that time. The proposed final conclusions were so definite and satisfactory that there appeared no reason against adopting the plans as recommended, which called for a long rock cut with a cross-section sufficiently large to carry 600,000 cu.ft. per minute. And the canal was built with this capacity.

The opposition of the U. S. Government to the withdrawal from Lake Michigan of that amount did not appear until later. Conversations with some of the engineer officers when the designs were being made drew out no objection. Our studies revealed no reasons for anticipating any hydraulic objection that could not be fully and readily neutralized when required. The greatest difficulty at first seemed to be the addition of this quantity of water to the flood flows of the Desplaines and Illinois rivers. When it was found that not many centuries ago Lake Michigan naturally discharged over a low divide into the Desplaines River, the accumulated alluvial soil upon the rock now being but one or two inches deep over large areas, an examination was made of the old river bed for perhaps a hundred miles down stream, which indicated that a much larger current had formerly passed down the valley; and that the erosion to be caused by the additional flow would increase the section available for flood waters, and possibly cause no increased flood heights whatever. But, if this should be the case, Chicago might be obliged to bear the expense of some shore regulation which could not be more than a small amount. It was not worth considering at all in such a large project at that time.

The other possible objection, the effects of diverting water from the Great Lakes, could be more readily subjected to an engineering investigation, and this was subsequently undertaken.

When municipal water supplies, or water for power purposes, are to be taken from small streams, it is a common practice to equalize their flow to a sufficient extent by building storage reservoirs so as to make it more uniform throughout the year than the dry-weather months on the one hand and floods on the other would permit. In the case of the Great Lakes there can be a regulation of the flow at both ends, by controlling works at the Sault Ste. Marie rapids, and by similar works in the Niagara River above the falls. The latter was by far the more complicated and expensive proposition. Its effect upon the City of Buffalo was material, and the diminution of its value to the Drainage Canal, by the fall in the St. Clair River, made such a solution insignificant for the desired conditions at Lake Michigan.

Computations at the other end resulted in the conclusion that a movable dam, not over 18 in. in height, if I remember rightly, built at Sault Ste. Marie, would add far more water to Lake Michigan, by a temporary storage of flood waters in Lake Superior, than could be dangerously abstracted by the drainage canal. When this conclusion was reached there seemed to be no physical objection to the building of the latter.

During the World's Fair in Chicago in 1893 a number of European engineers, engaged in river and harbor work and in regulating the large rivers in France, Holland, Germany and Austria, examined the drainage canal and its design. It was interesting to have their opinion on our great diversion project, because of the excellent results they had achieved in their respective countries. I heard nothing but praise of American enterprise in utilizing our vast natural advantages. One of them enthusiastically said that, if undertaken soon enough, Lake Superior alone could be developed by increased storage to furnish more wealth in water power for the United States and Canada than could all Europe, excepting only Switzerland and Scandinavia; and incidentally create large navigable waterways with ample flow of water from the Great Lakes to the Gulf of St. Lawrence and to the Gulf of Mexico with dimensions that could not be thought of in Europe.

What has our United States Government accomplished at the proper time in this direction? What are the United States courts doing to encourage such a development?

Incidentally, I would like to add that I signed the report recommending the drainage canal, primarily for sewage dilution purposes, together with Benezette Williams and Samuel G. Artingstall as consulting engineers, in January, 1887. Our designs, estimates of cost and recommendations were then based on a sufficient dilution for a term of thirty years, ended several years ago. This canal, in my opinion, could, even at its best, now no longer take proper care of all the sewage entering it, without a prior partial treatment of an annually increasing proportion of it.

Whatever objectionable conditions may have existed in the canal during intervals in the past, or possibly now exist, would be due partly to the insufficient sewage dilution allowed by the courts, partly to the admission of much private trade waste, and partly to the absence of sufficient dredging of the sludge deposited in the river, all of which is against the advice given in the original reports.

New York City. RUDOLPH HERING.

[The news note mentioned in Mr. Hering's first sentence was followed by essentially the entire decision (p. 129) and by an editorial (p. 99) in our issue of July 15.—EDITOR.]

An American Hydraulic Laboratory

Sir—In your issue of June 24 appears an article entitled "The Need for an Endowed American Hydraulic Laboratory." This is a most timely subject and I wish to encourage you in your efforts to place the matter before your readers.

Congress has just passed a water-power bill under the provisions of which the enormous power resources will, it is anticipated, be developed. Fortunately, through private endeavor, there is considerable reliable data at hand covering the use of water for the development of hydro-electric power and consequently there should not be the enormous waste of water in these proposed developments that we find in many other instances. In order to bring to the public attention the need for a more scientific use of water, reference can be made to the article appearing in the June 10 issue of your paper by E. A. Moritz, affecting the use of water in irrigation, where the following statement is found: "The quantity of water lost in transit on an irrigation project is enormous and in some cases appears to equal or even exceed, the quantity delivered to the farms."

This statement is without doubt based on facts obtained through Mr. Moritz's long experience and permits of only one conclusion to be drawn from his article; that is, under the present condition of operation it is necessary to divert twice as much water from a source of supply for any given irrigation project than is intended to deliver to the farms owing to the fact that one-half of all water so diverted would be lost in transit. The actual loss of water is not the worst feature but rather the resulting over-watering of lands, seepage of canals, ditches, etc., because of which large areas have become fairly water-logged and entire districts are now being organized for the purpose of drain-

age. As a matter of fact, when one stops to consider the entire problem of the economical use of water, so many points are immediately brought to mind that considerable surprise is occasioned that a federal hydraulic laboratory has not been in existence for some time.

We have been experimenting for a great many years with the use of water and the Reclamation Service has spent millions of dollars in various works scattered over the Western states. The engineers in charge should have had at all times the benefit of a properly equipped hydraulic laboratory and a thoroughly competent research department. It seems to me that an amendment to our recently passed water-power bill, or a rider attached to the sundry civil bill providing for our reclamation work, would be a proper manner in which to take care of the proposed hydraulic laboratory.

It would, without doubt, be well to bring this matter to the attention of irrigation institutes held in the several Western states and the attention of the Irrigation Congress, proposed to be held in Seattle next September. The parties interested in these institutes are paying a bill, a large portion of which could no doubt be eliminated if a more scientific use was being made of the various water supplies now appropriated.

Seattle, Wash. E. J. BARTELLS.

Efficient and Responsible City Government

Sir—In your editorial on "Hope for Better Government" p. 1133, June 10, 1920, you say: "A single small legislative body with legislative powers only, and a chief executive officer, chosen for competence only, and well paid, is the plan for a city that wishes to show twentieth century progress and efficiency."

How is a small, paid legislative body to adequately represent a large body of constituents, and to throw off politics, graft, partisanship and other kindred evils to which a large non-paid, two-body councils had been accustomed; and which of the two bodies can be the greater pull-back? Of course if every person elected or appointed to public office were to conscientiously abide by pre-election promises and oaths of office, we would not need to question the fact that progress and efficiency would be the result. And even if the mayor is above reproach, his hands are likely to be tied and his efforts towards progress thwarted by a division in his council. The seriousness of this division seems less likely to be a controlling factor with a large than with a small legislative body of councilmen. Will not the effect of partisanship increase in direct proportion to the decrease in the number of votes?

I have in mind our own city government in Philadelphia which, since January last, has been in the hands of just such a body as you mention, with a few question marks in parenthesis.

Our local papers frequently ask editorially, What has our council done but draw its pay regularly? To be sure, it is rather early to predict what it might do, but the taint of partisanship is there. To my mind, with a small, single body this condition can be far worse, in the last analysis, than with a large, more nearly representative body, the majority of which is less likely to be influenced in any one direction.

Therefore, I will thank you for a qualification of the above quotation from your editorial to clear away my doubts on this subject and incidentally those in other minds where they might have been raised. Please understand that I am not making criticism but seeking information, as this subject is rather foreign to my education.

Philadelphia, Pa. S. W. BARAKAT.

[The words "well paid" in our editorial note referred to the "chief executive officer" and not to the "single small legislative body" of a city. The consensus of opinion among students of municipal government is for the plan outlined in our editorial note, and is very strongly against large, two-chambered city councils—which style of council has in fact almost completely disappeared in the United States. The present-day conception of efficient city government is set forth in detail, with supporting arguments, in a considerable number of books published within the last few years and reviewed in our monthly Engineering Literature Section. Most of these books stand for the commission-manager form of city government, rather than for the mayor-and-council type, but there is general agreement on the advisability of separation of executive and legislative powers. With such a clear-cut separation of powers, separation of responsibility for action or inaction is equally clear.—Editor.]

Facts and Common Sense at the Niagara Power Plants

Sir: In your issue of July 1, 1920, p. 18, appears an article entitled "Common Sense and Engineering," consisting of paragraphs from a lecture delivered by J. E. Aldred to the students of Johns Hopkins University. In this lecture Mr. Aldred makes a comparison of the plants of The Niagara Falls Power Co. and the Hydraulic Power & Manufacturing Co. at Niagara Falls, N. Y., criticising severely the design of the former and giving high praise to the design and construction of the latter, eulogizing in particular Wallace Johnson, the engineer of the Hydraulic Co. Mr. Johnson was a friend of the writer and he is glad to read Mr. Aldred's words of praise which are a just tribute to Mr. Johnson's memory. The criticisms of the design of the Niagara Falls Power Co.'s plant are, however, based on a lack of knowledge or a suppression of the facts affecting that design and are unjust to its engineers. While we agree with Mr. Aldred as to the necessity for common sense and reason in engineering design, it is equally important that these qualities be based on facts, and this is also true of criticisms of design.

It would perhaps be unnecessary to answer Mr. Aldred's attack if it stood alone, but it has become the fashion to criticize the design of a plant which was in its day one of the monumental engineering works of the country and one which has exercised the greatest influence on the development of some of our greatest industries.

The plans for the N. F. P. Co.'s development—which fixed for all time its fundamental features—were passed upon by an international commission consisting of Lord Kelvin, Prof. Unwin, Dr. Coleman Sellers, Col. Turrettini and Prof. Mascart. It would seem impossible that these gentlemen should have attained the position of leaders in engineering in their respective countries without being endowed with and exercising both common sense and reason. The standing of these engineers cannot be adversely affected by criticism by Aldred or anyone else, but as some of them have passed away it seems proper that some one familiar with the facts should rise in their defense, lest the criticisms of the unthinking or ignorant should give the younger generation of engineers the impression that an engineering blunder of magnitude had been made in the design referred to.

The fundamental features of the design of the plant of The Niagara Falls Power Co.'s plant and that of the Hydraulic Co. are the short entrance canal and long discharge tunnel of the former plant and long canal and very short discharge race of the latter. No hydraulic engineer will question the superiority in most cases of the latter design, both from the engineering and commercial standpoints, but in the plant in question the following facts, among others, should be considered:

(1) The canal of the Hydraulic Co. was commenced and the right-of-way acquired through what is now the heart of the business section of the City of Niagara Falls, about 1860. The first work on the plant of the Niagara Falls Power Co. was started in 1890. The acquisition of a right-of-way for a second canal from the upper to the lower river at the latter date would have been very costly and probably would not have been permitted by the city authorities. In any case the canal would have been of great length and have involved an immense initial outlay which would have made it impossible for the later plant to compete with the earlier and less expensive plant.

(2) The State Park was established at Niagara Falls subsequent to the building of the Hydraulic Co.'s canal and the erection of numerous mills operated by hydraulic power

under low heads by means of water taken from the canal. These mills and their surroundings were considered an eyesore in the vicinity of the falls and the Park Commission would not have consented to a duplicate of such a plant. The engineers of the N. F. P. Co., were therefore faced with the problem of developing power in such a manner as to preserve the scenic beauty of the falls and their surroundings. The financiers of the company were in full accord with the views of those who sought to protect the natural scenery. They wished to build a plant which would not only be a commercial success but which would add to the beauty of one of nature's wonder spots and not detract therefrom. It is difficult if not impossible to conceive—even after the advances in engineering science during the past 30 years—how any engineers having a full complement of common sense and reason could have solved the problem by any method other than that adopted.

(3) It was necessary to provide factory sites near the power house and the acquisition of such sites along the lower river at the top of the lower river bank would have been expensive if not impossible. This factor of near-by factory sites would not enter into the problem today, but in 1889 and 1890 it was paramount and farm lands were available at a moderate price along the upper river. The importance of having sites near the power house will be appreciated when attention is called to the conditions of transmission at that day. Plans were received by the International Commission for transmission of power by rope, by water under pressure, by compressed air, and by electricity, but none of these was satisfactory for more than a few miles and the efficiency was low even for such distances. In 1890 the late Mr. George Westinghouse advised a prominent man interested in the company that power could not be transmitted by electricity from Niagara Falls to Buffalo. This difficulty of transmission made it still more necessary to locate the power house along the upper river so that if all methods proved a failure factories might be located along the line of the canal and develop their power hydraulically. The earlier plans shown such an arrangement and the location of the present canal was fixed by this consideration. While Mr. Aldred does not criticise the fact that more land was purchased for factory sites than would be sufficient today for the consumption of all of the power from the canal, this action doubtless has its critics who also do not know the facts, but the power company's engineers must again be exonerated from blame when the conditions are known. In 1890 electro-chemistry was in its infancy, electro-metallurgy was not a commercial possibility. It was anticipated that all the power produced would be used by textile or other factories using a maximum of 1000 hp. and employing about one person per hp. A large acreage would therefore have been necessary for factories and home sites.

(4) Mr. Aldred says "Everything about this enterprise indicated a disregard of economy." Those who were connected with the plant know this criticism to be unfounded and that it is based on a superficial inspection. It is freely admitted that the cost per hp. was greater than that in the plant of the Hydraulic Co. whose chief asset in land is said to have been bought for $60,000 but Mr. Aldred has used the word "enterprise" in a happy manner as applied to the plant of the N. F. P. Co. It required enterprise, vision and faith both on the part of its financiers and its engineers. Its design constantly dealt with problems in the untried. The plant was a pioneer. Careful search fails to disclose a turbine operating under more than 100 ft. head prior to 1890 or having more than 2500 hp. capacity. Yet the first turbines installed in this plant were of 5000 hp. capacity and operated under 136 ft. head; there were no data for friction coefficients in the tunnel; the conditions as to electrical transmission were those above described; it was considered impossible to switch 2200 volt current. These are only a few of the problems and we all know that it costs more to blaze the trail.

In regard to Mr. Aldred's criticism of extravagance on the part of the engineers who were connected with the construction of the plant as shown by a flagstaff (which, by the way is wood and not bronze) and by ornamental details on power house and office building, our critic from his experience as a business man must be aware that engineers do not erect flagstaffs and ornamental buildings unless these forms of construction are desired by the men who are furnishing the money. A good engineer will insist on safe and stable construction but not on ornaments. The latter depend on the owners. So why direct all the criticisms at the engineers? The men who had faith in the future sufficient to invest their own millions—not the public's—in this plant are too eminent to need an advocate but the writer believes that he is correct in stating that they desired it to be an ornament to the city. There are still men who look beyond the dollar. Why Mr. Aldred should think that substantial or even ornamental construction should indicate "An expensive upkeep" is hard to understand. The books of the company show the contrary.

The plant of the Niagara Falls Power Co., is not one of the substantial failures to which Mr. Aldred refers elsewhere in his lecture. It always paid its bond interest; for many years before its recent sale it paid 8 per cent on its common stock in addition to amassing a surplus of several millions. It will hardly do to say that it did this in spite of its engineers.

There is no question that the ideal plant is yet to be built at Niagara, the one in which the water will give its maximum duty, but the national government and not engineers has prevented the use of water in the way that common sense and reason would dictate in this day, but destructive criticism is easy and it is well for a critic of a plant designed in the early 90's to know facts.

Later in his lecture Mr. Aldred states "Personally I have seen hundreds of reports on water-power projects but I have never yet seen an unfavorable report"; then, after blaming engineers for a loss sustained in an unfortunate power development he continues, "Engineers always want to do a job of work. They never turn down a job." The first statement must be accepted as fact even though Mr. Aldred's experience probably stands alone but the last general statement should not pass unchallenged as it is an adroit way of stating that engineers are dishonest and will always report favorably on a project so that they may construct the work. This is unfair to the members of a profession whose ethics are certainly as high as those of the business man and promoter even though in rare cases an engineer at the solicitation of a stock jobber may make his report too favorable. It is unfortunate that the students at Johns Hopkins should receive from their lecturer such an unfavorable impression of engineering ethics.

Buffalo, N. Y. A. H. VAN CLEVE,
Civil Engineer.

Where Is Our Road Program Taking Us?

Sir—As a constant reader for more than thirty years of your good, comprehensive publication, I noted the excellent article by J. N. Mackall, chief engineer, Maryland Roads Commission, entitled, "Where Is Our Road Program Taking Us?" in your issue of May 6, p. 914. He states the fact concisely by saying that there is no kind of "permanent" road or pavement; also that maintenance includes repairs, resurfacing and rebuilding when that becomes necessary. Maintenance should always be paid for from current income, such as annual taxes, automobile and other licenses for use of highways, and never from bond issues or general funds, which, if done, would "eventually bankrupt the government" of nation, state, county or town.

The writer, from thirty years study and practice of road and pavement construction and maintenance, differs with Mr. Mackall where he seems to imply that it is economical to construct portland cement concrete roads with a view to use them eventually as foundations for bituminous surface layers. His statement is: "When it (meaning a portland cement concrete or any road or pavement without a wearing surface layer capable of consistent maintenance) reaches a point where it can no longer be economically maintained as a concrete road it can be resurfaced with some form of good, hot-mixed bituminous pavement to give another period of long life, conserving the entire initial investment.

The fact is only a portion of the initial investment is

conserved or salvaged, because much of that investment has gone by reason of abrasion, disintegration or "fatigue," as Mr. Mackall calls it, and cracking of the concrete from wear of traffic and effects of weather.

The first cost of a cement concrete road or pavement, adequate to support traffic for a reasonable period of years, is greater than the first cost of a foundation of cement concrete or good foundation of other material, together with a substantial wearing surface layer of some form of good, dense, hot-mixed bituminous pavement or other standard material. Such surface layers distribute the impact and pressure of traffic and protect the foundation from injury from traffic and weather. The subsequent maintenance of this standard construction, including resurfacings at long intervals of years, can be economically done, and it is possible always to have a good, solid foundation on which to keep this maintained layer. Such a surface layer is more lasting on a foundation made for it than where placed on an old, worn out and cracked cement concrete road or pavement.

The value of an old concrete road, which can no longer be properly repaired by filling cracks and holes with bituminous compounds, etc., is much less than the initial investment. Many such old concrete roads and pavements which the writer has had to use, when necessary, for foundations for wearing surface layers of other materials have had an appraised value of less than half of the cost of the original cement concrete roads or pavements. It is a fallacy to argue that cement concrete roads should be constructed because, when beyond repair, they will have a high salvage value for foundations for future roads of any kind.

Relatively new concrete roads appear to a layman and to engineers not familiar with road and pavement records to be "permanent" and they rely on "durability" of a new pavement as the only factor of economy; whereas the experienced engineer knows that repairs to all roads and pavements must begin soon after construction and be constantly kept up.

The problems of how to construct a portland cement road so that constant eventual maintenance will be economically possible and how to maintain such a road in constant, smooth, viable and handsome condition are problems not yet solved. They are worthy of careful study. These problems have long been solved for many other kinds of roads and pavements by constructing practically everlasting foundations, laying on them substantial wearing surface layers of suitable materials and thicknesses, then maintaining those surface layers by "a stitch in time saves nine" and resurfacing with the same materials at very long intervals of years. There are hundreds of such examples in all the important cities and countries of the world, among them Pennsylvania Ave., from the Capitol to the Treasury, Washington, D. C., laid in 1877; Fifth Ave., from Eighth to Forty-second Sts., New York City, laid in 1898; Bergere St., Paris, France, where a wearing surface layer of bituminous limestone was laid on a durable foundation, and that reparable surface layer kept in good condition ever since.

J. W. HOWARD,
Consulting Engineer.
New York City.

Shall Engineering Societies Admit the Sales Engineer?

Sir—A well known dictionary defines engineering as follows: "The art and science by which the mechanical properties of matter are utilized in structures and engines."

To be an engineer, then, one must primarily deal with the mechanical properties of matter as applied to structures or engines. Many men, of course, devote their entire lives to the abstract study of mechanics, but there are others who do not and are properly considered engineers worthy of the highest recognition by engineering societies. In fact, there is a premium placed upon the ability to conceive a problem as a whole rather than its intricate calculations. Some of the world's most noted engineers were not students of mechanics.

Ferdinand de Lesseps was an engineer; he saw the economic possibilities of the Suez Canal. He was the engineer who so ably determined that the channel should be maintained at sea level. Yet, it cannot be said that his greatness was due to his intimate knowledge of the mechanics of materials with which he worked. His success, it might be suggested, was in no small measure because of his ability to make other people believe in him—that is, selling his ideas. So, also, a consulting engineer sells his ideas, many of which do not involve mechanics.

Another man recognized by technical societies, but not a true engineer in the narrow definition of the word, is the contracting engineer. His work usually involves the selling of his services and then the organization of his forces. While selling his services he frequently requires the help of a man not connected with his organization nor recognized as an engineer—the sales engineer. Let us review a typical example:

Take the case of the bidder on a contract for the movement of a large quantity of earth, with a considerable bonus offered for time saving. Keen competition makes the contractor marshal all of his engineering knowledge and that of his co-workers. Before he gets very deep into his problem, however, he realizes that he needs the help of an engineer well versed in the application of machinery. For this specialized help the contractor rightly applies to the machinery manufacturer, who offers the service of his sales engineer. This particular and specialized engineer has been developed in recent years to satisfy a real need.

The last decade has seen rapid improvement in material-handling machinery and in the application of machinery to construction work. Indeed, it has been so rapid that the contracting engineer and the consulting engineer have not attempted to keep fully informed upon all methods and all machines. They rely upon the manufacturer to furnish expert help when needed.

The work of the sales engineer begins when the contractor first opens the advertisement and concludes only when the success of the undertaking is assured. In fact, the engineer practically becomes part of the contractor's organization—assisting and advising on the estimates of cost, planning plant layout, supervising the erection of the plant and directing its early operation. The usefulness of the sales engineer is not ended, however, when the actual construction is in progress, as he is called upon to remedy any subsequent troubles that might hinder the efficiency.

No one doubts that certain experience and engineering ability are necessary to render such service. More than experience and ability, however, are required as an entrée to the engineering societies; they request that the applicant be charged with certain financial responsibilities. It is true that the sales engineer is not financially responsible for the success of the contractor's undertaking, nevertheless, he is morally responsible in so far as success is dependent upon machinery. If the engineering were not sound, if the recommendations were not profitable to the contractor, the position of sales engineer could not exist.

The justly conservative engineering societies have had time to investigate the desirability of admitting sales engineers and it is proper that they should voice their opinions. They can give no more fitting recognition, however, than to invite into their midst sales engineers who have contributed to the success of their members.

New York City.
NICHOLAS GERTEN,
Allied Machinery Co. of America.

[An entirely different opinion on the general subject discussed by Mr. Gerten was expressed in a recent paper by John W. Cunningham, consulting engineer, of Portland, Oregon; see article entitled "Free Engineering Advice," *Engineering News-Record*, July 1, p. 21.—Editor.]

Rochester Water-Works Shop Always Open

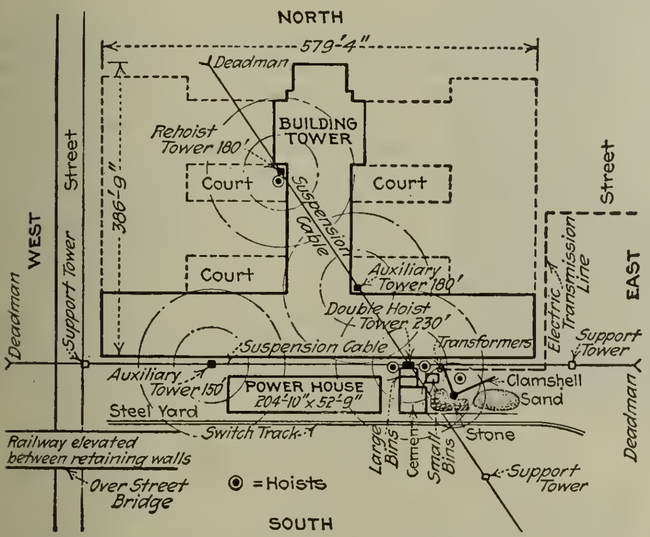
The key to the water-works repair shop of the City of Rochester was thrown away forty years ago, said Beekman C. Little, superintendent, in a paper at the recent Montreal meeting of the American Water-Works Association. The shop is always open, with some one on duty.

Hints for the Contractor

Concrete Building Plant Plan—III

Large Area T-Shaped Factory Spouted From Five Towers

EXCEPTIONALLY heavy tower and suspension cable equipment characterizes the chute distribution plant for the Bunte factory being constructed in Chicago. With a double hoist tower 230 ft. high chuting two ways to auxiliary towers 150 ft. and 180 ft. high and a rehoist tower 180 ft. high, two lines of 1⅜-in. suspension cables, with spans of about 1,000 and 1,200 ft., were required. In a measure, this equipment was planned for a more extensive operation, as is indicated by the plan. The structure shown by the dotted lines, as well as the T-shaped building and the power house, was contemplated when the plant arrangement was determined. This additional construction would have



TOWER LAYOUT FOR TWO-WAY CHUTE DISTRIBUTION

increased the volume of concrete to 50,000 cu.yd., or to about double the yardage of the present operation.

Railway tracks elevated between retaining walls, with a street bridge just west of the building, determined the take-off of the permanent factory switch from the east and also, incidentally, the corresponding location of the construction switch. With a stub street on the east having only light traffic the logical location of the unloading and mixing plant was next to the railway switch and east of the power house. Located in the angle between the main building and the east end of the power house, a double hoist tower, spouting direct and chuting two ways to three other towers, enabled about three-quarters of the area of the two buildings to be reached with 100-ft. radial spouts, and allowed all of the towers to be located clear of the structure. The rehoist tower, as located, also permitted spouting to all floors of the nine-story building tower rising five stories above the main structure.

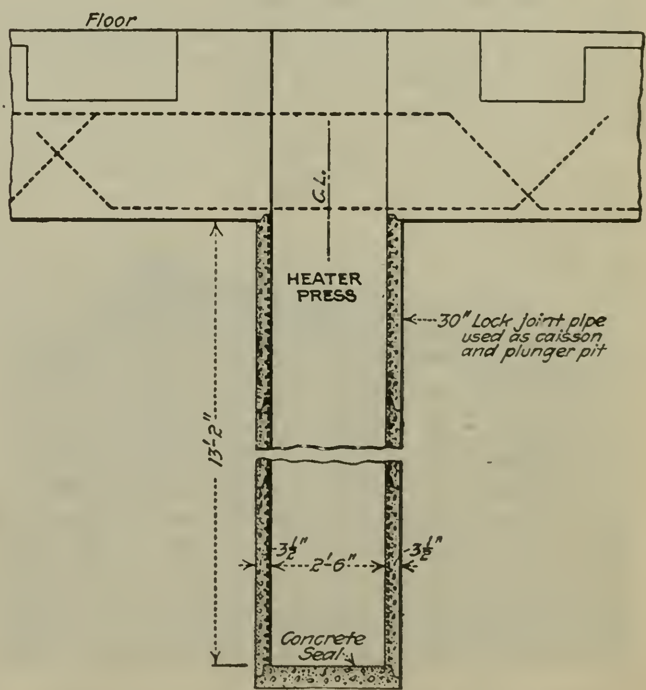
Arriving by rail the sand and stone are unloaded by a 1 cu.yd. clamshell into stock piles and bins and the cement by hand into a 3,000 bbl. shed. Sand and stone are lifted by the clamshell into the small bins holding 90 cu.yd. of stone and 60 cu.yd of sand. These bins are primarily hoppers, within convenient derrick reach, for feeding a horizontal conveyor and a bucket elevator which delivers to the 480-cu.yd. stone compartment and the 220-cu.yd. sand compartment of the large bin. A 5 hp. motor operates the chain conveyor and the elevator motor is 20 hp. The mixers are two 1 cu.yd. machines. For unloading and mixing, the organization consists of one operator and two laborers unloading sand and stone; one operator and two laborers on the conveyor and elevator; four men unloading cement and carrying it to the mixer, and a mixer crew of two operators, one man feeding sand and stone and two men charging the cement.

For the double tower a 90-hp. and a 60-hp. electric hoist are operated by a crew of one operator, one man at the bottom and two men on the tower. When they are in use there is a man on each auxiliary tower. Inability to obtain power service necessitated a 9 x 10-in. steam hoist for the rehoist tower. One operator and one towerman is the required crew. Distribution on the floor requires eight wheelers, three men grading concrete and a man at the hopper.

The plant was installed by R. C. Wieboldt, general contractor, Chicago, Ill.

Recast Concrete Pipe for Plunger Pits

IN A RECENTLY completed factory building there were required for some presses 64 plunger pits, each 2 ft. 6 in. inside diameter and 13 ft. deep. For the outer casing of the pits vertically placed precast concrete pipe were sunk in the earth and a steel casing,



SECTION THROUGH PLUNGER PIT MADE WITH SECTIONAL CAST CONCRETE PIPE

containing the press plunger, afterwards put in. In executing the work a hole was excavated approximately 2 in. smaller in diameter than the pipe and carried down a distance of approximately 13 ft. Two or three lengths of pipe were then set up in a verticle position over this hole, and guided by a template, were allowed to settle under their own weight as far as they would go. A head block was then put over the top pipe and by means of a steam hammer the pipe driven to the bottom of the excavation. The excess material which the lower edges of the pipe cut away on its descent was then removed from inside the shaft and the bottom of the hole was concreted in.

The work was done by Stone & Webster, of Boston, Mass., using pipe made by the Lock Joint Pipe Co., Ampere, N. J.

Tamping Holes in Quarry Work

COMMENTING upon a recent fatal accident caused by the use of a heavy plunger and employment of hard tamping in charging a line of holes for quarry excavation, a recent bulletin issued by the Bureau of Mines, Department of Interior, asserts that for all purposes a wooden tamping bar should be used. And even with a wooden tamping bar the tamping should not be continued beyond the minimum time necessary. If it is found necessary to use a lead puncher, as was the case in the aforementioned accident, it should be provided with a copper rather than an iron eye. Subjecting of any explosive to frequent impact with any heavy weight is dangerous practice, says the bulletin.

Hospital Service Costs Contractor Seventy-Five Cents a Case

ABOUT $1,100 built and equipped the field hospital illustrated, which gave first aid to a force of 700 men constructing a large industrial plant at Buffalo, N. Y. The work involved the usual construction of brick, steel and concrete, with track work and considerable carpenter work on forms. There were no serious accidents and the treatment given was generally of the nature of caring for hand and foot injuries. About 43 employees a month were treated and the cost per case, where only first aid was rendered and the period of disability did not involve any lost time, was about 75c.

EMERGENCY FIELD HOSPITAL, 10 x 20 FT., WHICH COST $482

As illustrated, the hospital building is 10 x 20 ft., with a beaver board partition dividing it into halves.

FIELD HOSPITAL EQUIPMENT, COST $600

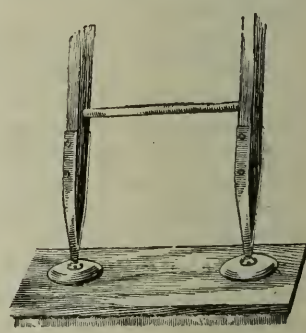
The cost of construction was $232 for labor, $17 for lighting and $233 for materials. The equipment cost $600. In the entrance room there was a supply case containing the necessary bandages and such simple instruments as a field nurse can deftly handle. This room also contained a waste jar and an electric sterilizer and hot water heater, a chair and a telephone. In the rear room in the corners behind the partition were two cots, and a chair and a curtain. A trained nurse in constant charge was paid $30 a week for her services.

The hospital was installed by the contractors, The Austin Co., Cleveland, O., and this description has been prepared from information furnished by F. J. C. Dresser, district manager.

Non-Slip Mats Give Ladder Safety

LADDERS equipped with safety non-slip mats, as illustrated below, are being used extensively in the works of the Eastman Kodak Co., Rochester, N. Y., a member of the National Safety Council.

W. T. Barrett of the Eastman Co., who designed the appliance, writes that it is giving complete satisfaction. The mat is attached to the ladder by means of ball and socket joints which permit the ladder to stand at any angle while the mat rests flat on the floor.—*National Safety News.*



SIMPLE DEVICE REDUCES LADDER ACCIDENTS

Blasting Out Broken Post Stumps

A quick and easy way to extract a broken post stump is to drive a hole close to the stump and to a few inches below its bottom with a pointed steel bar and charge this hole with half a stick of dynamite. The blast removes the stump and also excavates the hole for a new post.

NEWS OF THE WEEK

New York, July 22, 1920

Subway Contract Relet at Large Increase in Cost

Award of a contract to complete part of the 14th St. subway line in New York City to Patrick McGovern has been approved by the Board of Estimate, New York City, the contract price being $3,364,000. The work involved in completion of the contract section originally let to the Degnon Contracting Co. for $1,972,349, and abandoned by the contractor in July, 1919, when about 35 per cent of the work had been completed. Some months prior to that the contractor offered to complete the contract for the sum of $626,000 over and above the original contract price. The amount to complete the section under this offer would have been approximately $1,800,000. The offer was approved by Transit Construction Commissioner John H. Delaney and its approval recommended to the Board of Estimate by him, but the Board of Estimate rejected the recommendation and ordered the uncompleted section relet. Under the new contract the work is to be completed in fifteen months.

Missouri River Highway Bridge To Be Built

A bridge having three 470-ft. riveted truss spans, with concrete roadway and sidewalks, is to be built across the Missouri River at Bismarck, No. Dak., to carry the state highway between that city and Mandan. The trusses will be spaced 30 ft. center to center and bitulithic concrete will be used for the roadway. For the approaches there will be 1,100 ft. of reinforced concrete viaduct. C. A. P. Turner, of Minneapolis, is designing and supervising engineer for the state and the counties, and the work will be under the direction of W. H. Robinson, chief engineer of the state highway commission. Contracts have been let to the Foundation Co. for the substructure and to the American Bridge Co. for the steel work of the superstructure. The total cost is said to be nearly $1,000,000.

Bay State Highway Engineers Get Pay Increase

As a result of the efforts of the Boston chapter of the American Association of Engineers, the employees of the state highway division of the Massachusetts Department of Public Works have been granted an increase in salary averaging 20 per cent and effective June 1, 1920. Other engineering departments were given an increase which is reported to average about 12 per cent.

General Marshall Becomes Manager of Associated Contractors

Brigadier-General R. C. Marshall, Jr., former chief of the Construction Division of the United States Army, was appointed July 1 to the newly created position of general manager of the Associated General Contractors, following his resignation from the service. The Construction Division, as has been noted in these columns recently, has become a part of the Quartermaster Corps and the rank of brigadier-general applying to the chief of the division therefore ceases.

BRIG.-GEN. R. C. MARSHALL, JR.

The new office which General Marshall has taken is the result of a great enlargement of the functions of the Associated General Contractors. It is announced that his selection marks the beginning of an active campaign to carry through the program which has been developing during the past year of preliminary work. Besides the direction of the work of sixteen committees, this program includes the development of the publication and information service, the contractors' service corporation, the legislative service and other service bureaus of the association and the several members' divisions, including the building contractors' division, the public works contractors' division, the highway contractors' division and the railroad contractors' division, many of which have been organized in charge of different members of the staff during the past year.

General Marshall graduated from the Virginia Military Institute just before the Spanish War and became a

(*Continued on p. 189*)

Joint Committee Discusses Federation Problems

Bulletin Just Issued Explains Details Relating to Representation and Finances of New Organization

In the second of its bulletins dealing with matters concerning the organization of the Federated American Engineering Societies the Joint Conference Committee, representing the four founder societies, discusses questions of representation and finance. Extracts from the bulletin follow:

Basis of Representation

"There seems to be difficulty in understanding what the basis of representation should be where a state organization exists and where there are also strong local organizations and affiliations. The constitution provides that a state council or organization, representative of the engineers and allied technologists in the state, can be represented on the American Engineering Council on the basis of all the engineers and allied technologists in the state. If, however, there exists a strong local organization or affiliation which elects to have its own representative or representatives on the Council then the state council or organization is entitled to representation on the basis of all the engineers and allied technologists in the state, less the engineers and technologists that are to be represented through their local organization or affiliation. This will not prevent the local organization or affiliation from participating in the work of the state council or organization in the consideration of matters affecting the state only.

Member Societies to Supply Funds

The Joint Conference Committee has received several letters inquiring as to the provisions for dues. The constitution and by-laws (see *Engineering News-Record*, June 10, p. 1139) provide for funds contributed by the member-societies for the support of The Federated American Engineering Societies. Inasmuch as it would be unreasonable for a small local society to pay as large a contribution as a national society the constitution provides that the contribution shall be on the basis of the number of members in the organization at the rate of $1.50 per member for national societies and $1 per member for local, state and regional organizations or affiliations. The individual, therefore, does not directly pay any dues but the member-society of which he is a member contributes to the support of the Federated American Engineering Societies on a per capita basis

of its membership. It therefore follows that any one who is a member of several organizations which hold membership in The Federated American Engineering Societies will be counted in the total membership of each society as a basis of its contribution.

"As to the statement that the organization is expensive, it is pointed out that on the basis of the present membership of Engineering Council the income from the contributions provided in the constitution of The Federated American Engineering Societies would be about $75,000. At no time in the history of its existence has the budget of Engineering Council exceeded $50,000. Provision is made, however, that 'The Executive Board shall, whenever practicable, provide for the whole or a part of the expense of members or of representatives attending its own meetings and those of the Council.'

"On the basis of past experience, it is estimated that if the expense of all the representatives on American Engineering Council and of the members of its Executive Board were paid to each meeting of these bodies, there would be involved an annual expense of about $25,000. The purpose of these expenditures was to secure a full attendance of the representatives of The American Engineering Council and on the Executive Board, especially during the earlier years of the organization. As will be noted in the excerpt from the constitution, the expenses of representatives of the Council and members of the Executive Board will be provided from such funds as may be available. If, in the judgment of the Executive Board, this money should be required for more urgent work, the expenses of the representatives and members would not be provided for. It seems to the Joint Conference Committee that it would be highly desirable to have sufficient funds to pay the expenses of this representative body of men who contribute their time for the good of the engineering and allied technical professions. The payment of these expenses is the only part of the organization that can be said to be expensive.

Organization Democratic Not Autocratic

"It has also been stated that the form of organization that has been set up is 'autocratic, not democratic.'

"If a democratic organization is taken to mean one in which its constituents have a voice in its affairs then the Federated American Engineering Societies is truly a democratic organization. Member-societies of this organization are represented on the American Engineering Council which has full power to control and to direct the activities of the American Engineering Council and of its Executive Board and can determine whether it is necessary for the former to meet annually, bi-annually, or tri-annually, or how frequently the latter shall meet.

"The Joint Conference Committee is unqualifiedly of the opinion that an opportunity has been created for bringing about a solidarity of the engineering and allied technical professions that has never heretofore been available and that the success of the movement will depend on the whole-hearted support of each American engineer and of each technologist, who, if determined that this movement shall succeed, will obviously not bother with the details of the form of organization, in his effort to secure the end desired."

W. G. Thompson Joins Lakewood Organization

W. G. Thompson, formerly state highway engineer of New Jersey, has become associated with the Lakewood Engineering Co. of Cleveland. Although his new connection, effective July 16, will be in a general engineering capacity, Mr. Thompson will for the present give specific attention to the handling of construction work and industrial equipment, with headquarters at the company's New York office.

Since 1904, when he was an inspector of dredging and breakwater work on Long Island Sound, Mr. Thompson has been engaged on a variety of engineering projects. From 1905 to 1910 on the Panama Canal his duties included general survey and construction work, including topographic and railroad surveys and railroad and shop building construction. The following year he was draftsman in the chief engineer's office of the Oregon & Washington R.R., at Seattle, engaged principally on passenger terminal and freight classification yard layout, and from 1911 to 1916 he was supervisor and superintendent of construction on the locks and terminal facilities of the Panama Canal, his work including the construction of reinforced-concrete wharves, foundations and shop buildings, as well as general construction of terminal facilities. During this period he was in full charge of the construction of the Cristobal coaling plant at the Atlantic entrance to the Canal. Subsequently, for a short period he was superintendent of the Raymond Concrete Pile Co., New York, on the construction of the Sun shipyard at Chester, Pa., and the Bethlehem steel plant at Steelton, Pa. In April, 1917, Mr. Thompson was appointed assistant state highway engineer of New Jersey, and a year later became state highway engineer.

Everglades Drainage Act Upheld

The constitutionality of the act enlarging the Everglades Drainage District (Chap. 7862, Fla. Laws, 1919) has been upheld in a decision by the Supreme Court of Florida, in a suit brought by Robert L. Bonnerman. The act authorized a bond issue of $2,500,000. The Commissioners of the Everglades Drainage District were represented by Glenn Terrell, Tallahassee, Florida.

Lt.-Col. Whiteside Temporary Head of Construction Service

Lt.-Col. Warren W. Whiteside has been designated as the temporary head of the construction service in its new status as a subdivision of the Quartermaster Corps, U. S. Army. No changes have been made in the heads of the various divisions of the construction service. The work will be carried on in exactly the same manner as was the case when it was a separate division of the War Department. The permanent chief of the construction service, it is understood, will be selected within the next few weeks.

Construction Division Becomes Part of Quartermaster Corps

Effective July 15, the Construction Division of the Army became one of the subdivisions of the Quartermaster Corps. The text of the formal order reads as follows:

The Secretary of War directs that pursuant to the act of Congress approved June 4, 1920, amending the act entitled "An Act for making further and more effectual provisions for the national defense, and for other purposes," approved June 3, 1916, the Transportation Service, the Motor Transport Corps, the Construction Division and the Real Estate Service, and the records and enlisted and civilian personnel pertaining thereto, are transferred to the Quartermaster Corps, effective July 15, 1920. The commissioned personnel pertaining thereto are detailed temporarily for duty with the Quartermaster Corps, effective the same date. Thereafter these services will operate under the direction of the Quartermaster General.

The Construction Service shall be organized and operated as a separate service of the Quartermaster Corps and shall be charged with the construction, maintenance and repair of buildings, structures and utilities of the Army other than fortifications and with the operation of utilities. The Construction Service shall also be charged with the acquisition of all real estate and the issue of licenses in connection with Government reservations after authority for such acquisition or license has been obtained in each case from the Secretary of War.

The Construction Service, Quartermaster Corps, shall be charged with the consummation of the sales of those surplus Government properties heretofore assigned to the Construction Division and the Real Estate Service for disposition. Real estate, plants, facilities, etc., belonging to the War Department and hereafter declared surplus and ordered disposed of will be disposed of by an agency to be designated by the Secretary of War in each case.

Brig.-Gen. R. C. Marshall, who has been head of the Construction Division, has retired from the service, as noted elsewhere in this issue.

To Report on More Water for Philadelphia

For the purpose of studying the water-supply requirements of Philadelphia for the next fifty years, Mayor Moore has appointed the following commission: J. Waldo Smith, chief engineer New York Board of Water Supply; George W. Fuller, consulting engineer, New York City; J. W. Ledoux, consulting engineer, Philadelphia; and Joseph F. Hasskarl, formerly director of Wharves, Docks and Ferries, Philadelphia. A preliminary report is expected by Sept. 15.

Program for Am. Soc. C. E. Meeting Announced

The local committee on arrangements for the fiftieth annual convention of the American Society of Civil Engineers to be held at the Multnomah Hotel, Portland, Ore., Aug. 10-12, has tentatively adopted the following program:

Aug. 9—Meeting of the Board of Direction; short automobile trips.

Aug. 10—Addresses, followed by business session, during morning and afternoon; dancing in the evening.

Aug. 11—Trip up the Columbia River to Eagle Creek, about 45 miles. One-half of the party will go by boat and return by automobiles, and the other half will go up by automobiles and return by boat. At a smoker in the evening, to which ladies are invited, Frank Branch Riley will give an illustrated talk on the scenery of the Northwest.

Aug. 12—This day will be devoted to the individual tastes of the members and their guests. Transportation and other facilities will be provided for those wishing to play golf, an inspection trip about the harbor has been arranged, and trips to the wood-pulp paper mills at Oregon City and to the hydroelectric plant of the P. R. L. & P. Co. at Cazadero will be made.

By invitation of the Seattle Section, the Spokane Section and J. L. Lytel, project manager of the U. S. Reclamation Service at Yakima, members and their guests are asked to include Seattle, Yakima and Spokane on their return trip, leaving Portland Aug. 12 at 11 p.m. on the Northern Pacific Ry.

The Calgary Branch of the Engineering Institute of Canada has extended an invitation to Am. Soc. C. E. members and their guests to attend a western professional meeting at Banff, Aug. 14-18 inclusive. The meeting will be held in true western style under canvas.

Complete Appointment of Grand Trunk Arbitration Board

With the appointment on July 12 of Hon. William Howard Taft to the Grand Trunk Arbitration Board, the membership of this board is now complete, including Sir Walter Cassells, chief justice of the Exchequer Court, as chairman; Sir Thomas White, ex-Finance Minister of Canada, representing the government; and ex-President Taft, representing the Grand Trunk Railroad.

The board will begin its sittings in September for the purpose of determining the value of the first, second and third preferred stock, and the common stock of the railway company, which have a total par value of £87,-078,491. The award is to be made by the arbitrators within nine months of the time of their appointment unless the time is extended by the government. In case the award is not unanimous an appeal can be taken to the Supreme Court of Canada or to the Judicial Committee of the British Privy Council.

Colonel Taylor Named Assistant to Chief of Engineers

Col. Harry Taylor, Corps of Engineers, U. S. Army, has been appointed to the newly-created position of assistant to the Chief of Engineers, with rank of brigadier-general. General Taylor was the first chief engineer of the American Expeditionary Forces, accompanying General Pershing to France in May, 1917.

He was born in Tilton, N. H., June 26, 1862, where he attended the public schools. He entered West Point in 1880 and was graduated four years thereafter. His first important work was done on the Pacific coast, where he was stationed for nine years. He was engaged on construction for practically all the fortifications on Puget Sound and was in charge of the Seattle river and harbor district for a time. He served three years as district engineer in Boston, was two years at Philadelphia and five years at New London. Under his supervision the lock gates at the Cascades on the Columbia River were completed in 1896. In 1911 he was called to Washington as assistant to the Chief of Engineers in charge of the river and harbor section of the office. Except for a short time, while in charge of the first New York district, he continued directing the river and harbor work until the outbreak of the war.

BRIG.-GEN. HARRY TAYLOR

In May, 1917, he went to France with General Pershing as chief engineer officer of the A. E. F., later being promoted to brigadier-general. In September, 1918, he was returned to Washington at the request of the Chief of Engineers to resume charge of the river and harbor work. During his period of service in France, a consolidation of various departments was effected which resulted in Major-General William C. Langfitt being made chief engineer, A. E. F. General Taylor continued in charge of the Division of Military Engineering and Engineer Supplies until his return to the United States.

General Taylor is regarded as an authority in fortification construction and is given credit for an important part in the development of the Army searchlight. It was under his direction that the hoist for raising projectiles from magazines to gun platforms, now the army standard, was developed.

General Taylor will continue in charge of the river and harbor work of the Corps of Engineers.

St. Louis To Build Concrete Sewer by Day-Labor Plan

On July 29 the City of St. Louis received bids for the construction of 4,500 ft. of 12-ft. and 3,400 ft. of 6- to 8-ft. reinforced-concrete sewer, to be known as the South Harlem public sewer. The appropriation for this work was $350,000. The lowest bid was that of the Moreno-Burkham Construction Co., amounting to $382,000. After a thorough analysis of the situation it was found that the bid was exceptionally well balanced and entirely reasonable in consideration of the increased cost since the date of the original appropriation. However, because sufficient money was not available it was impossible to award the contract, and after some deliberation it was decided to carry out the work with the city's forces. To this purpose, a special section is being organized under the Division of Sewers and Paving. W. W. Burden will be engineer in charge of construction under W. W. Horner, chief engineer, sewers and paving. E. R. Kinsey is president of the Board of Public Service.

Brig.-Gen. R. C. Marshall, Jr.

(*Continued from p. 187*)

captain of volunteers in that war. After the war he taught for a while at the Virginia Military Institute, but in 1902 joined the United States Army with the rank of second lieutenant. He was a captain in the Quartermaster Corps when the World War broke out, having been for a number of years connected with the construction work of the army. In 1917 he became General Littell's assistant in the then Cantonment Division and was rapidly promoted to rank of colonel. On General Littell's retirement, early in 1918, he was made officer in charge of construction of the division with the rank of brigadier-general. His services in this connection are well known to the engineers and contractors of this country. The direction of the Construction Division was one of the successful features of our conduct of the war. No small part of General Marshall's success in his office was his ability to work successfully with the great number of engineers who were connected with the division either as temporary officers in the army or in a civilian capacity.

Commerce Commission Needs Valuation Engineers

The United States Civil Service Commission states that the Interstate Commerce Commission is making every effort to expedite the valuation of common carriers. The importance of hurrying this work is emphasized, in view of the law which provided for the return of transportation properties to private control and which specifies that the Interstate Commerce Commission shall adjust rates so as to insure a fair return upon the aggregate value of the railway property of carriers, the basis being the valuation made by the Commission.

The office technical force of the Commission is now engaged in the computation and assembly of the large amount of data furnished by the field engineers. For this office work the Commission needs architects and engineers (civil, mechanical, electrical, structural, signal, telegraph and telephone). Senior architects and engineers are offered entrance salaries from $2,100 to $2,700 a year; junior engineers, $720 to $1,920; junior architects, $1,320 to $1,920. Rodmen and chainmen at $720 to $1,080 will also be appointed in the field and office forces. Employees are given a daily allowance for subsistence, as well as transportation expenses, when away on official business, and are also allowed the increase of $20 a month granted by Congress. The Civil Service Commission will receive applications for these positions until further notice.

North Carolina Has Substantial Road Program

Five hundred and eight miles of gravel and hard surface roads, representing an outlay of $7,327,823.58 have been completed or are under construction by the North Carolina Highway Commission, according to figures given out by Frank Page, chairman of the commission. The figures include expenditures for bridges along the various roads under construction. The total mileage of highways is divided among 73 projects in more than half the counties and represents work accomplished since the re-organization of the commission in 1919, the only exceptions being one bridge in Mecklenburg county and two or three minor stretches of road. The average cost per mile for the 127.2 mi. of hard surface road under construction or contact is $31,468, and for the gravel roads $8,495 per mile.

Electrification of Swedish State Railways

According to recent statement in Commerce Reports, the Swedish Parliament has now definitely approved the electrification of the state railways between Stockholm and Goteborg, and has appropriated 23,000,000 krone (normally $1,164,000). It is expected that the work will be completed by 1925.

To Complete Subway Contract By Force Account

Following the abandonment of work on the Eastern Parkway subway route in Brooklyn, New York City, by the Inter-Continental Construction Corporation on July 1, 1920, the city's Board of Estimate has just authorized the Transit Construction Commissioner to complete the contract by force account. The work is nearly completed, and by resorting to force account work it will be possible to open the line to traffic before a new contract could be advertised and let. The line is expected to be opened for service in about four months.

Minnesota Cities Would Develop Water Power

The Municipal Electric Corporation, representing the municipalities of Minneapolis and St. Paul and the University of Minnesota, will apply to the national waterpower commission for priority of license to utilize the power generated at the Federal High Dam in the Mississippi River between the two cities. Application will be filed as soon as the Federal Power Commission is organized.

According to estimates of engineers, the dam will develop between 15,000 and 20,000 hp. It is held by those seeking control and utilization of this power by the public that it would supply all the needs of the state university, located in Minneapolis, and serve municipal works in Minneapolis and St. Paul as well.

Mayor L. C. Hodgson of St. Paul is chairman of the Municipal Electric Corporation, Mayor J. E. Meyers of Minneapolis is secretary and Fred B. Snyder, of Minneapolis, president of the board of regents of the University of Minnesota, is the third member.

If the national commission grants the license requested, as against possible like requests from private power companies, the municipal corporation will erect a power plant at the dam and arrange for distributing the power.

Settle First Rail Claim Winding Up Federal Operation

The first settlement with a railroad company covering all claims as a result of Federal operation has been announced by the Railroad Administration as the agreement to pay the Spokane, Portland & Seattle R.R. $1,600,000 in cash as the sum remaining after balancing accounts. Nearly 500 claims remain to be settled, and it is the belief of Railroad Administration officials that most of them will be made on the lump-sum basis after balancing conflicting claims. The claims of some companies amount to $10,000,000 or $12,000,000. No attempt has been made to estimate the amount which will finally be paid to wind up all of the affairs of the Railroad Administration or the length of time that will be necessary.

Women Organize National Engineering Society

The American Society of Women Engineers and Architects has been organized with a view to the professional improvement of its members and the general advancement of women in engineering and architecture. The officers are: Lou Alta Melton, Boulder, Col., president; Hilda Counts, Pittsburgh, vice-president; and Hazel I. Quick, Detroit, secretary-treasurer. Social intercourse among members is to be encouraged. These results are to be accomplished by the publication of such papers, discussions and communications as may seem to be expedient, and by personal letters. An official publication is to be maintained.

The primary reason for organization of the society, as explained by Miss Quick to *Engineering News-Record's* representative, grew out of the fact that the organizers felt the need of a society and were not received into the existing societies organized for and by men in the engineering profession.

The organization was started by correspondence in December, 1918, and the society was formally organized in February of this year. The preliminary work of getting together information for the organization was done by the women engineers of the University of Colorado. All universities and colleges having engineering departments were canvassed by mail and the names and addresses of women engineering graduates and students were obtained. It was found that about 200 women are now engaged in the field of engineering and architecture.

Qualifications for membership at present are such as to admit both college graduates and non-graduates who have a certain specified amount of engineering or architectural experience. Women who have been in active practice for at least two years are eligible for membership, one year's credit in an engineering college of recognized standing being considered equivalent to one-half year's actual experience. A woman who is a graduate, a senior or a junior student in a school of engineering or architecture of recognized standing is considered eligible for membership.

The society now has eleven members working in the following branches of engineering: Three in civil, three in electrical, two in mechanical, one in chemical and two in architectural engineering. They represent the universities of Colorado, Michigan, Kentucky, Kansas, Cornell, Ohio and Armour Institute of Technology. As the membership increases it is planned to form local chapters and to hold regular meetings.

Vote on Interest Rate Increase for California Road Bonds

Returns on the initiative petition of July 14 to raise the interest rate on the highway bonds of the State of California, in order to make them salable,

indicate, according to a telegram received from A. B. Fletcher, state highway engineer, that more than 75,000 voters have approved the proposed measure. The California law requires only 55,000 names on petitions of this sort. Mr. Fletcher states also that time extensions secured in many counties may result in adding enough signatures to the petition to bring the total number to double that legally required.

Advisory Council to Mapping Board Is Organized

Organization of the advisory council to the Board of Surveys and Maps, was completed at a meeting in Washington, July 12. The executive committee of the advisory council is to consist of Dr. E. B. Mathews, Division of Geology and Geography, National Research Council, chairman; A. G. Seiler, American Automobile Association, secretary; William A. Nelson, president of the Association of State Geologists; A. Stuart Baldwin, vice-president, Illinois Central Railroad; J. H. Milburn, office engineer, Baltimore & Ohio Railroad. Additional members were assigned to committees as follows: Co-operaiton, Dr. George Ashley, State Geologist of Pennsylvania and A. D. Flinn, secretary, Engineering Council; technical standards, George S. Hosmer, Massachusetts Institute of Technology; topographic maps, W. W. Atwood, president, Clarke University, and Isaiah Bowman, American Geographic Society; highway maps, W. O. Hotchkiss, State Geologist of Wisconsin and A. G. Seiler, American Automobile Association; general maps, A. B. Hoen, Baltimore, Md., and W. P. Northrup, Buffalo (representing commercial map makers); control, J. F. Hayford, Northwestern University; information, P. Lee Phillips, Library of Congress.

The Board of Surveys and Maps and its advisory committee expect to continue work actively during the summer. Reports will be submitted at a general meeting which will be held in Washington September 14.

A Chance to Buy a Concrete Ship

The United States Shipping Board is asking for sealed proposals for the purchase of the concrete steamship "Polias" which lies on a jagged rock off Penobscot Bay in Maine. Sealed proposals will be received at the office of the Shipping Board in Washington until July 30 for the purchase of the above steamer on a lump-sum basis "as is, where is." The vessel was stranded on Old Gilley Ledge, off the coast of Maine, on Feb. 6, 1920, as described in *Engineering News-Record*, March 4, 1920, p. 483. The sale includes certain nautical instruments and equipment in possession of the Coast Guard Station near the scene of the wreck. Bidders must include in the offer an agreement to dispose of wreckage. The terms of payment are cash on acceptance of the offer and a certified check for 10 per cent of the offer must accompany the bid.

Latest reports from the ship are that it has moved little, if any, since it struck the rock. It is about five miles out to sea, but easily accessible in ordinary weather. The reports that were made right after the wreck were that the bottom was badly ripped, but that the frame was intact. The "Polias" was built by the United States Emergency Fleet Corporation at Flushing Bay, Long Island, N. Y., and was launched about a year and two months ago.

Electrification of Swiss Railways

As a "part of a program for the gradual electrification of the government railway system of Switzerland," a syndicate of New York bankers recently offered $25,000,000 of Government of Switzerland twenty-year 8 per cent bonds at par, the entire proceeds of which are to be spent in the United States. The circular issued by the syndicate states that Switzerland has estimated water power resources of 2,700,000 hp. and that the progressive utilization of this power will effect large economies by substituting hydro-electric power for fuel which Switzerland now must buy at high prices.

A. A. E. Activities

The Cleveland Chapter has elected the following officers for the year 1920-21: President, William P. Blair; vice-president, C. I. Long; secretary, T. J. Brennan; treasurer, Ben Davies.

The San Francisco Chapter, in a report on the California State Civil Service, recommends that all engineering positions be freed from statutory limitations as to salary and that all engineers, excepting chief administrative officers, be placed under civil service. Minimum salaries were advocated as follows: Junior engineer, $1 800; assistant engineer, $2,400; senior assistant engineer, $4,000; engineer, $5,000. No limit was placed for salaries of chief engineers.

A chapter has been organized at Honolulu, T. H., the president of which is John H. Wilson, mayor of Honolulu, and vice-president, Lyman H. Bigelow, superintendent of public works and chairman of the board of harbor commissioners of the Territory of Hawaii. The chapter was organized by J. L. Young, consulting engineer and contractor, Honolulu. George M. Collins is secretary.

The Executive Committee of the Association has requested chapters in states bordering on the Great Lakes and the Canadian Border to urge upon the President of the United States and United States Senators the desirability of appointing an engineer to the vacancy on the International Commission.

Civil Service Examinations

United States

For the United States civil service examinations listed below, apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the Civil Service Commission, for Form 1312.

Engineer Examiner, Class A, $3,900 to $4,800 a year. Applications should be filed without delay.

Engineer Examiner, Class B, $2,220 to $3,600 a year. Applications should be filed without delay.

Highway Engineer, $2,100 to $2,700 a year, Bureau of Public Roads, Department of Agriculture. Applications should be filed not later than Sept. 9.

Junior Engineer, Grade 1, $1,500 to $1,920 a year. Applications received until further notice.

Engineer, $2,400, or over, a year.

Assistant Engineer, $1,800 to $2,340 a year.

Junior Engineer, $1,440 to $1,740 a year.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Portland, Ore., Aug. 10-12.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Sept. 13-17.

The American Wood Preservers' Association will hold its seventeenth annual meeting in San Francisco Jan. 25-27, 1921. It will be the first convention of the association held west of the Mississippi River. The annual convention of the National Association of Railroad Tie Producers will also be held in San Francisco the same week. The plans being made by the various association committees include a special train, via the Santa Fe; a meeting with the southern California engineers and wood users in Los Angeles on Jan. 24; a joint dinner and meeting with San Francisco engineers and lumbermen on the evening of Jan. 25, and meetings in Portland and Seattle following the convention. Trips are planned also to lumber yards, waterfront structures, mills, treating plants, logging camps and into the Redwood and Douglas fir timber.

American Concrete Institute.—An innovation in the American Concrete Institute was a sectional meeting held in New York City on July 16. This meeting, which was called by President H. C. Turner, was on the subject of shear in concrete and was addressed mainly by W. A. Slater of the U. S. Bureau of Standards, who described a number of the tests on especially designed beams

for the Concrete Ship Section of the Emergency Fleet Corporation in which special attention was paid to the investigation of shear strength. The meeting was very largely attended, not only by members of the Institute, but by other New York engineers who were notified in advance.

The Iowa Engineering Society has voted favorably on the adoption of a new constitution which would include as members all existing local organizations. The vote was 173 for and 7 against, out of a membership of 350. Thus far no local club has taken action on the matter, although some of them have the proposition under consideration by committees. Action is not looked for until fall.

Personal Notes

T. S. Bond, assistant engineer of the International & Great Northern R.R., with headquarters at Palestine, Tex., has been appointed chief engineer, with same headquarters.

M. M. Buck has resigned as road engineer of Ottawa County, Mich., to engage in private practice. He will be succeeded by George Borck, of Grand Haven, Mich.

B. S. Voorhees, district engineer, New York Central R.R., has been promoted to the position of general office engineer, New York Central Lines, on the staff of George A. Harwood, assistant to the president.

W. E. Holland has resigned from the Central Foundry Co., Chicago, and will engage in waterworks construction under the firm name of Cole & Holland, South Bend, Ind.

H. W. Alden, of Detroit, past-president of the Society of Automotive Engineers, has been designated as the representative of that society on the Federal Highway Council committee on transportation and committee on subgrade in relation to road surfacing.

Kastenhuber & Anderson, civil engineers and surveyors, of Easton, Md., announce the withdrawal of John Anderson from that firm. Edwin G. Kastenhuber, Jr., will continue business under the present firm name of Kastenhuber & Anderson. Mr. Anderson has taken up work as an instructor at the Citadel, Charleston, S. C.

W. G. Worden has resigned as town engineer of Oshawa, Ont., and has been engaged by the board of water commissioners as superintendent of water-works.

John Berg has been appointed state engineer of South Dakota to succeed Homer M. Derr, resigned. Mr. Berg has been deputy state engineer during the past year.

The W. B. Rollins Engineering Co., Kansas City, Mo., will hereafter conduct the business of W. B. Rollins & Co. One of the new members of the company is Robert H. Hammond, recently county highway engineer in Southern Iowa. The other member is F. H. Frauens, Jr., who has been connected with the firm since 1914.

G. H. Edgecombe, Ottawa, Ont., has been nominated as surveyor for forest resources for the Canadian Commission of Conservation.

C. L. Spaulding has been appointed district engineer, Eastern District, New York Central R.R. This district has been extended to include the electric zone, exclusive of the Grand Central Terminal.

C. N. Campbell has been appointed assistant valuation engineer, Southern Pacific, Texas and Louisiana Lines, with headquarters at Houston, Tex.

F. H. Murray, state highway engineer of South Carolina, has resigned to enter private practice with J. Roy Pennell, former state highway engineer. Mr. Murray has been succeeded by Charles H. Moorefield, formerly district engineer with the U. S. Bureau of Public Roads.

William D. Ennis has resigned as professor of marine and mechanical engineering in the post-graduate department of the U. S. Naval academy, to become vice-president of the Technical Advisory Corporation of New York. Mr. Ennis has been associated with the latter corporation since its organization and will be hereafter located at its general offices, in New York City.

Huntington Smith has been appointed office engineer of the New York, Chicago & St. Louis Railroad Co. at Cleveland, in place of J. W. Wilkinson, deceased; C. R. Wright has been appointed division engineer between Painesville and Bellevue, with headquarters in Cleveland, succeeding Mr. Smith; Herman Koch has been appointed supervisor of bridges and buildings, Buffalo and Cleveland divisions, with headquarters at Conneaut, Ohio, succeeding H. H. Oppelt, retired, and Wilson Sprague, who has been on leave of absence, has resumed his duties as division engineer between Buffalo and Painesville, with headquarters at Conneaut.

Harvey C. Rose has been appointed resident engineer, with headquarters at Guelph, Ont., in connection with the construction of Provincial highways in western Ontario.

R. H. Murray, engineer of the Bureau of Public Health of Saskatchewan, has been appointed director of the newly organized Division of Sanitation of the Bureau.

Edmunds Wilkes, for several years connected with the Interstate Commerce Commission as senior engineer, and also with the bridge department of the Kansas City Terminal Railway Co., has opened an office as structural engineer, 706 Mutual Building, Kansas City, Mo.

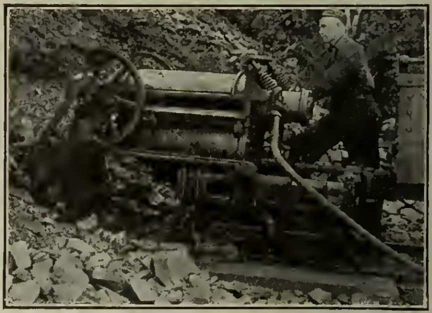
Business Notes

William F. Harvey, formerly in charge of the Chicago territory for the Truscon Laboratories, has taken a position as sales manager with the Viscous Paint Oil Co., Chicago.

O. P. Cherdron, former president and founder of the Lynch Cannon Engineering Co., has sold out his interest in that company and formed the Cherdron Construction Co., with headquarters in Salt Lake City. The Cherdron Co. will handle all kinds of industrial work, office buildings, hotels, etc.

Shuveloder Has Adaptability for General Contracting

A mechanical material handler primarily designed for use in mining work, but which may be used by general contractors in loading muck in tunnels and cuts is the "shuveloder," shown in the accompanying illustration. The shuveloder, built by the Lake Superior Loading Co., Duluth, Minn., is a compressed-air operated machine, comprising three main elements: A truck with wheels suiting the gage of the track; a platform or turntable providing lateral movement to the shovel; and a body member containing the operating cylinder and shovel guide members in which the shovel and its arm function.



NEW MUCK HANDLING MACHINE

The body piece consists of four cast-iorn cylinders and their pistons; three operating valves; and a crosshead which travels in horizontal guides and carries the rope sheaves to which are fulcrumed the dipper arms and the dipper. The shuveloder is not of the continuous-operation or cycle type, but each motion has a separate control that is reversible. The digging and loading movements are performed by the action of compressed air upon direct pistons and require no gears, chains, clutches, belts, conveyors nor engines.

The length of the shuveloder is 6 ft. and its overall width and height 4 ft. It has a wheelbase of 19½ in., a dipper width of 30 in., and the contents of the dipper are 4.45 cu.ft. It weighs approximately 4,300 lb. and is rated at a capacity of 45 tons per hour.

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AND CONTRACTING

E. J. MEHREN
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Water-Filter Sand Studies

THE contribution on the shrinkage of water-filter sands elsewhere in this issue has a wider appeal to engineers than its title indicates. It should stimulate other investigators in a field where too little observation and experiment has yet been undertaken. Some discussions of the ideas advanced by Messrs. Wolman and Powell will appear in a latter issue.

Fuel From Garbage Again

ABOUT this time look out for the promoter who proposes to convert the garbage of our city into fuel briquettes. Such a sentence, if there were a municipal almanac like the old farmers' almanacs, might well be inserted at some convenient place under each month. One or more Texas cities have had disappointing experiences with fuel-from-garbage promoters. Quite recently such a promoter gained serious attention from a city of considerable size in another part of the South. All such proposals should be either ignored by city councils ro referred to a competent engineer for investigation.

Annexations and City Planning

ANNEXATIONS of territory to cities are generally made either through a desire for increase in size or to secure public improvements in outlying districts. An added reason might well be the furtherance of comprehensive city planning. This does often enter in to some extent, but generally in a detached way and rarely if ever with a clear far reaching view of all that enters into city planning—major traffic streets from outlying districts to the center of the city, parks, transportation service and other utilities. The argument should not be carried as far as to make the extension of these facilities conditional on annexation, for a proper spirit of co-operation between cities and outlying districts will make regional planning possible without consolidation.

First Cost and Maintenance Expense

POSSIBILITIES of effecting large economy in maintenance by a moderate increase in first cost are illustrated by the unusual track construction adopted for the main line approach to the new union station at Chicago, described on p. 223. In such cases not only may an increase in capital outlay be demanded but in addition it may be more important to reduce the volume of maintenance work than to cut down its cost, since extensive maintenance work on busy tracks interferes with the movement of many trains. Stability and permanence of construction, therefore, are specially desirable. Settlement of track due to ballast working into the earth roadbed will be prevented by the concrete foundation slab. Wear is provided for by heavy rails and by hard, wear-resisting steel parts for special track work. A ballast bed on the concrete will absorb vibration. With this combination the work and cost of maintenance should be reduced to a minimum.

What Is an "Engineer"?

IN 22 single-spaced typewritten pages Engineering Council's Committee on Licensing of Engineers records the result of its studies of definitions of the terms "engineer" and "engineering." While the report brings together a vast amount of research data on terminology, the quest for something specific in the form of a usable definition has, thus far at least, been in vain, for the committee frankly concludes that "it was impracticable to write a definition suited to its purposes." It should be kept in mind that a definition of engineering entirely suitable for a commemorative tablet is useless as a means of defining, in the eyes of the law, the scope and character of professional practice referred to in a bill governing the registration of engineers. Admittedly the task of defining engineering, either for the one purpose or the other, is difficult, but it should not be regarded as impossible. However, the committee's work, in which the services of lawyers were enlisted, shows one thing clearly: Any definition which aims at completeness from the legal point of view is sure to be so long-winded and involved as to make impossible its use for any other than statutory purposes. On the other hand, a concise, easily remembered definition of the "slogan" type would offer an easy target for attack in the courts. Engineering today, with its almost endless ramifications into specialties unheard of several generations ago, is susceptible of no such simple description as is contained in Tredgold's famous definition. The inference drawn from the committee's findings, therefore, is that a single definition of engineering cannot be "all things to all men." Eventually, it appears, there must be two word-formulas, one for popular use and the other for legal purposes. In the meantime, the question "What is an engineer," despite the laborious efforts of Engineering Council's committee, remains unanswered.

A Source of Inspiration

APPRECIATION of the achievements of the past is fertile soil for the growth of ideals and active enthusiasm out of which present and future achievements may develop. So the art of engineering will surely progress so long as it is enlivened by a love for its historic works. In this spirit engineers may feel grateful to the small group of men who interested themselves in the maintenance of High Bridge as a notable work of an earlier period of American construction and of its famous men. If the movement that has been started succeeds, the living record of our engineering development will be richer and will serve as a greater inspiration to ourselves and our successors. In speaking here of the relation of High Bridge to engineers, it is not because we are blind to the equal or greater historic meaning of the structure to citizens of other classes, and to the city of New York as such. On the city, of course, lies the duty of proceeding in the matter, and on it also

lies the burden of expense. But it is long since accepted almost universally that the great public works which tell of the progress of civilization must never be allowed to perish if the spiritual interests of succeeding generations are not to be hurt. It may be taken for granted that New York will respect its obligation in this regard. What is of immediate moment to the engineering profession is the fact that at a moment of need engineers were there, with disinterested initiative, to do their share of urging that the famous old structure be preserved, and of devising means by which it might be done. Just as this old bridge for carrying the first Croton Aqueduct over the Harlem River is an ever-potent source of inspiration to the construction engineer, so the public-spirited act of this group of citizens is an inspiration toward further and ever fuller and more effective public service by the men of our profession.

General Langfitt Leaves Service

BY THE recent retirement, at his own request after 40 years of service, of Col. W. C. Langfitt the Corps of Engineers, U. S. Army, has suffered a great loss. As chief engineer of the American Expeditionary Forces, with rank of Major-General, he left behind him in France a record of achievement which made him one of the outstanding figures of the engineering arm of our service during the World War. In addition to our own distinguished service medal, French, British and Belgian decorations were awarded to him in appreciation of his effective work overseas during a period of two years.

As head of the biggest staff corps of the A. E. F.—175,000 officers and men at the time of the armistice—General Langfitt occupied a post of immense responsibility and power—one which called for the exercise of all of the great administrative ability and tact of which he was in such large measure possessed. To a man who had discharged successfully the duty of co-ordinating the efforts of so large a personnel as that of the Engineers in France it is understandable that the army readjustment to a peace-time basis, carrying with it reduction in rank, curtailment of opportunity and return to the more or less routine operations of the service, should prove unattractive. Such changes inevitably form the aftermath of a great war. While General Langfitt is no longer an active member of the Corps of Engineers, his work will endure as an inspiring example of organizing ability and getting results—the only things that count in military operations.

To a degree unusual in a regular officer he had a full and sympathetic understanding of the engineer who left civilian practice to assume the new and exacting duties of service in an army uniform. His consistent policy of promoting a close liaison between regular and temporary officers was productive of great good and was by no means the least of his many noteworthy accomplishments. It augurs well that the newly created Society of American Military Engineers is insistent on exactly the same policy. General Langfitt leaves the service followed by the best wishes of a host of military and civilian associates. In the words of *The Military Engineer*, "the Corps has lost one of its biggest men, a man of wide experience and ripe judgment, yet still possessed of the vigor, enthusiasm and resourcefulness of youth."

Society Reconstruction and the Convention

A LONG-SOUGHT opportunity is before the members of the American Society of Civil Engineers. In the re-shaping of the society's government that will be discussed at the Portland, Ore., convention next month there is a realization of what has for years been the wish of the entire society: that it might be made possible for every member to share fairly in its admintration. With the presentation of five different sets of constitutional amendments, all elements of the society are called upon to co-operate in internal reform.

Responsibility for guiding the reconstruction of the society's government is thereby placed on the members, particularly those attending the convention. If the opportunity to do constructive work at the present juncture is not taken, the membership will have evaded a service which it demanded as a privilege. Clear-visioned study of the amendments, in order that they may be harmonized, is required for proper discharge of this responsibility.

The occasion is not one for contention. The proposed amendments all aim at advancement of the society's interests, and bear the impress of serious endeavor. But they overlap and conflict, and the work of the day is to adjust their incompatibilities. What the convention has to deal with is not a contest but a problem, including as major elements a question of finances and a question of how to realize distributed government.

A specific obligation is laid upon the convention by the society's constitution. The proposed amendments cannot be tabled or rejected, but (except under one condition) they must go out to letter ballot either in their original form or as the convention may see fit to revise them. In so far as they are not compatible, then, it is manifestly the convention's duty to work out a final adjustment, or confusion is threatened. Confusion may result also if the adjustment is not so carried out that any one or more of the amendments may either pass or fail without affecting the others. The only way in which the convention can relieve itself of the work is by referring the amendments to a committee for report at the January meeting. This would mean half a year's loss of time.

Of the two main questions brought to the front by the amendments, that of finances is least adapted to postponement. At present cost levels the society is likely to find difficulty in maintaining the strength of its technical work, of which the *Proceedings* have hitherto been a vital element; it is reported that steps have already been taken to curtail the scope of the *Proceedings* heavily, in order to economize. Further, a working surplus should be available to permit of broadening the society's activities wherever practicable, and it needs to be remembered that entrance into the Federated American Engineering Societies will put a substantial claim on the society's treasury. Thus, the call for more funds has a foundation of hard fact, and the amendments concerned with dues merit prompt consideration. Three of the five amendments are in conflict on the subject of dues, one of them by omitting to change the present dues, while the others propose different methods of increase. It will be for the convention to weigh the needs and the possible resources, and make a choice.

With this matter, however, is involved the wiping out of the long-standing distinction between New York members and others. Placing all members on an equal

footing of financial accountability to the organization is in a way a parallel to the changes which aim to give equal representation and administrative voice to all part of the country. For this reason discussion of the first question may involve reference at the same time to the second, that of distributed government.

On this latter question two of the amendments are in competition. We say competition rather than conflict, for they differ only in minor ways. Representation on the Board of Direction, the manner of bringing the local sections into the society's government, and the creation of an advisory council to the Board, are at issue. It is unfortunate that the views on these matters were not harmonized before the amendments were drafted, since they must be harmonized by the convention, a far more difficult task. But the differences between the committee amendments and the competing set are not great, so that satisfactory adjustment should prove readily feasible.

Prospects are at hand, then, that the convention will be able to achieve such constructive work in considering the major questions of the day that an early vote will be possible. With finances and local participation in society government taken care of, and with the two important detail changes proposed in the other amendments duly weighed and acted upon, the society will have made clear progress toward increased strength and usefulness. How soon and how completely this desirable end will be realized, the action of the Portland convention will determine.

Municipal and State Housing in England and America

THERE has been much talk, but little else as yet, of municipal housing to meet the house shortage that prevails in many of our cities. How different the case is in Great Britain, where action speaks louder than words, Mr. Mehren's article on p. 217 shows.

Two strong reasons why municipal housing is going ahead so rapidly in England are (1) the dire need for houses there, the shortage being far greater in England than in America, and (2) the fact that municipal housing has been practiced for decades in Great Britain and has full warrant of law. Recent statistics, not mentioned by Mr. Mehren, show that many thousands of British families are living in one room. More striking still, as compared with American conditions, the shortage of even half way decent houses in rural England is and long has been acute. Unfortunately, all that Mr. Mehren outlines as having been undertaken thus far will go but a small way to meet Great Britain's house shortage, which runs into hundreds of thousands of dwellings and is increasing through population growth as fast as if not faster than it is being met by the present huge program.

A desire to eliminate slum areas as well as to provide better dwellings led London, Liverpool and other British cities and towns to buy and demolish ramshackle and insanitary houses years ago and to build model dwellings on the sites cleared. A common though not quite universal result has been that while the slum areas were cleared nearly all the people thus dispossessed went to other slums, aggravating evil conditions there without having their own made any better by the enforced change. This has been largely due to the fact that even though much of the cost of the land expropriated, and of streets widened or opened anew or improved, has been "written off," yet the rent for the new houses has been more than the people dispossessed were able to pay. In other words, the wages earned by these people is not enough to pay "economic rent" for small but comfortable and sanitary dwellings. The outcome has frequently been that clerks and mechanics, instead of unskilled day laborers, have rented the houses provided at municipal expense. More recent housing schemes have fared better in this respect.

The earlier municipal housing projects in Great Britain were generally authorized by special acts, applicable to specific cities. Some general legislation there was prior to 1909 but that year saw the passage of the notable Housing and Town Planning Act. Thus five years before the great war broke out comprehensive housing and town planning schemes were made possible in Great Britain. The procedure laid down was slow and cumbersome. Additional housing legislation, better suited to the needs of the day, was enacted by Parliament in 1919. In that year, too, a Ministry of Health was created and in it was vested the control of housing and town planning formerly held by the Local Government Board.

Sketchy as the foregoing notes necessarily have been (British housing literature fills many volumes) they may serve as a background for present British housing activities and throw into proper perspective the very little that has yet been done in the United States toward municipal and state housing. Canada, its provinces and municipalities have together appropriated millions for house construction but, aside from our Federal war activities, what has been done to aid housing by nation, states or cities this side of the border? Little if anything except by way of investigation. There has been state and city legislation against rent profiteering, but even this Justice Swayze, of the New Jersey Supreme Court, has declared to be unconstitutional, in language apparently broad enough, if not specifically so intended, to apply to municipal housing. In giving an opinion that resolutions aimed at profiteering landlords, passed by the City Commission of Jersey City were void, Judge Swayze said: "No doubt it is desirable that there should be houses for all citizens, but they cannot be provided legally by using without leave or confiscating the property of house owners. Housing can only be provided either in the ordinary commercial way, or by private charity." The Newark *News* comments approvingly on this decision and says that the same fate would doubtless have met a number of housing bills enacted by the lower branch of the State legislature had they become law.

If this Judge and this newspaper may be considered to voice the opinion of the American courts and press, there is little likelihood that Great Britain's immense housing scheme will be emulated here. This we say without regard to the merits of the case.

Presumably, the building and renting of houses will remain in private hands here. But it is conceivable that the risks incident to building and renting out houses in these days of high construction and capital cost, and of state and municipal regulation, will so discourage private capital that public enterprise will be forced to act. If so, much can be learned from the housing experiences of British cities and the results of the financial aid that is being rendered by the British Government.

Deep Pit Rock Excavation by Dragline Machines

Operating Ranges of 175 Ft. Horizontally and 100 Ft. Vertically Found Practicable in Rock Cuts for Miami Valley Flood Retarding Dams

NOTEWORTHY figures on radius and depth of excavation in blasted rock with dragline excavators have been obtained by the construction forces of the Miami Conservancy District. In preparing the emplacements for the outlet structures of the flood-retarding dams, rock cuts as wide as 174 ft. have been excavated without shifting the machines from the center line, and rock has been removed from a pit floor 63 ft. below the excavator track, and from the same position the machine has pulled down material from 37 ft. above track level, thus operating through a lift of 100 ft. Besides satisfying the requirements of wide reach and high lift, without rehandling the load, the dragline method at these dams has facilitated concrete construction, eliminated certain flood risks and reduced the manpower required by other methods.

Their volume of 400,000 cu.yd. places the outlet channels for the five Conservancy dams among the largest of recent rock excavation operations. Though performed in separate locations the work was virtually a single operation, because the overhead direction and planning were the same for all locations; the method of excavation was standardized for all; and equipment, procedure and supplies were interchangeable in any degree that seemed desirable. The outstanding development of the operation was to establish the dragline excavator as a tool having notable flexibility and efficiency in handling blasted rock.

Limestone and shale are the ledge rocks of the flood-retarding dam sites. Broadly speaking, the limestone is structurally hard and durable and the shale is shaky and breaks up when exposed to the elements. At all locations except Lockington, the two rocks are in combination, generally in alternate thin strata. Under the glacial till overburden, the strata, down to depths as great as 10 ft., are loose, because of partial disintegrations of the shale.

At no two of the dam locations are there the same combinations of limestone and shale. There is no shale at Lockington and the limestone belongs to a different formation than that at the other dams. It is a hard

FIG. 2. CONDUIT FLOORS CONCRETED CLOSE BEHIND EXCAVATOR OPERATIONS

and a fairly tough rock which, in the blasting, breaks up into blocks suitable for plum stones and was extensively used for this purpose in the concrete walls of the outlet structure. At Englewood the shale and

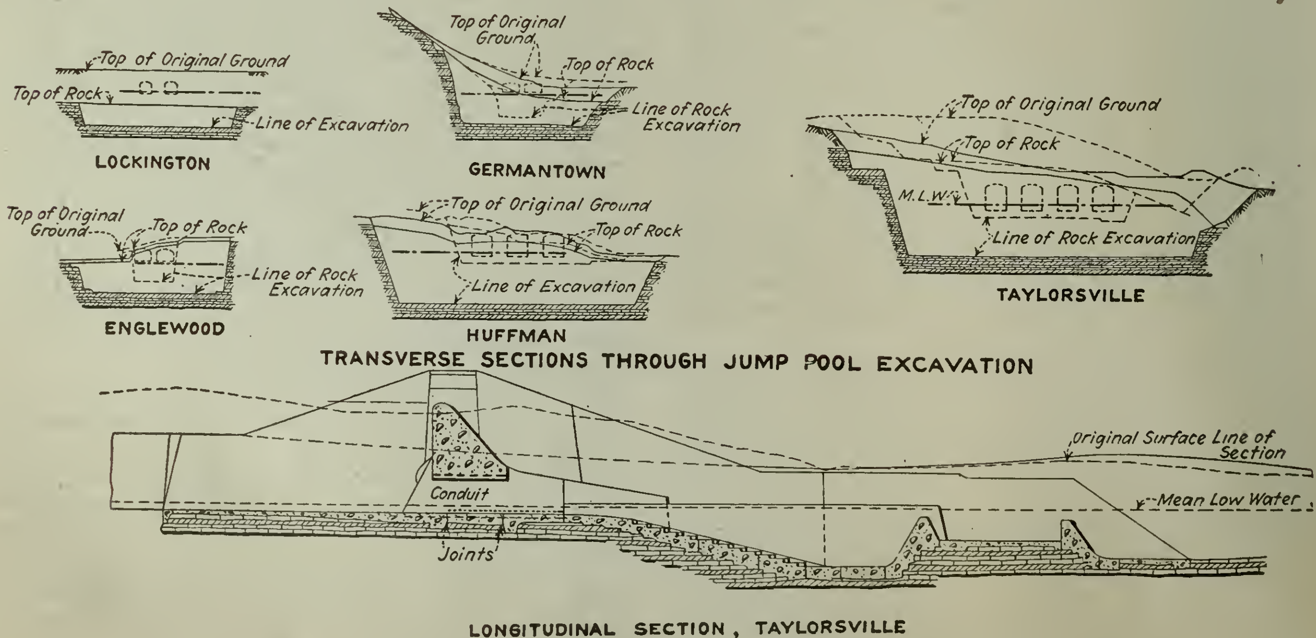


FIG. 1. TYPICAL SECTIONS OF ROCK CUTS FOR OUTLET CHANNELS

FIG. 3. PIT TRACKS ELIMINATED AND DRILL SHIFTING SIMPLIFIED

limestone are distinct strata, which separate readily into slabs a maximum of a few inches thick. For the most part, the two rocks, at Taylorsville, are in mingled thin strata, but at one level of the excavation there was a layer some 5 ft. thick, composed of limestone strata up to 13 in. firmly cemented together by ⅛- to ¼-in. strata of shale, so that, in blasting, the layer frequently broke into large blocks which had to be reblasted. At Huffman dam the shale and limestone are blended or mixed and the blasted fragments broke down rapidly when exposed to the weather. The Germantown rock contains only a small proportion of limestone.

Rock Used for Filling

Except at Lockington the excavated rock was of use in construction only for filling. As a filling material it had no place, of course, in the hydraulic fill dam except as a buttress fill against the earth slopes. It was used for this purpose, and, particularly at Huffman, for railway and levee embankment. These practicable uses are important to keep in mind because they point to the fact that disposal of excavated rock involved hauls of considerable length.

The ledge opening to be made was similar at all dams. It was a channel, or rock cut, in which was to be built the concrete outlet structure that passed the stream under or through the earth dam. Above the dam the cut was wide for an entrance channel, then it narrowed for the distance through the dam and finally it widened into an outlet channel below the dam. The cross-sections of Fig. 1 indicate by dotted lines the narrow conduit cuts and by full lines the wider and deeper cuts for the outlet and hydraulic jump pool. As the deeper pit for the jump pool is a characteristic of all the rock cuts it is also shown in Fig. 1 in longitudinal section for the Taylorsville dam.

Pit volumes and dimensions may be particularized briefly as follows: At Germantown and Englewood the channels were much alike. With a middle portion 30 to 35 ft. wide the ends widened out to 100 ft. and the depth ranged from 30 to 40 ft. At Englewood the cut was about 1,000 ft. long and the volume of excavation was 57,700 cu.yd.; at Germantown the corresponding figures were 800 ft. and 40,000 cu.yd. To provide for the flood flow at Huffman dam, a three-conduit outlet was required and this and the local topography called for a rock cut about 115 ft. wide and 40 ft. deep in the body and 174 ft. wide and 60 ft. deep at the outlet. The volume of excavation was 39,500 cu.yd. The Taylorsville cut was the greatest of all, involving about 250,000 cu.yd. of rock cut, and the removal of some 523,000 cu.yd. of earth overburden.

Conditions Governing Spoil Removal

With the ledge and pit conditions described, the greater rock-excavation problem was that of spoil removal. Obviously, also, only machine methods of digging and loading could be considered. The conditions governing the choice of method were fixed by the definite construction requirements; (1) that excavation and concrete construction must proceed together; (2) that the equipment must be safe from flood; (3) that the service railway requirements must be simple and (4) that economy of manpower must be kept in the forefront.

Each of the requirements stated had a constructive purpose. All the rock channels were in large part merely emplacements for concrete structures which

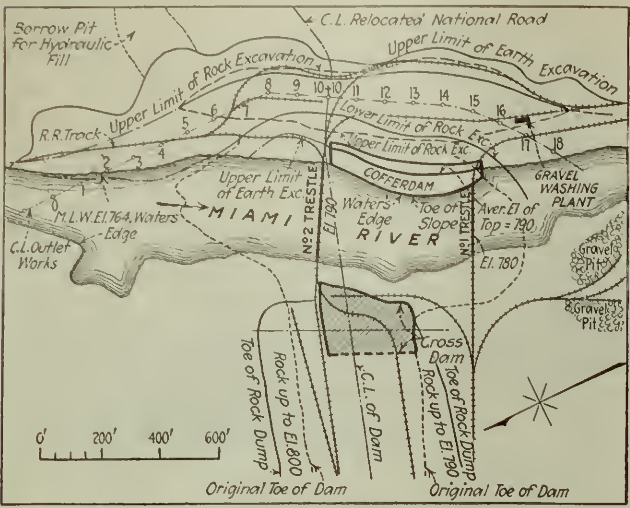


FIG. 4. PLAN OF CHANNEL EXCAVATION OPERATION AT TAYLORSVILLE

formed the real outlet channels and the completion of which, except for certain final closure parts, was necessary before any part of the channel could be used to convey water. Speed of completion, therefore, required a method of excavation which would permit as nearly as possible simultaneous concrete construction. Pit inundation was always a possible danger, if not a practical certainty, in the spring flood season. Flood safety, therefore, required an outfit for rock excavation which presented the smallest chance of being entrapped. With war in progress difficulty in securing labor was certain. Men were required for the army and for war construction and it was felt that the available labor supply should be devoted to these purposes before all others. Because labor was scarce, therefore, and also because war work had a priority right to labor, a method of excavation was required which would call for the fewest possible workmen.

Probably the third requirement stated counted for the most. Utilization of the excavated rock for railway embankment and to buttress earth dam slopes necessitated such long hauls that heavy-train railway transportation was the only economic method of disposal. Therefore, a digging and loading method was required which would lift the load high and swing it wide to cars on the surface, where permanent tracks and moderate grades for heavy spoil-train service could be maintained. Any other method, practicable for heavy rock excavation in large volumes, would require pit tracks with steep grades out of the pit and much shifting of track across the pit floor.

The excavation and loading machine, which best satisfied the four requirements enumerated and the further condition that a mobile excavator was demanded by extended longitudinal dimensions of the pits, appeared to be the dragline excavator. By traveling along the axis of the pit this machine could complete the channel to depth and width in one cut. As soon as a section of channel was excavated, as shown by Fig. 2, construction of the concrete structure could begin and thereafter concreting could follow closely the excavating. Working from the surface the machine could not be drowned out if the pit was flooded. Its wide swing and high lift permitted the service railway to be located on the surface along the side of the excavation and so be out of the reach of overflow. Only the drills in the pit risked inundation and at indications of danger they could be picked up and hoisted to safety by the dragline. Surface location of the service railway eliminated all problems connected with pit track gradients, track shifting and road-bed construction. In respect to operating labor, dragline methods afforded economy chiefly by reducing track gage.

Dragline Equipment and Methods

Dragline excavation was employed at all locations except Lockington. Here the yardage was so small—except in the pit only 16 ft. deep for the jump pool—that heavy machine excavators could not profitably be operated. Also, the rock was a hard limestone and the large pieces were wanted as plums in the concrete so that hand loading into skips handled by the derricks installed for placing the concrete was a preferable procedure. By this arrangement the derricks lifted the plum-stone material directly into the wall forms and unloaded the skiploads of small waste rock into 5-cu.yd. cars which took it to points where riprap was wanted. The total volume of rock excavated at Lockington was less than 5,000 cu.yd.

The operating procedure at the four channels excavated by dragline was to start the machine at one end and travel down the longitudinal axis. In detail the operation differed at each dam because, chiefly, of differences in the depths and the widths of the cuts excavated. The maxima of these two dimensions were at Huffman and Taylorsville so that description of the procedure at these two locations gives the upper ranges of dragline efficiency as determined by the results of the Miami Conservancy District operations in blasted rock. At both dams the excavation of the deep pit for the hydraulic jump pool was the operation which tested radius and depth of dragline performance.

In excavating the jump pit at Huffman dam the dragline took out a channel 174 ft. wide without moving from the center line. The depth of the cut in rock was 60 ft. The machine used had a boom length of 100 ft. and operated a 4½-cu.yd. bucket. In the deepest place the bottom of the pit was 58 ft. below the excavator track and the distance from the pit bottom to spoil track was 64 ft. From one position the machine excavated and loaded 25,000 cu.yd.

At Taylorsville, besides the rock cut of 250,000 cu.yd. there were some 523,000 cu.yd. of earth overburden to be removed. Fig. 4 is a plan of the operation. About 30,000 cu.yd. of the earth cover were taken across the river by train to construct the cross-dam as described in *Engineering News-Record*, June 10, 1920, p. 1142. The remainder of the overburden was broken down by blasting and by hydraulic giants, sluiced to sumps and pumped across the river for hydraulic fill in the main dam.

The rock cut was 1,850 ft. long, had a maximum width of 380 ft. and a maximum depth of 77 ft. A top lift of overburden and loose rock was taken off by steam shovel and dragline down to elevation 789. About 6,000 cu.yd. of rock were removed in this manner to provide a rock platform at elevation 789 for the dragline excavator and the spoil-train tracks. The excavator had a 100-ft. boom and a 3½-cu.yd. bucket and loaded into trains of 12-cu.yd. dump cars. At the deepest cut the excavator took rock from 63 ft. below the track level.

To cover the full width of the pit the machine was shuttled back and forth on transverse tracks.

At the maximum depth the dragline output was reduced about 50 per cent. It was increasingly difficult to load the bucket as the pit deepened, particularly in wide-radius operation, when to make the reach, the bucket had to be cast beyond the boom reach. Then the bucket would often bump over the rock without digging in or would turn bottom up and have to be hauled in and cast out a second time. In this operation electric power was a disadvantage since the process of hauling in the empty bucket could not be speeded up as is possible with a steam hoist. At maximum depth and reach, no different bucket design or construction was employed. Both bucket and cable wear was increased. At Taylorsville bucket repairs ran about 3c. a yard and cable replacements about the same. Cables had an average life of 6,000 cu.yd.

Construction requirements generally imposed a method of procedure which make it difficult to present outputs which fairly represent dragline capacity in handling blasted rock. At Huffman, when the conditions rather favored high records, the 200-hp., 4½-cu.yd., 100-ft. boom machine, loaded a maximum of 115 cars in a ten-hour shift. As the 12-cu.yd. cars averaged 9 cu.yd. each, this is, in round numbers, an output of 1,000 cu.yd. An output of 700 to 800 cu.yd. per shift was frequent. At Taylorsville, with a 225-hp., 3½-cu.yd., 100-ft. boom dragline the average output per month working two shifts has been 16,740 cu.yd., or about 335 cu.yd. per shift for, say, 50 shifts a month.

FIG. 5. CHARACTER OF ROCK BREAKAGE FOR DRAGLINE EXCAVATION

Drilling and Blasting Practice

As drilling and blasting problems, the channel operations were difficult chiefly because of the streaky and shaky character of the rock. The deep-hole blasts had to be kept well within the limits of the planned dimensions of the rock cut. This required a considerable volume of cut enlargement by small blasts. A final trimming with picks was also required to remove the loose rock and get a firm backing for the concrete of the outlet structures.

Practice varied at the different locations. At Lockington the shallow cut, which permitted the concrete work to follow the excavation very closely, and the plan to utilize the rock largely for plums in the concrete, did not permit heavy blasting. Shallow holes were drilled and light charges were forced. Using 40 per cent dynamite, about 0.75 lb. per cubic yard of rock blasted was required. While the consumption of explosive was somewhat high by this procedure, it gave a good rock for plum stones and riprap and the blasting was kept close to the neat lines of the cut which reduced trimming and overbreakage.

With long narrow cuts in comparatively soft and uniform rock at Englewood and Germantown the practice in drilling and blasting was similar. Tripod drills, starting 2½ in. and finishing 1⅞ in., were used. The holes were spaced about 5 ft., and also 5 ft. from the face, and each was charged with about eight sticks of 40 per cent dynamite. The trimming holes were drilled with jackhamers. The average explosive required was, at Englewood, 0.75 lb. per cubic yard, and at Germantown, 0.5 lb. per cubic yard.

With a wider and deeper cut at Huffman dam, 4-in. well and wagon drills were used, driving 20-ft. holes spaced 10 ft. apart and 10 ft. from the face. A drill averaged about 45 ft. a day. Blasting was done with 40 per cent dynamite. The average was 0.52 lb. per cu.yd.

At Taylorsville dam the rock was drilled and blasted in two lifts. About 26 ft. below elevation 789 were taken out in the first lift, and the second lift went to the bottom, a maximum of 37 ft. below the first. In a measure, the ledge conditions determined the 26 ft. depth of the first lift. Deeper holes extended below the thick limestone layer, previously described, and blasting broke the layer into large blocks which required much reblasting to fit the rock for dragline excavation. With the charge exploded in and just at the bottom of the limestone layer little reblasting was required.

Well drills were used for the main operations. These were operated by 7½-hp. electric motors using 440 volts. They averaged about 50 ft. of 4⅝-in. holes a day. The holes were spaced 10 ft. each way but none was drilled nearer than 2 ft. to the bottom. At first 40 per cent dynamite was used, and later, 72½ per cent gelatin dynamite, made originally for the Italian government for war and after the armistice purchased at reduced cost by the Conservancy District. About 75 to 100 lb. was the charge for the deep holes. The average amounts of explosives used per cubic yard were 0.72 lb. of 40 per cent dynamite and 0.5 lb. of the high-power gelignite. Ordinarily, from 75 to 100 holes were fired at a shot. Drilling cost about 12c. a cu.yd. and blasting about 15c.

All work at the five dams was performed by the construction forces of the Miami Conservancy District, Arthur E. Morgan, chief engineer, Charles H. Paul, assistant chief engineer and C. H. Locher, construction manager.

Motor Operation Costs as Affected By Highway Location and Grade Design—Part III

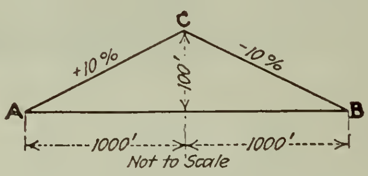
Comparison of Alternate Locations from Standpoint of Motor Operating Costs—Table of Capitalized Operating Cost on Different Grades Established

By Wilson G. Harger
Former Senior Highway Engineer Bureau of Public Roads

It is even more difficult to analyze alternate locations involving different distances, rise and rates of grade than the simpler cases cited at the conclusion of Part II. At present a close approximation is not possible. With more definite data on motor operation a closer approximation will be possible, but the great variety of motor vehicles will probably even then tend to weaken the value of the figures. In order to show the effect of the time factor a simple case will be outlined:

Assume two villages, *A* and *B*, 2,000 ft. apart, separated by a hill 100 ft. high with a 10 per cent grade on either side. Assume an operating cost of a truck as \$24 per 10-hr. day or 4c. per minute, exclusive of fuel and oil. Assume the fuel cost as 8c. per mile, operating on the level. Assume a rolling resistance of 40 lb. per ton on the level.

Under these assumptions, if the truck starts from *A* and stops at *B*, coasting down grade from *C* to *B*, the



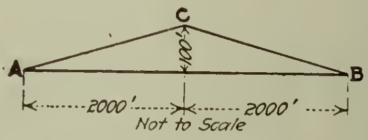
energy expended per ton of load would be approximately, (1,000, distance in feet, $\times$ 240, pull in pounds) + (an allowance for the engine running free from *C* to *B*, say 10 per cent of energy required for running 1,000 ft. on the level, or 10 per cent of 40,000 ft.-lb.) = 244,000 ft.-lb.

The amount of energy required per ton of load from *A* to *B* on the level would be 2,000 (distance in feet) $\times$ 40 (pull in pounds) = 80,000, number of ft.-lb. Assuming that the fuel expenditure is directly proportional to the expenditure of energy, the fuel consumption over the hill would be $\frac{244,000}{80,000}$ or 3 times as great as on the level, or in money at 8c. per mile on the level it would be $\frac{2000}{5280} \times$ 8c. $\times$ 3 = 9c. The fuel consumption on level = 3c.

Suppose we consider the time factor. Assume that the maximum speed on the level is regulated by law to 12 mi. per hour. The time consumed to go 2.000 ft. on the level is approximately two minutes, which amounts in money at \$24 per day to about 8c. Suppose the truck makes 3 mi. per hour in low gear traveling from *A* to *C* and 6 mi. per hour coasting down the hill from *C* to *B*. The time over the hill would be six minutes or in money 24c. The total operating cost over the hill would be about 33c. and on the level 11c., or a difference of 22c.

If these assumptions were correct we could afford to increase the length of the road to 6,000 ft. on the level or three times as far to avoid the hill, so far as the operating cost of the truck is concerned. The cost of construction of the two routes would of course be balanced against the operating cost.

Take the same case for the two villages *A* and *B* 4,000 ft. apart on 5 per cent grades.



The energy over the hill per ton of load is assumed as (2,000 $\times$ 40) + (10 per cent of 2,000 $\times$ 40) = 288,000, number of ft.-lb.

The energy on the level	= 160,000 ft.-lb.
Fuel consumption over the hill	= 11c.
Fuel consumption on level	= 6c.

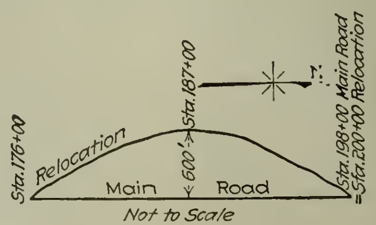
The speed climbing the 5 per cent grade would probably be about 6 mi. per hour, and about 12 mi. per hour coasting down the hill, provided the alignment is good, as the extreme control necessary on a 10 per cent grade is not required.

The time over the hill becomes approximately	6 min.
The time on the level becomes approximately	4 min.
The time cost over the hill approximately	24c.
The time cost on the level approximately	16c.
Total cost over hill	35c.
Total cost on level	22c.

In this case we could afford to increase the distance only 50 per cent to get a level road from the standpoint of operating cost.

As previously discussed, the value of the reduction of rise and fall decreases as the rate of grade decreases so that while in extreme cases it is desirable to increase distance to eliminate rise, this expedient must be used with care for light grades and small hills for, in general, short distance outweighs minor, intermediate rise and fall.

Simple Example.—To give a practical application of such figures we will cite a concrete example known as the Pugsley Hill relocation of the Mendon-Pittsford Road in New York State. (Figure below.) The main



straight road goes over the top of a high hill; the natural saddle is located about 600 ft. west of the main road and is 25 ft. lower than the summit on the main road. The main road used a 7 per cent cut-and-fill

grade reduction and the relocation a 4 per cent balanced side-hill location. The snow conditions are much better on the new location, the cost of construction is less and the rise less. Suppose we make a rough comparison of the cost of operating over the two locations:

Cost of Operating over Main Line (Trucks).

Fuel: $\frac{(180 \times 1{,}100) + (10 \text{ per cent of } 44{,}000 \text{ ft.-lb.})}{212{,}000 \text{ ft.-lb. per mile on level}} \times$ 8c. per mile on level = 8c.

Time: Average 6 mi. per hour, 4c. per min. (assumed). = 16c.

Total cost, = 24c.

Cost of Operating over New Line (Trucks).

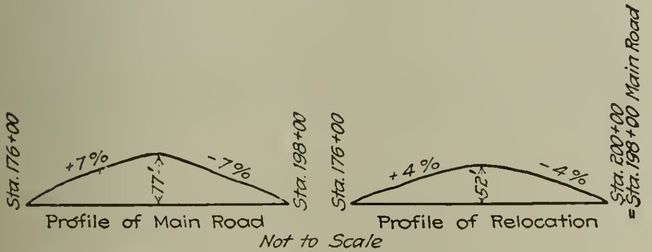
Fuel: $\frac{(120 \times 1{,}300) + (10 \text{ per cent of } 52{,}000)}{212{,}000} \times 0.08$ = 6c.

Time: Average, 10 mi. per hour (assumed), = 12c.

Total cost, = 18c.

That is, we have enough data to conclude that the operating cost on the new line is slightly less than the old main road. These data do not, however, warrant our putting a money value on this difference, as there are too many unknown factors, particularly that of time. Purely as a matter of academic interest we can carry this example a little further. This road carries today a traffic of approximately 950 motor cars and 80 trucks per day in summer. It is safe to assume that this amount of traffic applied for 250 days per year will about represent the total yearly traffic. If we assume that the pleasure cars cost about one-seventh as much to operate as the trucks we can arrive at a rough guess of the yearly saving—$3,000. This capitalized at 5 per cent would amount to $60,000, which represents theoretically the additional amount we would be justified in spending to get the new location.

As a matter of practical interest we will say that, despite the advantages of an apparently lower operating



cost, less snow trouble, and lower construction cost, this new line was not built on account of the difficulty of acquiring right-of-way. The farmer wanted $5,000 for 3½ acres because the location cut up his property. It was undoubtedly poor policy to let this stand in the way and it is probably only a question of time before the relocation will be made, as this hill controls the maximum grade on a through state route.

Quick Method of Comparison

For quick rough comparisons of such relocations we can compile a table which in the absence of really reliable data will serve the purpose. We will compute the approximate comparative cost of operating on different rates of grade. The actual cost given is of very little value but the comparative costs are close enough to give some basis for judgment on the relative value of two locations from the standpoint of motor operation.

We will make this on the basis of 11c. average motor operation on a +1 per cent grade. This is considered a reasonable cost for the proportions of truck, car and horse traffic on main roads. We will assume that the speed is reduced to one-half normal at +5 per cent and to one-fourth normal at +10 per cent grade. We will assume that the speed stays at normal on the level and remains normal on down grades to —5 per cent. and that after this rate of grade is passed that it is reduced to one-half normal at —10 per cent grade. We will assume an average fuel cost per mile on the +1 per cent grade of 3c. and that the fuel consumption is directly proportional to the theoretical energy expended in climbing. We will make some arbitrary allowances on down grades, and we will assume a theoretical drawbar pull of 40 lb. per ton on the level. The assumed cost of operation per mile on the different grades is as follows:

Level	$0 107	Level	$0 107
+ 1%	.110	— 1%	.104
+ 2%	.126	— 2%	.098
+ 3%	.148	— 3%	.092
+ 4%	.176	— 4%	.086
+ 5%	.210	— 5%	.083
+ 6%	.244	— 6%	.095
+ 7%	.278	— 7%	.107
+ 8%	.312	— 8%	.119
+ 9%	.346	— 9%	.131
+10%	.380	—10%	.143

These costs were derived as follows. The operating cost of 11c. per mile on a +1 per cent grade was apportioned as follows:

		Remarks
Fuel	$0 03	Variable fuel factor.
Tires	.015	Constant distance factor.
Repairs	.01	½ distance, ½ time factor.
Driver's time	.015	Time factor.
Depreciation	.02	½ distance, ½ time factor.
Interest on investment, insurance, garage, license, etc.	.02	Time factor.
	$0 11	

To determine the operating cost on any other grade it is necessary to assume three factors: The constant

ANALYSIS OF RELATIVE OPERATING COST OF AVERAGE MOTOR TRAFFIC FOR ONE MILE OF DISTANCE ON DIFFERENT RATES OF GRADE. BASED ON 11c. PER MILE ON A ONE PER CENT GRADE

	Distance Factor $0.02 for 1% Grade		Fuel Factor $0.03 for 1% Grade		Time Factor $0.06 for 1% Grade		
Rate Grade	Factor Ratio for Each Rate of Grade	Cost for Each Grade	Factor Ratio for Each Rate of Grade	Cost for Each Grade	Factor Ratio	Cost for Each Grade	Total Operating Cost
+10	1	$0.02	4	$0.12	4	$0.24	$0.380
+ 9	1	.02	3⅔	.11	3.6	.216	.34
+ 8	1	.02	3⅓	.10	3.2	.192	.312
+ 7	1	.02	3	.09	2 8	.168	.278
+ 6	1	.02	2⅔	.08	2.4	.144	.244
+ 5	1	.02	2⅓	.07	2	.120	0.210
+ 4	1	.02	2	.06	1 6	0 096	.176
+ 3	1	.02	1⅔	.05	1 3	0.078	0.148
+ 2	1	.02	1⅓	.04	1 1	0.066	0 126
+ 1	1	.02	1	.03	1	.06	0.110
Level	1	.02	0.9	.027	1	.06	.107
— 1	1	.02	0.8	.024	1	.06	0.104
— 2	1	.02	0.6	.018	1	.06	0.098
— 3	1	.02	0.4	.012	1	.06	0.092
— 4	1	.02	0.2	.006	1	.06	0.086
— 5	1	.02	Engine running free 0.1	.003	1	.06	0.083
— 6	1	.02	0 1	.003	1 2	.072	0.095
— 7	1	.02	0.1	003	1.4	.084	0.107
— 8	1	.02	0.1	.003	1.6	.096	0.119
— 9	1	.02	0.1	.003	1 8	.108	0.131
—10	1	.02	0.1	.003	2 0	.120	0.143

NOTE—If anything the fuel factor of 0.1 between the grades of —5% and —10% is a trifle low.

The time factor between the rates of grade of —5% and —10% depends very largely on the alignment, the individual driver, and whether or not he is in the habit of driving on steep grades. It is probably about right for passenger cars but too high for truck operation, and might be reduced to 1.5 at a — 10% grade for truck traffic in hilly country.

The time factor on grades of +2% to +10% is too high for high power touring cars as on good aligment the normal speed is often not reduced at all up to 6%.

distance factor made up of tires, one-fourth of the repairs and one-fourth of the depreciation. The variable fuel factor and the variable time factor made up of driver's time, interest, three-quarters depreciation and three-quarters repairs. This last factor is the largest factor, it depends on the speed of the operation and is largely a matter of judgment until we have more and better data.

The data given are based on the author's best judgment in assigning arbitrary values to these factors and ratios on different grades:

	Per Mile
Time cost on a 1% grade	$0.06
Fuel cost on a 1% grade	.03
Distance factor cost (constant)	.02
Total	$0.11

TABLE OF APPROXIMATE CAPITALIZED COST AT 5%, OF YEARLY OPERATING 100 AVERAGE MOTOR CARS DAILY FOR 365 DAYS PER YEAR FOR ONE FOOT DISTANCE ON THE VARIOUS GRADES. (TIME FACTOR CONSIDERED)

Rate of Grade	Yearly Operation 100 Cars Daily (36,500 Cars Yearly)	Capitalized Yearly Operation Cost	Rate	Yearly	Capitalized
Level	$0.74	$14 80	Level	$0.74	$14.80
+ 1%	.76	15 20	— 1	.72	14.40
+ 2%	.87	17 40	— 2	.67	13.50
+ 3%	1.02	20 10	— 3	.63	12.70
+ 4%	1.22	24 40	— 4	.60	11.90
+ 5%	1.45	29 10	— 5	.57	11.50
+ 6%	1.68	33 70	— 6	.66	13.10
+ 7%	1.92	38 40	— 7	.74	14.80
+ 8%	2.16	43.20	— 8	.82	16.50
+ 9%	2.39	47 80	— 9	90	18.10
+10%	2.62	52.50	—10	.99	19.80

NOTE—This table to be used only for general comparisons of the relative value of routes or alternate locations. The actual costs given are of very little value. The figures are based on an average operating cost for all classes of travel at 11c. per mile on a +1% grade.

To illustrate the use of this table suppose we compare the two locations over Pugsley Hill previously given.

CAPITALIZED OPERATING COST MAIN LINE

1,100, distance in feet on +7% grade, × $38.40 =	$42,240
1,100, distance in feet on —7% grade, × 14.80 =	16,280
Total operating capitalized cost for 100 vehicles per day	$58,520

RELOCATION LINE

1,300 distance in feet on a +4% grade, × $24.40 =	$31,720
1,300, distance in feet on a —4% grade, × 11.90 =	15,470
Total capitalized cost for 100 vehicles per day	$47,190

This indicates that possibly the relocation warran... an additional expenditure of $10,000 per 100 vehicles per day. This road averages 700 vehicles per day making the total warranted additional expenditure on the relocation for this particular volume of traffic $70,000. Even assuming that gasoline and time mean nothing to 75 per cent of the road users, this location would still be worth while.

A comparison of this kind may not warrant placing a money value on the saving in operating cost, but it certainly justifies the general conclusion that the relocation is the better line from the standpoint of operating cost. [*This is the concluding article in Mr. Harger's series.*—ED.]

American Shipbuilding During 1919-1920

During the fiscal year ending June 30, 1920, according to the U. S. Department of Commerce, the total shipping built in the United States and officially numbered by the Bureau of Navigation, aggregated 2,241 vessels of 3,860,484 gross tons as compared with 2,158 vessels and 3,734,741 gross tons for the preceding fiscal year. The peak of production was reached in the Autumn of 1919 and the following winter when, from September, 1919, to February, 1920, the output was at the rate of 4,250,000 gross tons per year.

Simple Plant Makes Good Record in Dam Construction

Favorable Location Permits Plant With Few Units To Place Concrete in 300-Ft. Dam With Small Labor Force

SIMPLE equipment, carefully planned to reduce manual operations is giving high output records in constructing the Devil's Gate concrete arch dam near Pasadena, Cal. With a force of approximately 21 workmen, aggregates have been excavated, hauled, crushed and screened and concrete has been mixed and placed at the rate of 300 cu.yd. in an 8-hour shift.

The Devil's Gate Dam is one of the structures being built by the Los Angeles County Flood Control District. It is located in the deep gorge of the Arroyo Seco, is about 300 ft. long and has a volume of about 30,000 cu.yd. of concrete. In their analysis of the construction task the contractors gave particular attention (1) to performing the construction operations to as great a degree as possible by mechanical means and (2) to simplifying the equipment and its arrangement.

About 17,000 cu.yd. of gravel, sand and rock had to be removed in preparing the foundations for the dam proper and in excavating the spillway. About 9,000 cu.yd. in the dam foundations were handled by a guy derrick having an 85-ft. boom and operating 1 cu.yd. skips loaded by hand. One foreman and 12 to 16 men loaded about 100 skips in an 8-hour shift. The spoil was piled just above the upstream face of the dam and will be leveled off to form a fill against the masonry. Two shifts a day were worked, as it was desired to get the dam completed above flood level before the rainy season. The spillway channel, which was located in a draw east of the dam, was excavated with fresno scrapers.

A high promontory, against which one end of the dam abutted, was selected, as shown by the illustration, for the site of the crushing plant, materials bins and concrete mixer. This location was well above danger from floods and was at a height which permitted about 75 per cent of the concrete in the dam to be chuted directly from the mixer and also permitted direct chuting to the spillway beyond the hill.

Suitable materials for concrete were found in the bed of the Arroyo about 1,500 ft. above the site of the dam. At that point, sand and gravel, and boulders up to 16 in. in diameter, are loaded by a steam shovel, having a ¾-cu.yd. dipper, directly into dump trucks to be hauled to the mixing plant. Three 5-cu.yd. trucks are used, traveling over 3 per cent to 4 per cent grades, and making the round trip to the mixing plant in about 12 minutes. A gyratory crusher that will handle rock up to about 16 in. in diameter is located beneath the truck-dumping platform and all materials from the trucks go through this crusher. From the crusher the materials are taken by a 70-ft. elevator to screens on top of the bunkers. These screens separate as sand all material up to ¼ in. in diameter. That which falls through the screen, with 3-in. perforations, is classified as rock, and larger material passes on to another gyratory crusher which reduces it to 1-in. size for use in the tunnel, or elsewhere where reinforcing is used. This crusher is arranged so that it requires practically no attention. The supply of oversize rock from the big plant is quite uniform and well within the capacity

MIXING PLANT ON HILL BUILDS CONCRETE DAM BY DIRECT-CHUTING

of the small crusher, and after passing through this crusher the rock is taken to bunkers by a conveyor.

From the screens the sand and rock drops into bins, the sand bin holding 80 cu.yd. and the rock bin 100 cu.yd. Immediately beneath the bins is the hopper of a 45-cu.ft. mixer which, in turn, delivers to a spouting system running out over the dam. Three cables span the gorge directly over the dam. The center cable is 1½ in. in diameter, the others, one 30 ft. on either side, are 1 in. in diameter. Concrete chutes are suspended from the cables by block and tackle so that they can be adjusted to the desired height or swung to position over any portion of the dam. Time and labor were saved in handling the delivery chutes by arranging them so that three swivel joints and a single discharge trough could be used instead of the single swivel joint and two gates used at first. At the outset of the work there was so great a drop from the mixer to the bottom of forms that the concrete was first dropped through a wooden chute to a level from which the suspended chutes could deliver on a moderate grade.

About 75 per cent of the total concrete yardage can be poured directly from the mixer into the dam. When the dam has reached a height such that there will be insufficient grade to carry the concrete all the way across, a section at the end near the mixer will be carried up to its final height. On this short section a trestle will be built so that cars can be used to carry the concrete out to a new dumping position. From this point another section of the dam will be built up and the trestle extended to a new dumping position, and this operation will be repeated across the dam.

Because the dam is of the simple arch type, the form work is not complicated. Two carpenters were all that were required until the concrete had been carried to about half the ultimate height of the structure. The forms are wood panels, 3 x 10 ft. in size, and two men can handle them easily. They are held in place by wires running to anchors set in the last 3 ft. of concrete poured. When the forms are stripped they are raised to the new position by means of tackle suspended from the cable above.

The distribution of the men on the job is as follows: In the material pit the steam-shovel crew consists of one operator, one fireman, and two tenders. This crew can load 75 trucks or 330 cu.yd. in 8 hours. Each of the three trucks averages about 25 loads per day. The crusher crew consists of one mechanic and sub-foreman, two crusher feeders and one elevator feeder. It can handle 300 cu.yd. in an 8-hour shift. The mixer crew, which consists of one mixer man and three men feeding the hopper, handles an average of 220 batches or 250 cu.yd. per 8 hours. The concrete placing crew includes one working sub-foreman, two spreaders and one man on the chute. With this organization as much as 300 cu.yd. of concrete has been put into the dam in 8 hours. As the duties of most of the men consist of seeing that the machinery does its work properly, if the crew is several men short on some days, the output is not cut down materially so long as the machinery is working well.

J. W. Reagan is engineer for the Los Angeles Flood Control District. Bent Bros., of Los Angeles, Cal., are the contractors and L. T. Grider is superintendent in charge of construction.

Deep Piers for Missouri River Bridge

Deep piers are to be sunk for the main channel spans of the new Bismarck-Menden highway bridge across the Missouri River. The structure will comprise three through truss spans of 476 ft. c. to c. pins, and about 1,000 ft. of approach consisting of reinforced-concrete deck on wooden piles. The four river piers, spaced 481 ft. on centers, must be sunk to depths of 50 to 90 ft. below low water, passing through sand and silt to a stratum of hard clay shown by borings. The Foundation Co., of New York, has contracted to construct the piers and approaches, and according to information received from this company the open excavation method of sinking will probably be used, although air will be put on after the piers have been landed, to place the bottom and seal concrete. The two outer piers of the four will consist each of two 20-ft. circular pedestals 35 ft. apart on centers, joined by a connecting member at the top. The two middle piers will be 23 x 65-ft. rectangles. The C. A. P. Turner Co., of Minneapolis, engineer for the bridge, will direct the construction. The American Bridge Co. will build and erect the trusses. The bridge and the highway are Federal aid projects.

Provisions of the Federal Water-Power Act

Abstract of the Law Creating a Federal Power Commission and Permitting Long-Time Use of Water Power on Government Lands and Navigable Streams

UNDER the official title of "The Federal Water-Power Act" the President on June 10, 1920, signed the long pending Water-Power Bill which provides for the long-time leasing of water-power rights on government lands and navigable streams under the jurisdiction of a new body known as the Federal Power Commission. The act itself is quite lengthy, but there is given below a fairly complete abstract of its main provisions. The abstract follows in order the paragraphs of the act itself.

A commission is created and established to be known as the Federal Power Commission, to be composed of the Secretary of War, the Secretary of the Interior, and the Secretary of Agriculture. The President shall designate the chairman of the commission. This commission shall appoint an executive secretary who is to receive a salary of $5,000 a year, and it may also request the President to detail an officer from the United States Engineer Corps to serve the commission as engineer-officer. The duties of both of these men are to be prescribed by the commission. The work of the commission is to be performed by and through the Departments of War, Interior, and Agriculture and their engineering, technical, clerical, and other personnel, except as may be otherwise provided by law. The sum of $100,000 is appropriated for such other expenses of the commission as are not to be taken care of by the three contributing departments.

Definitions of Terms in Act

The words used in the act are to have for the purposes of the act the following meanings:

"Public lands" means such lands and interests in lands owned by the United States as are subject to private appropriation and disposal under public land laws. It shall not include "reservations" as hereinafter defined.

"Reservations" means national monuments, national parks, national forests, tribal lands embraced within Indian reservations, military reservations, and other lands and interests in lands owned by the United States, and withdrawn, reserved, or withheld from private appropriation and disposal under the public-land laws; also lands and interests in lands acquired and held for any public purpose.

"Corporation" means a corporation organized under the laws of any State or of the United States empowered to develop, transmit, distribute, sell, lease, or utilize power in addition to such other powers as it may possess, and authorized to transact in the State or States in which its project is located all business necessary to effect the purposes of a license under this Act. It shall not include "municipalities" as hereinafter defined.

"State" means a State admitted to the Union, the District of Columbia, and any organized Territory of the United States.

"Municipality" means a city, county, irrigation district, drainage district, or other political subdivision or agency of a State competent under the laws thereof to carry on the business of developing, transmitting, utilizing, or distributing power.

"Navigable waters" means those parts of streams or other bodies of water over which Congress has jurisdiction under its authority to regulate commerce with foreign nations and among the several States, and which either in their natural or improved condition, notwithstanding interruptions between the navigable parts of such streams or waters by falls, shallows, or rapids compelling land carriage, are used or suitable for use for the transportation of persons or property in interstate or foreign commerce, including therein all such interrupting falls, shallows, or rapids; together with such other parts of streams as shall have been authorized by Congress for improvement by the United States or shall have been recommended to Congress for such improvement after investigation under its authority.

"Municipal purposes" means and includes all purposes within municipal powers as defined by the constitution or laws of the State or by the charter of the municipality.

"Government dam" means a dam or other work, constructed or owned by the United States for Government purposes, with or without contribution from others.

"Project" means complete unit of improvement or development, consisting of a power house, all water conduits, all dams and appurtenant works and structures (including navigation structures) which are a part of said unit, and all storage, diverting, or forebay reservoirs directly connected therewith, the primary line or lines transmitting power therefrom to the point of junction with the distribution system or with the interconnected primary transmission system, all miscellaneous structures used and useful in connection with said unit or any part thereof, and all water rights, rights of way, ditches, dams, reservoirs, lands, or interest in lands, the use and occupancy of which are necessary or appropriate in the maintenance and operation of such unit.

"Project works" means the physical structures of a project.

"Net investment" in a project means the actual legitimate original cost thereof as defined and interpreted in the "classification of investment in road and equipment of steam roads, issue of 1914, Interstate Commerce Commission," plus similar costs of additions thereto and betterments thereof, minus the sum of the following items properly allocated thereto, if and to the extent that such items have been accumulated during the period of the license from earnings in excess of a fair return on such investment: (a) Unappropriated surplus, (b) aggregate credit balances of current depreciation accounts, and (c) aggregate appropriations of surplus or income held in amortization, sinking fund, or similar reserves, or expended for additions or betterments or used for the purposes for which such reserves were created. The term "cost" shall include, in so far as applicable, the elements thereof prescribed in said classification, but shall not include expenditures from funds obtained through donations by States, municipalities, individuals, or others, and said classification of investment of the Interstate Commerce Commission shall in so far as applicable be published and promulgated as a part of the rules and regulations of the commission.

The duties of the commission are detailed as follows:

(a) To make investigations and to collect and record data concerning the utilization of the water resources of any region to be developed, the water power industry and its relation to other industries and to interstate or foreign commerce, and concerning the location, capacity, development costs, and relation to markets of power sites, and whether the power from Government dams can be advantageously used by the United States for its public purposes, and what is a fair value of such power, to the extent the commission may deem necessary or useful for the purposes of the act.

In order to aid the commission in determining the net investment of a licensee in any project, the licensee shall, upon oath, within a reasonable period of time, to be fixed by the commission, after the construction of the original project or any addition thereto or betterment thereof, file with the commission, in such detail as the commission may require, a statement in duplicate showing the actual legiti-

mate cost of construction of such project, addition, or betterment, and the price paid for water rights, rights of way, lands, or interest in lands. The commission shall deposit one of said statements with the Secretary of the Treasury. The licensee shall grant to the commission or to its duly authorized agent or agents, at all reasonable times, free access to such project, addition, or betterment, and to all maps, profiles, contracts, reports of engineers, accounts, books, records, and all other papers and documents relating thereto.

(b) To cooperate with the executive departments and other agencies of State or National Governments in such investigations; and for such purpose the several departments and agencies of the National Government are authorized and directed upon the request of the commission, to furnish such records, papers, and information in their possession as may be requested by the commission, and temporarily to detail to the commission such officers or experts as may be necessary in such investigations.

(c) To make public from time to time the information secured hereunder, and to provide for the publication of its reports and investigations in such form and manner as may be best adapted for public information and use. The commission, on or before the first Monday in December of each year, shall submit to Congress for the fiscal year preceding a classified report showing the permits and licenses issued under the act, and in each case the parties thereto, the terms prescribed, and the moneys received, if any, on account thereof.

(d) To issue licenses to citizens of the United States, or to any association of such citizens, or to any corporation organized under the laws of the United States or any State thereof, or to any State or municipality for the purpose of constructing, operating, and maintaining dams, water conduits, reservoirs, power houses, transmission lines, or other project works necessary or convenient for the development and improvement of navigation, and for the development, transmission, and utilization of power across, along, from or in any of the navigable waters in the United States, or upon any part of the public lands and reservations in the United States (including the territories), or for the purpose of utilizing the surplus water or water power from any government dam, except as herein provided: *Provided*, that licenses shall be issued without any reservation only after a finding by the commission that the license will not interfere or be inconsistent with the purpose for which such reservation was created or acquired, and shall be subject to and contain such conditions of the secretary of the department under whose supervision such reservation falls as shall be necessary for the adequate protection and utilization of such reservation:

Provided Further, that no license affecting the navigable capacity of any navigable waters of the United States shall be issued until the plans for the dam or other structures affecting navigation have been approved by the Chief of Engineers and the Secretary of War. Whenever the contemplated improvement is, in the judgment of the commission, desirable and justified in the public interest for the purpose of improving or developing a water way or waterways for the use or benefit of the state or foreign commerce, a finding to that effect shall be made by the commission.

Provided further, that in case the commission shall find that any government dam may be advantageously used by the United States for public purposes in addition to navigation, no license therefor shall be issued until two years after it shall have reported to Congress the facts and the conditions relating thereto, except that this provision shall not apply to any government dam constructed prior to the passage of this act:

And Provided Further, that upon the filing of any applications for a license which has not been preceded by a preliminary permit under subsection (e) of this section notice shall be given and published as required by the proviso of such subsection.

(e) To issue preliminary permits for the purpose of enabling applicants for license hereunder to secure the data and to perform the acts required in this act, provided, however, that upon the filing of any application for a preliminary permit by any person, association, or corporation the commission, before granting such application, shall at once give notice of such application in writing to any state or municipality likely to be interested in or affected by such application; shall also publish notice in such application in the local newspaper.

(f) To prescribe rules and regulations for the establishment of a system of accounts and for the maintenance thereof by licensees hereunder; to examine all books and accounts of such licensees at any time; to require them to submit at such times as the commission may require statements and reports including full information as to assets, liabilities, capitalization, net investment and reduction thereof, gross receipts, interest due and paid, depreciation and other reserves, cost of project, cost of maintenance and operation of the project, cost of renewals and replacements of project works, and as to depreciation of the project works and as to production, transmission, use and sale of power; also to require any licensee to make adequate provision for currently determining such costs and other facts.

(g) To hold hearings and to order testimony to be taken in connection with the application for any permit or license, and to require by subpoena the attendance and testimony of witnesses in the production of documentary evidence.

Preliminary permits issued under the act are to be for the sole purpose of maintaining priority of application for license for a period not exceeding three years as in the discretion of the commission it may be necessary to make an examination of the surveys, preparing plans, etc. Each such permit shall set forth the conditions under which priority shall be maintained and license issued, and the permit may not be transferable. It may be cancelled by the commission upon failure of the permittee to comply with the conditions.

Licensing Under the Act

The licenses under the act are to be issued for a period not exceeding fifty years. Each such license is to be continued upon acceptance by the licensee of all the terms and conditions of the act and such further conditions, if any, that the commission shall prescribe in conformity with the act. Licenses may be revoked only for the reasons and in the manner prescribed under the provisions of the act, and may be altered or surrendered only upon mutual agreement between the licensee and the commission after ninety days' public notice. In issuing permits or licenses the commission is to give preference to applications by States and municipalities. Between other applicants the commission is to give preference to the applicant the plans of which it finds and determines the best adapted to develop, conserve and utilize in the public interest the navigation and water resources of the region. Whenever in the judgment of the commission the development of any project should be undertaken by the United States itself, the commission shall not approve any applications for such project by any one else, but shall cause to be made such examination of the project as it may deem necessary and shall submit its findings to Congress with such recommendations as it may deem appropriate concerning construction of such project.

No voluntary transfer of any license or the rights thereunder granted shall be made without the written approval of the commission, and any successor or assign of the rights of such licensee shall be subject to all the conditions of the license under which such rights were held by such licensee.

Each applicant for a license has to submit to the commission:

(a) Such maps, plans, specifications, and estimates of cost as may be required for a full understanding of the proposed project. Such maps, plans, and specifications when approved by the commission shall be made a part of the license; and thereafter no change shall be made in said maps, plans, or specifications until such changes shall have been approved and made a part of such license by the commission.

(b) Satisfactory evidence that the applicant has complied with the requirements of the laws of the State or States within which the proposed project is to be located with respect to bed and banks and to the appropriation, diversion, and use of water for power purposes and with respect to the right to engage in the business of developing, transmitting, and distributing power, and in any other business necessary to effect the purposes of a license under the act.

All licenses issued under the act are conditioned as follows:

(a) That the project adopted, including the maps, plans, and specifications, shall be such as in the judgment of the commission will be best adapted to a comprehensive scheme of improvement and utilization for the purpose of navigation, of water-power development, and of other beneficial public uses; and if necessary in order to secure such scheme the commission shall have authority to require the modification of any project and of the plans and specifications of the project works before approval.

(b) That except when emergency shall require for the protection of navigation, life, health, or property, no substantial alteration or addition not in conformity with the approved plans shall be made to any dam or other project works constructed hereunder of a capacity in excess of one hundred horsepower without the prior approval of the commission; and any emergency alteration or addition so made shall thereafter be subject to such modification and change as the commission may direct.

(c) That the licensee shall maintain the project works in a condition of repair adequate for the purposes of navigation and for the efficient operation of said works in the development and transmission of power, shall make all necessary renewals and replacements, shall establish and maintain adequate depreciation reserves for such purposes, shall so maintain and operate said works as not to impair navigation, and shall conform to such rules and regulations as the commission may from time to time prescribe for the protection of life, health, and property. Each licensee hereunder shall be liable for all damages occasioned to the property of others by the construction, maintenance, or operation of the project works or of the works appurtenant or accessory thereto, constructed under the license, and in no event shall the United States be liable therefor.

(d) That after the first twenty years of operation out of surplus earned thereafter, if any, accumulated in excess of a specified reasonable rate of return upon the actual, legitimate investment of a license in any project or projects under license the licensee shall establish and maintain amortization reserves, which reserves shall, in the discretion of the commission, be held until the termination of the license or be applied from time to time in reduction of the net investment. Such specified rate of return and the proportion of such surplus earnings to be paid into and held in reserve shall be set forth in the license.

(e) That the licensee shall pay to the United States reasonable annual charges in an amount to be fixed by the commission for the purpose of reimbursing the United States for the costs of the administration of this act, for recompensing it for the use, occupancy and enjoyment of its lands or other property, and for the expropriation to the Government of excessive profits until the respective States shall make provision for preventing excessive profits or for the expropriation thereof to themselves, or until the period of amortization as herein provided is reached, and in fixing such charges the commission shall seek to avoid increasing the price to the consumers of power by such charges, and charges for the expropriation of excessive profits may be adjusted from time to time by the commission as conditions may require.

Provided, that when licenses are issued involving the use of government dams or other structures all over the United States or tribal lands embraced within Indian reservations the commission shall fix a reasonable annual charge for the use thereof and such charges may be readjusted at the end of twenty years after the beginning of operations and at periods of not less than ten years thereafter in a manner to be prescribed in each right.

Provided, that the licenses for the development, transmission or distribution of power by States or municipalities shall be issued and enjoyed without charge to the extent that such power is sold to the public without profit or is used by such state or municipality for State and municipal purposes.

(f) That whenever any licensee hereunder is directly benefited by the construction work of another license or of the United States of a storage reservoir or other headwater improvement, the commission shall require as a condition of the license that the licensee so benefited shall reimburse the owner of such reservoir or other improvement.

Combinations, agreements, arrangements or understandings expressed or implied to limit the output of electrical energy to restrain trade, or to fix, maintain, or increase prices for electrical energy or service are prohibited. Projects of under 100 hp. may in the judgment of the commission not be required to follow the provisions of the act. Where the dam or other project works are to be across, along or in any of the navigable waters of the United States the commission may include in the license any one or more of the following provisions or requirements:

(a) That such licensee shall, to the extent necessary to preserve and improve navigation facilities, construct, in whole or in part, without expense to the United States, in connection with such dam, a lock or locks, booms, sluices, or other structures for navigation purposes, in accordance with plans and specifications approved by the Chief of Engineers and the Secretary of War and made part of such license.

(b) That in case such structures for navigation purposes are not made a part of the original construction at the expense of the licensee, then whenever the United States shall desire to complete such navigation facilities the licensee shall convey to the United States, free of cost, such of its land and its rights of way and such right of passage through its dams or other structures, and permit such control of pools as may be required to complete such navigation facilities.

(c) That such licensee shall furnish free of cost to the United States power for the operation of such navigation facilities, whether constructed by the licensee or by the United States.

Where navigable waters are concerned the commission may grant the application with the provisions expressed in the license that the licensee will install the necessary navigation structures if the government fails to make provision therefor within a fixed time, and shall at the same time, if it deems desirable, submit to Congress a recommendation that the government carry out the navigation necessities.

The licensee is required to commence the construction of project works within the time fixed by the license, which shall not be more than two years from the date of the license and has to prosecute it with due diligence. The period for commencement of the construction may be extended once, but not longer than two additional years. Failure to observe the time clauses of the license will cause cancellation of the license. Any project once started on which the license is cancelled is to be made the subject of a suit in equity by the Attorney General for the revocation of the license, the

sale of the works, or such other equitable relief as the case may demand.

The exact wording of the recapture provisions of the act is as follows:

Upon not less than two years' notice in writing from the commission, the United States shall have the right upon or after the expiration of any license to take over and thereafter to maintain and operate any project or projects . . . or the right to take over upon mutual agreement with the licensee all property owned and held by the licensee then valuable and serviceable in the development, transmission or distribution of power, and which is then dependent for its usefulness upon the continuance of the license, together with any lock or locks or other aids to navigation constructed at the expense of the licensee, upon the condition that before taking possession it shall pay the net investment of the licensee in the project or projects taken, not to exceed the fair value of the property taken, plus such reasonable damages, if any, to property of the licensee valuable, serviceable, and dependent as above set forth but not taken, as may be caused by the severance therefrom of property taken, and shall assume all contracts entered into by the licensee with the approval of the commission. The net investment of the licensee in the project or projects so taken and the amount of such severance damages, if any, shall be determined by agreement between the commission and the licensee, and in case they can not agree, by proceedings in equity instituted by the United States in the district court of the United States in the district within which any such property may be located: *Provided*, That such net investment shall not include or be affected by the value of any lands, rights of way, or other property of the United States licensed by the commission under this Act, by the license, or by good will, going value, or prospective revenues: *Provided further*, That the values allowed for water rights, rights of way, lands, or interest in lands shall not be in excess of the actual reasonable cost thereof at the time of acquisition by the licensee: *Provided*, That the right of the United States or any State or municipality to take over, maintain, and operate any project licensed under the act at any time by condemnation proceedings upon payment of just compensation is hereby expressly reserved.

That if the United States does not, at the expiration of the original license, exercise its right to take over, maintain, and operate any project or projects of the licensee, the commission is authorized to issue a new license to the original licensee upon such terms and conditions as may be authorized or required under the then existing laws and regulations, or to issue a new license under said terms and conditions to a new licensee, which license may cover any project or projects covered by the original license, and shall be issued on the condition that the new licensee shall, before taking possession of such project or projects, pay such amount, and assume such contracts as the United States is required to do: *Provided*, That in the event the United States does not exercise the right to take over or does not issue a license to a new licensee, or issue a new license to the original licensee, upon reasonable terms, then the commission shall issue from year to year an annual license to the then licensee under the terms and conditions of the original license until the property is taken over or a new license is issued as aforesaid.

Provision is made for the taking over of any project by the government in time of war with due recompense to the licensees.

Control of Rates

The control of rates is vested in the separate state regulatory bodies. The provisions of the law in this respect are as follows:

That as a condition of the license, every licensee hereunder which is a public-service corporation, or a person, association, or corporation owning or operating any project and developing, transmitting, or distributing power for sale or use in public service, shall abide by such reasonable regulation of the services to be rendered to customers or consumers of power, and of rates and charges of payment therefor, as may from time to time be prescribed by any duly constituted agency of the State in which the service is rendered or the rate charged. That in case of the development, transmission, or distribution, or use in public service of power by any licensee hereunder or by its customer engaged in public service within a State which has not authorized and empowered a commission or other agency or agencies within said State to regulate and control the services to be rendered by such licensee or by its customer engaged in public service, or the rates and charges of payment therefor, or the amount or character of securities to be issued by any of said parties, it is agreed as a condition of such license that jurisdiction is hereby conferred upon the commission, upon complaint of any person aggrieved or upon its own initiative, to exercise such regulation and control until such time as the State shall have provided a commission or other authority for such regulation and control: *Provided*, That the jurisdiction of the commission shall cease and determine as to each specific matter of regulation and control prescribed in this section as soon as the State shall have provided a commission or other authority for the regulation and control of that specific matter.

That when said power or any part thereof shall enter into interstate or foreign commerce the rates charged and the service rendered by any such licensee, or by any subsidiary corporation, the stock of which is owned or controlled directly or indirectly by such licensee, or by any person, corporation, or association purchasing power from such licensee for sale and distribution or use in public service shall be reasonable, nondiscriminatory, and just to the customer and all unreasonable discriminatory and unjust rates or services are hereby prohibited and declared to be unlawful; and whenever any of the States directly concerned has not provided a commission or other authority to enforce the requirements of this section within such State or to regulate and control the amount and character of securities to be issued by any of such parties or such States are unable to agree through their properly constituted authorities on the services to be rendered or on the rates or charges of payment therefor, or on the amount or character of securities to be issued by any of said parties, jurisdiction is hereby conferred upon the commission, upon complaint of any person aggrieved, upon the request of any State concerned, or upon its own initiative to enforce the provisions of this section, to regulate and control so much of the services rendered, and of the rates and charges of payment therefor as constitute interstate or foreign commerce and to regulate the issuance of securities by the parties included within this section, and securities issued by the licensee subject to such regulations shall be allowed only for the bona fide purpose of financing and conducting the business of such licensee.

Prior permits or valid existing rights-of-way, etc., are not to be affected by any of the provisions of the act, but any person holding such permits, etc., may apply for a license under the terms of the act provided that when application is made for a license for a project already constructed the fair value of such project determined as provided in the act shall for the purposes of the act and of said license be deemed to be the amount to be allowed as the net investment of the applicant in such project or projects as of the date of such license, or as of the date of such determination if license has not been issued. Such fair value may in the discretion of the commission be determined by mutual agreement between the commission and the applicant, or, in case they cannot agree, jurisdiction is conferred upon the district court of the United States in the district within such project is located upon the application of either party to determine the amount of such fair value.

Special provision for non-navigable waters is made as follows:

That any person, association, corporation, State, or municipality intending to construct a dam or other project works across, along, over, or in any stream or part thereof, other than those defined herein as navigable waters, and over which Congress has jurisdiction under its authority to regulate commerce between foreign nations and among the several States, may in their discretion file declaration of such intention with the commission, whereupon the commission shall cause immediate investigation of such proposed construction to be made, and if upon investigation it shall find that the interests of interstate or foreign commerce would be affected by such proposed construction, such person, association, corporation, State, or municipality shall not proceed with such construction until it shall have applied for and shall have received a license under the provisions of this Act. If the commission shall not so find, and if no public lands or reservations are affected, permission is hereby granted to construct such dam or other project works in such stream upon compliance with State laws.

Nothing in the act is to be construed as affecting the laws of the respective states relating to the control, appropriation, use, or distribution of water used in irrigation, or for municipal or other purposes, or any vested rights acquired therein.

The protection of licensees against the future action of Congress is given in the following paragraph:

That the right to alter, amend, or repeal this act is hereby expressly reserved; but no such alteration, amendment, or repeal shall affect any license theretofore issued under the provisions of this act, or the rights of any licensee thereunder.

Mailing Case for Water Bacteria Samples

To avoid the expense of packing water samples for bacterial analysis in ice and shipping by express the Provincial Board of Health of Quebec has for two years past used a mailing case for daily sampling purposes. During that time nearly 18,000 samples, principally from purification plants, have been handled satisfactorily. The case and its use were described in a paper presented to the American Water Works Association in June by M. H. McCrady, chemist and bacteriologist, Superior Board of Health of the Province of Quebec, Montreal, P. Q. Mr. McCrady has supplied the following abstract of his paper:

Small mailing cases, with four cork-stoppered tubes in each, the tubes containing a little concentrated lactose medium, are shipped in lots of 20 or 30 to the sample collector, who each day fills the four tubes of one case with the water to be examined. Each tube is filled only to a mark on the tube, such that 5 c.c. of water are placed in the tube. The case is then mailed to the laboratory, where a small inverted vial is placed in each tube, the tube tipped to fill the vial with the liquid in the tube, and the whole then incubated at 37 deg. C. in the usual manner, to obtain a presumptive test for organisms of the Colon group. The advantages of this system of sampling and analysis are: (1) Slight cost of outfits, as ordinary specimen vials constitute the only glassware required. The mailing-case is simply the outside can of the usual type of sputum mailing case employed by many laboratories. (2) Slight cost oftransportation. The case is shipped to the laboratory for the insignificant sum of 3c. (3) The excellent service of the mails is employed. (4) The labor of handling samples at the laboratory is reduced to a minimum, for the cases are handled at the rate of about one a minute. (5) The slight labor involved in collecting samples results in surprising regularity in such collection. (6) The results are quantitative, 4 samples of 5 c.c. being taken daily.

Vertical Curves for Coal Piers and Hump Yards

Sharp Circular and Parabolic Curves Connect Steep Grades of Cable and Gravity Inclines—Minimum Radius 82 Ft.

IN DESIGNING the track layout for coal shipping piers an important consideration is the radius and length of vertical curves at the ends of the steep grades for cable inclines and gravity tracks, and for the kick-backs where the direction of car travel is reversed. The use of vertical curves under such conditions is very different from their use on main lines, owing to the steep grades, the restricted length and the exceptional operating methods at coal piers. As very little published information on this subject is available the following particulars of recent practice will be useful for record or reference.

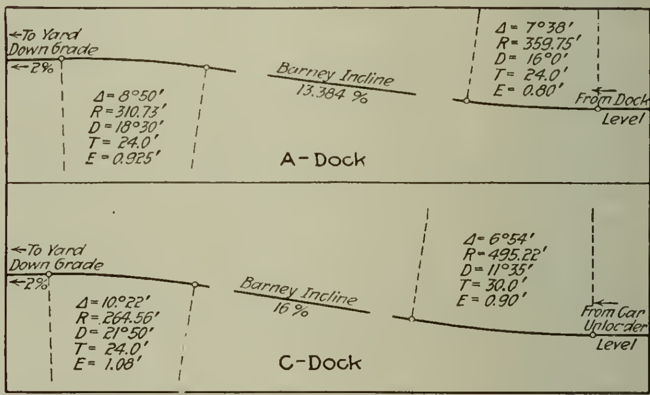


FIG. 1. VERTICAL CURVES ON COAL PIER INCLINES; LEHIGH VALLEY RAILROAD

To insure safe and free movements of cars over the sharp changes in grade, it is necessary to avoid undue strain on the center plates or king pins of the trucks and insure against fouling of brake rigging, hopper doors or other low hanging parts of cars with the track or the cable haulage system. If cars are operated in pairs or in trains there is also the factor of possible separation of the couplings in passing over the change of grade. The profile of grades and curves at each pier is selected to suit local conditions of construction and operation. In some cases it is the practice to lay out the profile of each curve and its adjacent grades on a very large scale and to plot the cars upon this, in order to see that there will be no interference.

On the new coal pier of the Central R.R. of New Jersey at Jersey City, N. J., which was described in *Engineering News-Record*, April 15, 1920, p. 759, parabolic, instead of circular, vertical curves are used, each offset from the theoretical grade line to the curve profile, being proportional to the square of the distance from the P.C. or P.T. of the curve. The length of curve varies with the grades. Thus, a curve 30 ft. long connects the 1 per cent gravity track for loaded cars with the 12 per cent cable incline and a 35-ft. curve connects this incline with the level track of the car dumping machine. At the end of the level track a 30-ft. curve connects with the empty descending grade (8 per cent from one machine and 11 per cent from the other), at the foot of which a 35-ft. curve connects with the $1\frac{1}{2}$ per cent ascending grade to the kick-

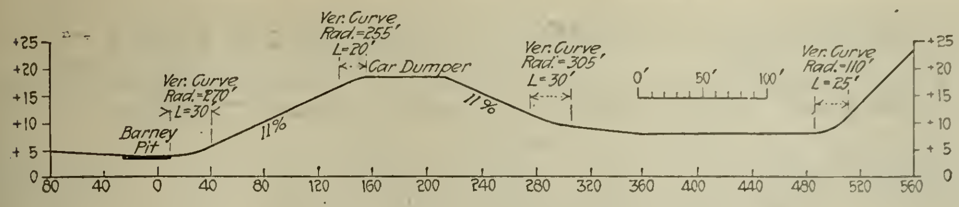


FIG. 2. VERTICAL CURVES ON GREENWICH COAL PIER

back track. A 45-ft. vertical curve connects this 1½ per cent grade with the 18 per cent grade of the kick-back. This arrangement will be understood by reference to the profiles in the article mentioned above.

Circular curves are used at the Buffalo coal pier of the Delaware, Lackawanna & Western R.R. The loaded cars pass over a curve 21 ft. long from the 2 per cent gravity track to the 12 per cent incline at the head of which a curve 24 ft. long and of 200 ft. radius connects with the level track of the car dumper. For the

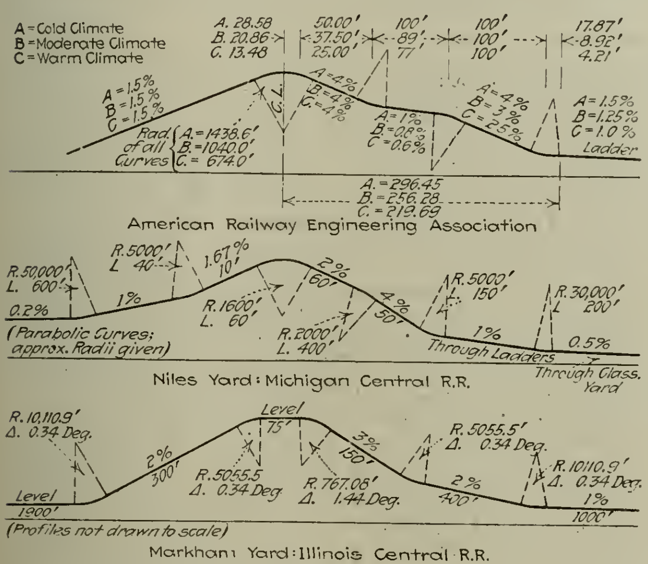


FIG. 3. VERTICAL CURVES AND GRADES OF SWITCHING HUMPS

loaded car kickback, however, a curve of 82 ft. radius and 32 ft. length is used. This appears to be the minimum radius for vertical curves. Fig. 1 shows profiles at two of the coal docks of the Lehigh Valley R.R., at Perth Amboy, N. J., where cars are handled coupled together. The minimum radius is 264 ft. at the head of one incline, as with sharper curves there will be trouble from the uncoupling of the cars. For cars operated singly this radius could be reduced materially. On coal piers of the Norfolk & Western R.R. the radius of vertical curves is 200 ft. at the foot of the barney or cable incline, 185 ft. from the head of the incline into the car dumper and from 185 to 200 ft. where cars run by gravity through a kickback.

On the Canton coal pier of the Pennsylvania R.R., at Baltimore, Md., the loaded cars run into a kickback about 120 ft. long, which is built on a vertical curve of 405 ft. radius and from which the cars are delivered to the cable incline leading to the car dumper. This incline has a grade of 13.2 per cent, with vertical curves of 288 ft. and 224 ft. at bottom and top, the length of curve being about 32 and 27 ft. respectively. On the Greenwich coal pier of the same road, at Philadelphia, the vertical curves are of 305 to 110 ft. radius, as shown in Fig. 2. Neither of these piers has a vertical curve at the connection of the level track of the car dumper with the empty gravity track, which track on the Canton pier has a grade of 4.1 per cent. On the Greenwich pier, however, there is a slight easing of the grade at the top of the 11 per cent gravity track.

The sharpest curve noted for the foot of a cable incline is 156 ft. on the car dumping pier of the Philadelphia & Reading R.R. at Port Reading, N. J. This curve connects a level yard track with the 11 per cent incline grade, a 309 ft. curve connecting the head of the incline with the level track leading through the car dumping machine.

Vertical curves on hump tracks for gravity switching are of considerably longer radius than those of

VERTICAL CURVES AND GRADES ON SWITCHING HUMPS

	Niles Yard: M.C.R.R.			Markham Yard: I.C.R.R.			
	Length, Ft.	Radius Vert. Curve, Ft.	Grade, per Cent	Length, Ft.	Enclosed Angle of Vert. Curve, Deg.	Radius Vert. Curve, Ft.	Grade, p.c.
Foot of ascent	600	50,000	....	....	0° 34′	10,110.9	
Ascent	2,800	....	1.00	300	....	....	2.0
Ascent	40	5,000	....		....	....	....
Ascent	10	....	1.67	....	....	....	....
Top of ascent	....	....	....	150	0° 34′	5,055.5	....
Summit	60	1,600	....	75	....	....	Level
Top of descent	....	....	....	150	1° 44′	767.1	....
Accelerating grade	60	....	2.00	150	....	....	3.0
Accelerating grade	40	2,000	....	....	0° 34′	5,055.5	....
Accelerating grade	50	....	4.00	400	....	....	2.0
Foot of accel. grade	150	5,000	....	....	0° 34′	10,110.9	
Through ladders	1,300	....	1.00	1,000	....	....	1.0
End of ladders	200	30,000	....	....	....	....	....
Through class yard	2.100		0.50	....	....	....	

coal pier tracks, owing to the flatter grades and the operating conditions, but their radius is much shorter than that of vertical curves on main line profiles. For switching humps the American Railway Engineering Association recommends three separate profiles for cold, moderate and warm climates, with grades connected by vertical curves of 1,436 ft., 1,040 ft. and 674 ft. radius respectively. Profiles of these arrangements of switching humps (not drawn to scale) are shown in Fig. 3, which shows also similar profiles of the humps at the Niles yard of the Michigan Central R.R. and the Markham yard of the Illinois Central R.R. (see *Engineering News-Record* of Jan. 8, 1920, p. 81, and Aug. 5, 1918, p. 313). The foregoing table gives the figures for the two yards mentioned.

These three profiles represent two types of humps. At the Markham yard the summit is a level stretch with a vertical curve at each end, but in the other designs the summit is formed by a single vertical curve. Further, the Niles profile shows a steepening of the ascending slope at its connection with the summit curve, the purpose of this arrangement being to close the cars together and thus facilitate uncoupling for the gravity movement. Parabolic curves are used at the Niles yard, the figures in the table and on the cut indicating the approximate radii. The break of grade on the descending side of the hump of the American Railway Engineering Association's profile is for the location of track scales.

The Surface Shrinkage of Rapid Filter Sand Beds

A Discussion of the Causes and the Importance of the Varying Degree of Adsorptive Power of Sand Grains—Application of Colloid Chemistry Concepts to a Sanitary Engineering Problem

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The authors suggest as the cause of the surface shrinkage of filter sand beds the presence of highly adsorptive sands. A quantitative method for measuring the adsorptive capacities of sand grains is described. By the use of such a measure, it is found that sands, apparently the same in character, disclose great differences in activity. Current methods of granulometric analysis do not supply all of the data which these investigations indicate should be known in regard to filter media, since such methods measure apparent size and not retentive or adsorptive capacity. This latter characteristic is frequently a concomitant of small-size sand grains, but is not necessarily of low value in grains of apparently large size or low specific area. The presence of highly-adsorptive sand is thought to be responsible for sand-bed contraction, since similar explanations have been developed in other fields to account for the phenomena of contraction, cementation, plasticity and cracking. The importance of the foregoing observations lies as much in the unforeseen disclosure of the powerful internal forces within the sand bed, and in the development of a new conception of the variability of sands, which usual procedures do not differentiate, as in the solution of the special problem of sand-bed shrinkage. It is concluded that the adsorptive capacity of sands is dependent upon their internal structure and active surface and not upon the presence of so-called colloidal films. Attention is called also to the value of studying other engineering problems, such as hydraulic-fill dams, subaqueous structures, and highways, from the standpoint of physical chemistry.

THE problems encountered by engineers in the purification of water have been interpreted usually in the light of chemical and biological laws. It is only within recent years that any explanation, for instance, of the mechanism of filtration and the function of the sand medium therein has been predicated upon purely physico-chemical concepts. The recent occurrence of such a condition as the surface contraction of a sand bed, therefore, results in opening up to the water-works engineer an interesting and unexplored field of research which leads one into the strange lands of ceramics, agriculture, and theoretical physical chemistry. The present paper should have its interest for the filtration engineer not so much in the presentation of the specific problem of sand bed shrinkage, as in the development of data and concepts borrowed from allied sciences. A brief survey of the materials with which the water-works man attempts to bring about purification of water indicates at once an array of particles of colloid dimension so striking as to cause one to wonder why the usual phenomena encountered have been so little studied by intensive colloid chemical methods. Within the filter bed there still remains to be probed a colloid microcosm of gels of silica, alumina and kindred other particles.

To engineers and scientists in general the data here discussed may serve as an introduction to methods of interpretation and investigation which as yet are but rarely employed. The significance of colloid particles in the hydraulic construction of dams, in the location of subaqueous structures, in the building of highways, in the flotation of ores and in many other engineering problems, where the state of subdivision of the materials employed frequently determines success or failure, cannot be too greatly stressed. The problems described in this paper are not peculiar to the field of filtration engineering. The underlying principles, though specific and restricted in their setting, are common to that vast twilight zone, which Ostwald, less than a decade ago, so aptly named the "world of neglected dimensions."

In the course of the routine control of the operation of a number of water filtration plants in the State of Maryland, there have come to our notice within the past few years various phenomena of filter sand action which appeared to require some laboratory study. The investigation of some of the little-discussed properties of sands used in filter beds has been carried out in the Bureau of Sanitary Engineering of the Maryland State Department of Health under the general supervision of the chief engineer, Robert B. Morse. The results of these preliminary studies are set forth in this paper in order that they may elicit further comment and study from other investigators. The findings here reported seem to be of sufficient importance to warrant publication even though more experimental work is desirable before the ultimate practical significance of all of the data becomes apparent. A number of the conclusions of the writers may appear to be somewhat hypothetical, but their substantiation is possible only by the reporting of similar phenomena and empirical facts by others. The demonstration of scientific theories is limited in its scope by the availability of correlated and pertinent phenomena. Only a few of the characteristics of these interesting occurrences have been noted by the present writers. If simultaneous and confirmatory observations are suggested by our brief remarks, then much will have been accomplished in the clarification of some of the complex properties of filter sands.

Under-Water Contraction or Shrinkage of Filter Beds. An extended search of published literature on filter sands or allied subjects has failed to produce any reference to the occurrence of actual under-water surface shrinkage of filter sands. In the latter part of June, 1919, a study of the operating records of the Springfield State Hospital rapid sand filtration plant revealed the fact that during the week of May 6 to 13, 1919, the B. Coli contents of both filter bed effluents became excessive and remained higher than previously, up to the time of this writing (January, 1920). This sudden rise in bacterial content was not accompanied by any modification in method of operation or by any apparent change in applied raw water. The abruptness of the change is indicated by the bacterial data shown in Table I. The accuracy of the analytical findings is attested by the fact that the same water after chlorination revealed no similar rise in B Coli content.

TABLE I. B. COLI PRESUMPTIVE TESTS IN FILTER EFFLUENT SAMPLES OF SPRINGFIELD STATE HOSPITAL RAPID SAND FILTRATION PLANT—1919

Date	B. Coli per 100 c.c. Filter 1	Filter 2	Date	B. Coli per 100 c.c. Filter 1	Filter 2
Jan. 28	0	0	July 15	35	5
Feb. 4	0	0	22	2,400+	231
18	0	No record	29	35	35
Mar. 4	0	0	Aug. 5	2	0
11	0	0	12	231	20
18	0	2	19	35	2,400+
25	0	0	26†	2	2
April 1	9	0	Sept. 2	5	0
8	0	0	9	2	20
15	0	0	16	0	0
22	2	0	23	2	0
29	0	0	30	0	0
May 6*	0	0	Oct. 7	0	0
13	2,400+	35	21	2	5
20	231	9	28	20	35
27	231	231	Nov. 4	231	35
June 3	35	35	12	0	0
10	231	231	18	0	2
17	2,400+	231	Dec. 9	2	2
24	35	35	16	0	2
July 1	15	15	23	15	5
8	5	9			

* May 6-13—New sand placed, less on filter 2 than on filter 1.

† Aug. 23—Five inches of top sand removed from filter 2. Although no directions were given to remove sand from No. 1 measurements disclosed a loss in depth of sand of from 3 to 4 in. on No. 1 following Aug. 23.

An inspection of the two filter beds during June and succeeding months disclosed the following facts: The entire sand bed in each filter had drawn away on all four sides from the concrete walls, to distances ranging from ½ to 1½ in. in width, and to depths of sand varying in filter 1 from 4 to 12 in. and in filter 2 from 2 to 6 in. This phenomenon of shrinkage existed under water and was apparent by drawing off the water to a depth of from 12 to 18 in. above the sand bed. The importance of the under-water contraction was immediately apparent to the observer, since the rate of filtration through the open area extending around the four sides of the bed was so much greater than through the bed proper that definite currents of water flowed with increased velocity, as shown by the carrying of alum floc down the sides instead of through the bed. The internal contracting force of the sand bed, in addition, was so great that the head of water upon the bed did not cause the sand surface to expand but simply spalled off portions of corners of the bed causing transverse cracks of great size within the bed. The intensity of this internal force was further demonstrated in the back-washing of the bed with a high velocity wash. The entire bed was lifted up by the incoming wash-water and raised without breaking, while the water gushed around the open spaces on the sides until the weight of the bed itself caused its collapse. After complete washing, the sand beds usually returned to fairly normal condition, although the existence of a circumferential crack was apparent. A number of inspections of the beds in succeeding months, while the investigation was being carried on, disclosed a continuation of the same phenomena.

The amount of the under-water shrinkage may be arrived at in the following manner: Each of the filter units is 8 by 11 ft. in surface area. With an average contraction on all four sides of 1 in. the total percentage shrinkage in surface area would be approximately 3.5. The minimum shrinkage observed was about 1.8 per cent and the maximum, with cracks of 1½ in., about 5.3 per cent. Approximately the same percentage shrinkage has been observed in a number of filter beds in another plant in Maryland. In this latter plant the filter areas are many times greater than in the Springfield plant, but the percent of shrinkage of surface is about the same. The absolute value of the percentage shrinkage, although significant, as giving the reduction of effective filtration area, is not as important as its resulting effect in permitting more than its proportionate part of the water to flow through the cracks. This latter fact should not be lost sight of in considering a quantity such as 1.8 per cent as mathematically insignificant.

An inquiry into the events preceeding the appearance of under-water contraction disclosed the fact that during the week of May 6, owing to the progressive loss of sand on the beds during previous months, the operator placed new sand on filters 1 and 2 to depths of 8 and 4 in. respectively. Some weeks previous to this time he forwarded to the Bureau of Sanitary Engineering a sample of sand for mechanical analysis, which he proposed using for replenishing the beds. This sand was condemned on account of the presence of excessive amounts of fine material and the operator was so informed. He asserted, however, that the condemned sand was not used, but that some of the left-over sand, originally used for the beds, had been placed. Samples of this left-over sand, other than that on the bed, the operator was unable to locate. The sudden appearance of shrinkage, differing in depths in the two beds roughly in accordance with the amounts of new sand placed, led us to believe that this new sand, whether the condemned or otherwise, was responsible, in a measure at least, for the phenomenon observed. The granulometric analyses of the condemned and of the top sand in place after May 13 are shown on Table II.

TABLE II. GRANULOMETRIC ANALYSES OF SPRINGFIELD STATE HOSPITAL SANDS

Source	Per Cent Passing Sieve Numbers and Retained on Next Higher Sieve 200	100	80	50	40	30	20	10
Condemned sand...	0.0	1.8	1.6	15.8	30.6	34.6	13.6	2.0
Top sand (washed)	0.0	0.0	0.2	0.6	18.0	76.6	4.2	0.4

The adhesive property of the top sand on the filter beds at Springfield was apparent physically when a handful of the sand was taken up. Ordinary moist clean filter sand, when clasped in the hand, falls apart in numerous grains when the clasping pressure is released, but the filter sands of those beds where shrinkage has been observed, under a similar release of hand pressure, retain well their ball form and adhere strongly to the rest of the mass of sand, which has a marked degree of plasticity and stickiness, foreign to sandy media of most filter beds. It is interesting to recall at this point Clark's reference in a different connection (1894 annual report of the Massachusetts State Board of Health) to the marked pasty feeling and appearance, when wet, of a white North Carolina sand of effective size of 0.20 mm. In his discussion he refers to the fact that this white sand behaved in a manner similar to cement; that when dried after saturation with water the sand grains cling together in lumps; and that the cementing of this white sand was greater than in any other examined. Although not emphasizing the significance of his observations, Clark pointed out the importance of the great cohesion of particles of some sands under favorable conditions. In the discussion to follow the reader will be able to fit Clark's observations into the general hypothesis regarding the cause or causes of under-water shrinkage.

The reader may well ask at this point why the study of the filter sands was pursued to the exclusion of other factors in the attempt to arrive at a solution of the

problem of shrinkage. The reasons for this decision appear in the fact that the sand in the Springfield instance was the *only* factor which varied during the period of transition from absence to appearance of contraction and that, in the other plant where the sand shrinkage was observed, all the operating and structural features were similar to those existent in plants showing no shrinkage, excepting that there were marked differences in the character of sands originally used in the beds. There was, in addition, no reason to consider the applied water in either of the two plants, as peculiar, since a study of the analyses and watersheds of the streams (which are 25 to 30 miles apart) disclosed nothing different, as indicated by tests now available, from other streams in the State.

Hypothesis Regarding the Cause of Under-Water Shrinkage of Filter Beds. The observation of the various conditions described above led to the formulation of hypotheses regarding the cause of causes of the shrinkage of the sand beds. A preliminary microscopic examination of a number of filter sands in comparison with the Springfield sand disclosed a characteristic film on the grains of the latter, after persistent washing, which was not apparent on other sands. This film, however, was not apparent on the sands of the beds of the other plant where shrinkage had occurred, so that the presence of a colloidal film of itself did not appear to offer sufficient proof of the unusual adhesive property of the sands under discussion. The action of the sand bed itself, however, seemed to require for explanation the following reasoning: The sand showed actual shrinkage, plasticity and cementation. These could be brought about, under the conditions, only by the existence of some internal force or adhesive property of the sand itself, which would consist in the pulling together or attracting of other sand particles. Such an internal force would have to be predicated upon an unusually high adsorptive power of the sand, aided by the cementing material or matrix, the coagulant. Since the latter is present in all plants, its mere presence would not be responsible for the shrinkage, but it would require in addition the nucleus of an active structure of a sand showing high internal interfacial attractive forces. To develop the evidence in support of the above hypotheses, it will be necessary to inquire into (1) the nature of the causes which produce in other substances shrinkage, cementation, plasticity and bonding power, (2) the variation of the adsorptive properties of different sands, and (3) the magnitude of the adsorptive force of the "shrinkage" sands in relation to that of "non-shrinkage" sands.

Shrinkage, Cementation, etc. in Substances Other than Sand. Considerable study has been devoted in past years to the causes of shrinkage, plasticity, etc. in clays. The evidence so far adduced appears to warrant the following conclusions, adapted from the studies of Ashley[1]:

(a) Clay is a mixture of granular matter and a colloid gel.

(b) The sources of the colloid matter are organic and inorganic, principally colloidal silicates and silica, less commonly alumnia and ferric oxide.

(c) Adsorption, the property colloids have of taking other substances out of solution or suspension, may be measured by the degree of removal of color from certain dyes by clays.

(d) The adsorption of a dye by clays gives an approximate measure of plasticity.

(e) The air shrinkage of clays varies with the amount of colloids present in a clay, as measured by the dye adsorption. This condition is illustrated graphically in Fig. 1.

(f) The amount of colloids in clays, as determined by dye adsorption, roughly varies with the surface-factor or total surface areas of clays.

Ashley[1] further states that air shrinkage and plasticity are highest with high colloidal matter, while increased fineness of grain in a clay results in increased air shrinkage. Colloidal alumina, for instance, is sometimes added to clays in order to assist in the cementing properties and in the increase of air shrinkage[2]. It is clear that the ceramists have dealt so far with the phenomenon of *air* shrinkage, but it is believed that the presentation of later data will indicate that the theories underlying the air-shrinkage of materials are also concordant with the explanations of shrinkage of filter sands under water.

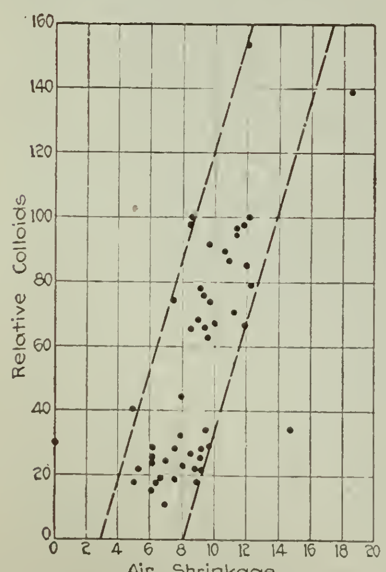

FIG. 1. RELATION BETWEEN AIR-SHRINKAGE AND COLLOID CONTENT OF CLAYS

Determined by malachite green test

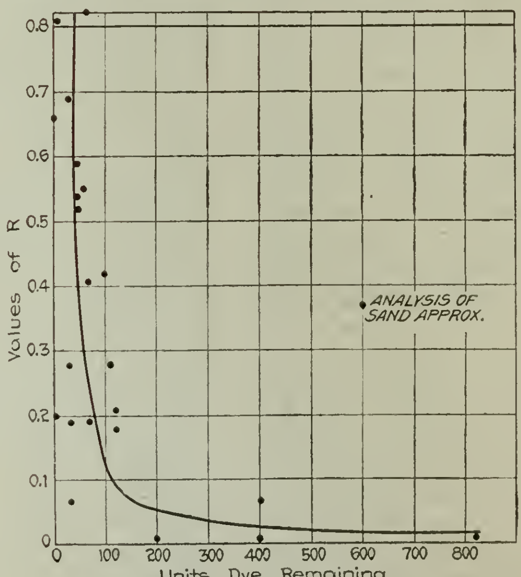

FIG. 2. RELATION BETWEEN VALUES OF "R" AND ADSORPTIVE CAPACITY

R = Surface area of per cent passing No. 35 sieve divided by total surface area of sample

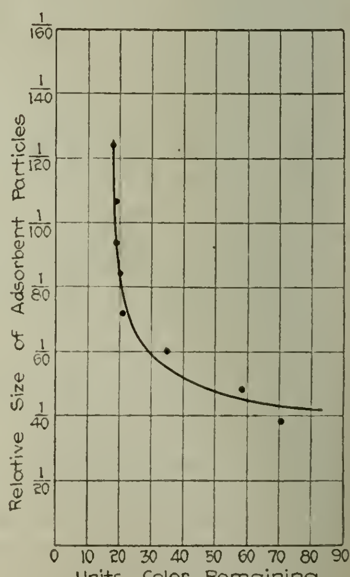

FIG. 3. RELATION BETWEEN SIZE OF PARTICLES AND ADSORPTIVE CAPACITY

Data recalculated from Bradley. See reference in text

Cushman[3] confirms Ashley's hypothesis regarding the plasticity and shrinkage of clays by his determination of the fact that mixtures of solutions of alum and sodium silicate (both colloids) increase the plasticity and shrinkage or binding power of clays. It is his opinion that both plasticity and binding power are merely manifestations of a colloid modification of matter which exists in rocks and clays. In the same way, he correlates[4] the cementing power of rock powders with the plasticity of clays and ascribes this power to the amorphous colloid structure of the particles of rock.

An interesting example of shinkage of substances in contact with a liquid is the phenomenon, scientifically termed "syneresis," or the separation of water solutions from highly hydrated substances such as silicic acid gels. Holmes, Kaufmann and Nicholas[5] describe the relatively enormous contraction of a silicic acid gel in a glass container lined with vaseline, to prevent the adherence of the gel to the glass so that the gel would be free to contract. In such contraction the gel simply squeezed out a volume of liquid equal to the decrease in volume of the gel. That this internal contracting force is dynamically powerful is indicated by the statement of Holmes et al[5] that "a paper-thin glass bulb, unlined with vaseline, was filled with the gel mixture and on setting, the gel contracted so powerfully that the glass caved in." *This powerful contracting force was not accompanied by evaporation of any of the liquor on and in the gel,* since the glass tubes were so sealed as to prevent such evaporation. It is important to call attention at this point to the conclusion of the above authors that the degree of syneresis or contraction of spherical gels closely parallels the change in the relation of surface to volume, or that syneresis varies directly as the free surface. The significance of this observation, in this instance, as well as in the explanation of the shrinkage of clays as due to the colloids (particles of great specific surface), will be more apparent in the discussion of the problem of filter sands.

It is of value, in discussing these factors of shrinkage, to refer to another field of science where the peculiar properties of sands have occasioned much thought and experimentation. Some ten years ago, Thompson[6] discussed, before the American Society of Civil Engineers, certain peculiarities of sands which had resulted in the failure of concrete structures in which they had been used. He described the failure of mortars to harden when certain sands were used, concluded that such defective sands contained excessive vegetable organic materials, and established tentative limits for organic material above which sands should not go if they were to be free from injurious effects. This same colloidal film, as a deterrent to the development of a union between cement and sand grains, was later discussed by Freeman, Free and Gaines[7] in separate articles. Gaines further explained the failure of cements to harden with certain sands as due to the retardation of reaction by colloidal films on the sand and to "steric" or structural hindrance, whereby substances accumulate on the surface of sand, *due to adsorption,* and prevent or retard chemical action with the cement.

The Adsorptive Power of Sand Grains. In all of the discussions presented above, the explanations of various phenomena dealing with plasticity, bonding power, shrinkage, negative and positive cementation have been reduced apparently to the effect of one primary action, common to the problems of ceramics, structures, highways, and specific physical chemistry, namely, adsorptive power. This adsorptive power in turn has been predicated by different writers upon the factors of colloidal surface film and upon specific surface area or character. It appears that the same property which increases plasticity of clays, binding power of rock powders and retards formation of concrete with certain sands, may be responsible for the peculiar action of the sand beds under discussion.

What then is the adsorptive capacity of sand grains and how may it be measured? The simplest procedure which we have been able to make use of for the determination of the adsorptive power of sands consists of determining the amount of color removed from a standard dye by a definite weight of a sand. Since the character of both the dye and the sand influences the color removals, the selection of a proper coloring material is important. For our purposes, the organic dye, malachite green, was chosen, since it had already been used successfully by Ashley[1] for similar purposes and since it is a basic dye. The basic dyes in general are electropositive while sand has a negative charge, so that malachite green would serve as an effective reagent for measuring comparative adsorption. Chamot also has pointed out that an excellent selective stain for gelatinous silica is malachite green. There is reason to believe that the values obtained with this dye may be correlated with the attractive forces of sands for aluminum hydroxide and, therefore, our results should reflect the action within the sand beds.

In measuring the removal of color from dyes, or the adsorbability of sands, the following standard procedure was adopted: The upper and lower amounts of sand and dye were found which would give most convenient proportions to obtain the readings between the wide ranges of results. In each experiment 100 grams of the dry sand to be tested were shaken 50 times with 250 c.c. of a 0.001 per cent distilled water solution of malachite green. This flask was then allowed to stand 24 hours to permit the fine material in the sand to settle. At the end of 24 hours 50 c.c. of the supernatant liquid were removed and matched in Nessler tubes against standard solutions of the dye to determine the strength of the residual color. The standard color was given an arbitrary value of 1000 units (the reciprocal of the percentage strength) so that the residual colors would range from 0 to 1000 units, depending upon the degree of adsorption.

The preliminary determination of relative adsorption of different sands in this manner was independent of the *causes* of such adsorption. It was our purpose, (1) to determine how much different sands vary in their adsorptive power (as measured by our arbitrary method), and (2) to attempt to discover the causes of such variations as might appear. The first sand examined in the manner described above was the Springfield sand originally condemned by this Bureau. This sand removed 994 units of color. A sample of the sand originally placed on the bed of another plant, where marked shrinkage had occurred, adsorbed 1000 units of dye, removing all trace of color. Contrasted with these two sands is a third sand, used on a bed where no shrinkage was apparent, which removed only 180 and left 820 units of dye, and a fourth sand, with no shrinkage, which removed only 400 units.

The above extreme variation in the adsoptive properties of these four sands led us to an examination of some twenty other sands from different localities, some in use on filter beds and others projected for use. The results obtained on these samples of clean dry sand are shown in Table III. It is interesting to note the extreme variations in filter sands in respect to their adsorbability. A great proportion of those samples showing high adsorption in Table III have not been placed in filters so that their actual shrinkage factor is not available for discussion. It is highly pertinent, however, to point out that the two sands, taken from entirely different sources and used in two widely separated plants, which show peculiar shrinkage also show the highest adsorptive capacity of any of the samples tested. It is possible at least that the explanation of the shrinkage phenomenon lies in this property.

TABLE III. A COMPARISON OF ADSORPTIVE CAPACITIES AND SURFACE AREAS OF VARIOUS CLEAN UNUSED FILTER SANDS

Lab. No.	Units Dye Remaining	Units Dye Adsorbed	Sq.Ft. Surface Area per 100 Lb.	*Ratio
18067	820	180	1,710	0.006
18068	600	400	1,925	0.37
18069	28	972	1,820	0.28
18084	400	600	860	0.07
18632	0	1,000	2,570	0.66
18073—I	32	968	1,830	0.19
18074—II	70	930	1,790	0.19
18075—III	36	964	1,625	0 068
18076—IV	60	940	2,530	0.552
18077—V	200	800	1,460	0.007
18078—VI	70	930	1,985	0.410
18079—VII	120	880	1,740	0.18
18080—VIII	40	960	2,245	0 52
18081—IX	110	890	1,810	0 28
18083	40	960	2,540	0.59
18360—XV	0	1,000	1,830	0.20
18361—XVI	400	600	1,560	0.007
18362—XVII	40	960	2,160	0.54
18363—XVIII	100	900	2,125	0.42
18364—XIX	30	970	2,600	0.69
18678	120	880	1,475	0.21
18061	6	994	3,325	0.84
18739	70	930	3,280	0.91

* Ratio (R) of surface area of per cent passing No. 35 sieve to surface area of total sample.

The Possible Causes of Variation in Adsorptive Power. The data in Table III answer the first of our questions regarding filter sands, namely, what is the quantitative variation in adsorptive power of sands. There still remains the problem of determining the factor or factors which predetermine the relative adsorption of dyestuffs by substances. Hatschek[9] states that "the amount of a substance adsorbed, other things being equal, is proportional to the active surface of the adsorbent." In other words, we shall expect that the greater the specific surface of a sand the greater will be its adsorptive capacity. The validity of this conclusion may be tested by comparing the sizes of different sands with their adsorptive capacities. A study of the surface areas of sands, clays and rock powders of spherical and cubical shape by Purdy[10] and many years later by Edwards[11] and Young[12] has shown that the surface areas of the particles per unit volume vary inversely as the diameters of the particles. In other words, a particle of sand having a diameter of 0.2 mm. has a surface factor of 5, while one having a diameter of 0.8 mm. has a relative surface factor of 1.25. Young has developed the method of calculating surface areas to a further degree by the use of the granulometric analysis of sands. This method, a description of which would require too much space and which may be found in the aforementioned discussion, has been adopted by the present writers for the calculation of the surface areas in square feet per 100 lb. of sand, from the mechanical analysis of the sands used in this study. Young's relative values for surface areas do not differ very much from those obtained by Purdy and other investigators.

The values obtained in the calculations of total surface areas (shown in Table III) indicate that in the sands studied the total surface areas per 100 lb. vary from 860 to 3,325 sq.ft. The variations in *character* of surface area are, of course, not taken into account in the method described. For instance, sample 18,084 shows a surface area of only 860 sq.ft. per 100 lb., but also has a relatively high adsorptive capacity. Sample 18,084 happens to be a coal filter medium of great effective size and more than usual specific surface on account of its slab-shaped irregular surface. It is apparent, however, from a study of Table III that no great correlation exists between *total* surface areas and adsorptive capacities. But it is important to remember that this correlation probably is masked due to the inclusion in the above figures of the areas of large particles which show only slight adsorption.

A better measure of the effect of specific area upon adsorption, therefore, should be a comparison between adsorptions and the ratios (R) of the surface areas of the finer grains in a sample to the total area of the sample. This last ratio (R) would indicate whether two total surface areas, both large, are made up entirely of large particles or, what is most important, of effective adsorptive small particles. When these ratios (R) are calculated by taking the ratio of the area of all the particles passing sieve 35 to the total area of all the particles in the sample, we get a different picture of the situation. In Fig. 2 the values of R have been plotted against "units of dye remaining." It is apparent from these results that a definite correlation exists between proportion of fine material in the sand and adsorptive power. From the meager data available it is difficult to indicate the exact value of R at which the flexure in the curve takes place, but it is clear that the adsorptive power decreases gradually with sharp decrease in values of R up to a critical value of R where adsorbability changes very rapidly. The above correlation between the relative area of sand grain and adsorptive capacity may be further demonstrated by the evaluation of the coefficient of correlation[13] between the actual percentage of material passing a No. 35 sieve and the number of units of dye remaining. The coefficient of correlation measures mathematically the degree of relationship between two variables. Its numerical value may lie between -1 and $+1$, denoting perfect inverse and direct correlation respectively. In the case under discussion, the coefficient of correlation was found to be about -0.5, denoting good or high inverse correlation between residual dye and proportion of fine sand. (This same finding has been reported in different connections by Dreaper and Davis[14] and by Bradley[14A], whose results are shown in Fig. 3.) The value of -0.5 may be considered excellent in view of the wide variation in character of the sands tested and of the rough methods of measurement of the factors correlated. It appears from the preceding discussion that the usual "effective size" values still play an important part as a diagnostic index of this additional characteristic of sand, although we are not prepared to state as yet what critical values of "effective size" should be considered as marking the transition point between shrinkage and non-shrinkage of sand beds. Such a critical value must be determined

by an analysis of empirical data accumulated from different plants and by independent observers.

In this connection, it is interesting to point out that those six filter beds in two different plants which show the greatest shrinkage of 38 beds studied (all of which contracted more or less in comparison with numerous other non-shrinkage beds) originally contained sands showing the following recorded characteristics:

Effective Size	0.31	0.33	0.27	0.27	0.33	0.23
Uniformity coefficient	1.98	1.79	2.04	2.13	1.77	1.80

The importance of this observation is apparent when it is mentioned that, after two to four years operation (in the five older beds), examination of the beds showed upper layers of sand, varying to depths of 3 to 4 in., of sizes finer than 0.28 mm.

Although the importance of size and large specific area have been stressed in the above discussion, it must be pointed out that high adsorption may occur with materials such as sand, even when the *apparent* size (by granulometric analysis) is great and the specific area per unit weight *apparently* low. We use these terms advisedly, since adsorption is a function of large *internal* active surface which often is not indicated by the usual mechanical analysis. Three striking examples of this active internal surface are mentioned briefly to illustrate the danger of pinning all our faith to the "effective size" only. One of these, the coal filter medium, has been referred to earlier in the discussion. This material showed adsorption excessive in proportion to its effective size (0.8 mm.). A second example is that of a standard Ottawa sand of about 0.5 mm. effective size, 100 grams of which adsorbed 988 units of dye, comparable with the adsorption of a normal sand of effective size of about 0.25 mm.

The importance of great internal surface in determining adsorptive capacity is brought out most clearly by an experiment carried out upon a synthetic silicon-dioxide, supplied through the courtesy of Professor Patrick of the Department of Physical Chemistry of the Johns Hopkins University. The material used by us has an effective size of over 0.5 mm. but is characterized by an exceedingly great internal surface consisting of minute capillary tubules which have the power of adsorbing vast quantities of gases and liquids to approximately 30 to 40 per cent of its own weight. Eighteen grams of this silicon dioxide adsorb completely 1,000 units of the dye used in our experiments. In other words, 18 grams of this material are equivalent in adsorptive capacity to 100 grams of the sand which showed excessive shrinkage and, incidentally, low effective size. The possible practical significance of the above relationship will be pointed out later. It need be emphasized only, at this point, that much caution should be used in reasoning from *apparent* size of grain to adsorptive capacity.

The Colloidal Film on Sand Grains and Organic Impurities in Sands. It is not believed that the mere presence or absence of a colloidal organic film on sand grains plays an important part in predetermining either their adsorption or shrinkage, since no definite correlation could be established between the presence of film or organic content and adsorptive capacity or cementation. The organic contents were determined in two ways, by the so-called Abrams-Harder test[15, 16] and by the determination of oxidizable matter in sands by ignition. (The Abrams-Harder test consists of treating a known weight of sand with a dilute solution of sodium hydroxide and observing the resultant color after the mixture has been allowed to stand 24 hours. The intensity of color is an approximate measure of the amount of organic impurities present.) It was found, in the case of one of the sands which showed high adsorption and excessive shrinkage, that the organic content by both of the above tests was excessive and this was confirmed by the presence of a heavy collodial film on the grains, which was easily to be detected under the microscope. The same thing, however, did not hold with respect to the other high-shrinkage sand and similar discrepancies appeared in other sands. (That cementation of particles is possible without the presence of organic film is further demonstrated by the work of Jensen[16A] on the phenomenon of "plowsole".) Although the Abrams-Harder test for organic impurities in sands may not disclose any real information regarding adsorption and shrinkage, yet its simplicity should recommend it highly to the water-works investigator for further correlated study.

Concluding Observations on Adsorption by Sand Grains. It is postulated frequently in textbooks and in other discussions of water filtration problems that it is desirable to use filter sands of high adsorptive power. Chamot[17], for instance, states in one of his interesting addresses that "the sanitary engineer in writing his specifications for sand beds ought to be able to include details looking toward the use of a filter medium of high adsorptive power." It is pertinent to ask, in the light of the possible correlation between high adsorption and shrinkage, with its attendant evils, whether the gain by the use of high adsorptive sands is not offset by the objectionable features? If high adsorptive capacity results in cementation, shrinkage, plasticity and cracking effects, is it desirable to specify high adsorption. Considerable remains to be done, of course, in the way of demonstrating the action of adsorptive sands in rapid sand filtration plants under varying conditions before the above question may be definitely answered. Preliminary findings, however, indicate that under the conditions peculiar to rapid sand filtration plants, high adsorption would not be entirely a desirable attribute of the sand medium.

The interesting relation between fineness of sand grain and adsorptive power also leads to the conclusion that, in those beds initially supplied with a proportion of fine sand, the finer particles do not appear to be washed out after years of use. It is stated often that a medium containing fine material may be used on a rapid sand bed, since successive washing will eliminate the finer grains. It is not believed that this gradual elimination actually takes place, for it has been found in our study of the 34 filter beds, showing varying degrees of actual shrinkage, that the bed showed the highest shrinkage which had had originally a fair quota of the finest sand. Even though this particular bed had been in use over several years, the objectionable effects of the fine material have not yet been removed. This would seem to indicate that the highly adsorptive sand was still in place. The possible reason for its persistency may well have its origin in the fact that, owing to its high adsorptive capacity, it seizes floc and other material and, hence, when backwashed, acts as particles of similar and large size owing to its accumulation of foreign substances.

It is suggested also that the existence of patches of highly adsorptive sand, of either small size or unusually

active surface, may be responsible for the formation of the objectionable and tenacious mud balls with which filter operators frequently are troubled. It is conceivable that such nuclei in a bed might react in such manner as to produce the above mentioned phenomenon, but here, too, experimentation is still much behind the practical problem. Attributing the formation of mud balls to faulty design of wash water systems does not explain the frequent development of mud balls where washing arrangements are apparently excellent.

In passing, mention should be made of a field of filtration where the highly adsorptive sand may and should possibly be specified. In the drifting-sand process of water filtration, at least a part of the purification is effected through the adsorptive power of sand grains. We are not aware, however, that this knowledge has led to any newer specification for sand grains to be used in the drifting portion of the bed. It would seem that such sands would be chosen for their increased adsorptive capacity over normal sands, and it might be desirable even to try experimentally some such medium as the synthetic silicon-dioxide already mentioned in this paper. Where the desideratum is almost entirely attractive and retentive capacity, as in the drifting-sand medium, it may be economy to purchase a more expensive, but a more powerfully activated, medium.

In conclusion, the writers wish to state that the comments and observations here set forth upon the adsorptive and colloidal properties of sands and their practical importance should be received as preliminary inquiries into a complex field, rather than as final and definite conclusions supported by a paucity of data. The phenomenon of under-water shrinkage of sand beds no doubt is intimately influenced by a series of factors, in which coagulant, algæ, characteristics of applied water, etc., have considerable importance, but it is our belief that the nature of the filter medium itself plays a predominating part or else the contraction phenomenon should be common to all plants. If this discussion should bring forth more experimentation upon the complex problems of the mechanism of filtration and the function of the sand medium therein, it will have served its purpose completely.

The writers take much pleasure in publicly thanking for their valuable aid in the preparation of the above discussion the following persons: Miss Burroughs, assistant chemist, Maryland State Department of Health, who is responsible for the analytical determinations of the adsorptive capacities of the different sands; Professor Patrick, of the department of physical chemistry of the Johns Hopkins University, who discussed with the writers their hypotheses and who suggested the experiment with the synthetic silicon dioxide; Mr. Bayliss, chemist of the Baltimore city water filtration plant, whose criticism of the final discussion was most helpful; Mr. Hannan, chemist of the Toronto filtration plant, who discussed in detail the final paper and offered a number of valuable suggestions as to context and additions to confirmatory references; Mr. Howard, bacteriologist of the Toronto filtration plant, who read and criticized the final manuscript.

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Grade-Crossing Removal Progress at Syracuse

Removal of the railway tracks at Syracuse, N. Y., and the utilization of the old Erie Canal bed there has been a project under consideration for a number of years, but it has been held up by general delay due to the war. The acquisition of the canal bank through the city is an essential preliminary to the grade-crossing elimination project. The Common Council in 1919 declared the intention of the City to take over all of the canal lands in the city which are to be abandoned and to make application to the Land Board pursuant to the provision of the so-called Walters Act of 1916. This act has recently been amended so as to enable the City to dispose of such canal lands as it might acquire and not use for public purpose. The city charter provided that such property shall not be disposed of at public sale, a method which it is thought would be disadvantageous in this case. The amendment which has been signed recently by Governor Smith provides that the land may be disposed of at "public or private sale." The Land Board has caused an appraisal of the land to be made, though the valuation has not yet been made public. It is probable that the next step will be a request from the city to the Canal Board to abandon formally the canal land. This being done, the City has to take the necessary steps within four months to raise the money to acquire the land. The City, it is understood, is still definitely in favor of the so-called Arnold scheme for grade-crossing removal as reported in 1915. In this scheme the old bed of the Erie Canal is utilized extensively to provide a depressed way through the city for the railroad tracks. While it is locally reported that the railroad is in opposition to this scheme, no definite action can be taken until the City presents to the railroad company a tentative contract based on the depression scheme. It is expected that this will be undertaken in the not distant future.

The British Government's Huge Housing Scheme

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REFERENCE has been made in the columns of *Engineering News-Record* to the restriction of "luxury construction" in England in order to allow the building of dwellings to proceed. What has been said, however, conveys no adequate impression of the magnitude of the housing enterprise which is being promoted and subsidized by the Imperial Government.

BRICK AND STONE DWELLINGS OF HOUSING SCHEME IN EDINBURGH

To the week ended May 22, plans had been approved by the Ministry of Health *for no less than 184,000 houses.* These approvals involve 3,700 separate schemes, covering 48,000 acres of land. Tenders had then been approved for 102,000 houses, and the chief architect of the Ministry, Mr. Raymond Unwin, estimated that between 30,000 and 40,000 houses were then under way. None of these figures include houses being built by private owners or speculative builders, but only those included in municipal housing projects. By "house" is meant not necessarily a detached single-family dwelling, but the apartment for one family. A four-family building, therefore, would be rated in the above figures as four houses.

There are various points of interest for American readers: While each building is a simple construction problem, the planning of the new villages and subdivisions is a city-planning or city-engineering problem of great total magnitude; the building of many small structures in a given area offers opportunity for skillful construction organization; the work is largely in the hands of engineers—in fact, some of the city engineers serve also as directors of housing; the scheme is a state financing plan that goes far beyond what has hitherto been considered the province of government either in Europe or in America; and, lastly, the Government deems the housing situation so urgent that it is curtailing unnecessary interfering construction.

Cities and villages in order to get the Government's subsidy must agree for 60 years to raise for housing one penny in the pound Sterling of taxable value. The taxable value, by the way, is not the market value of the property, but the annual rental thereof. Against the annual and fixed charges the cities will credit the rents and the proceeds of the one-penny tax. Whatever loss is shown will be paid by the Government.

The Government does not lend money to the larger communities for building operations, but since it has guaranteed to pay the losses, the bonds virtually are

guaranteed and the large cities have had no difficulty in disposing of housing bonds bearing 6 per cent interest. The smaller communities will be permitted to borrow from the Government.

In addition to this scheme, outright grants are made to individual owners and to speculative builders who put up houses having 1,400 sq.ft. of floor space or less. These grants, which are in cash, varied from £130 to £160 per house, depending on size, but these limiting figures have recently been increased to £230 and £260 respectively. In other words, if one builds a modest house, the Government will contribute from $1,150 to $1,300 toward the cost. The buildings, like those in the municipal schemes, must be of permanent construction and the plans must be approved by the Ministry of Health.

An additional feature of the housing scheme is that "public utility societies," which engage in building and limit their profits to 6 per cent per annum, can borrow 75 per cent of their capital from the Government and in addition are given a grant of 50 per cent of their capital charges for 7 years and 30 per cent for the ensuing 43 years.

While the communities are coming into the scheme in large numbers, the individual, whether speculative builder or owner, is not. He fears that the inevitable drop in values will more than wipe out the Government's subsidy. Building costs now are more than twice what they were before the war.

Obviously, the Government is likely to incur a heavy expenditure under the plan. Already rentals are being fixed which show a heavy annual loss, such rentals necessarily being based on those of nearly pre-war buildings. The estimates of the direct grants and the losses run into hundreds of millions of pounds, and the financial features have been widely condemned. Those who disapprove them admit generally that they are unable to suggest any better scheme. It is admitted that the housing situation is very serious and that the Government must take it in hand. The trouble is traceable not merely to discontinuance of house construction during the war, but to the cessation of speculative building after the passage of a law in 1910, fathered by Lloyd George, taxing away the "unearned increment" in property values. Even before the war the Government had been lending money on housing schemes but had not granted subsidies. One of the remedies proposed for the situation is the repeal of the act of 1910, but that proposal seems to find little favor with the powers that be.

The character of house contemplated by the authorities is indicated by the limitation of grants to houses having 1,400 sq.ft. of floor area or less, with a maximum of two living rooms (usually a combined living and dining room and a parlor) and four bedrooms. A bathroom and a scullery, or small kitchen, are always included but are not counted as "rooms" when, say, a six-room house is referred to.

The average price of the tenders to date I was not able to learn, but for the first 30,000 houses was £796. These were not all of the maximum size; in fact, they are more likely to be of the one-living-room- three-bedroom type. These figures include the cost of the building and the necessary land, paving and sewers, but not of the paying utilities such as the water, gas and electric mains. In general it is expected that the cost will be about £1,000 per house.

Some of the schemes, notably one at London under the London County Council, run into tremendous figures, involving the building of whole communities. On these the contractors will use much plant and big organizations. In practically all cases, on both large and small projects, the contractors bid unit figures which are used as a base from which actual cost figures, adjusted to the rise and fall of wages and material prices, are computed. In other words, the contractor does not carry the risk incident to rising prices. In one case, a large operation, the contractors were asked to bid their total profit, that profit, according to the agreement, to be a fixed sum.

The restrictive power reposed in the Ministry of Health has been delegated to local committees made up of city officials and of men familiar with business and building conditions and the local needs. So far, the restrictive power has been invoked against such proposed work as moving-picture theaters, and the building and alteration of retail stores.

The work actually done this year will be far less than either the Government or the communities desire. Transportation and labor will be the limiting factors. Materials are short, too, but they can be supplied, it is believed, as rapidly as they can be transported and put into the jobs.

Chief interest in the scheme just at present lies in the financial experiment involved. For the outcome we shall have to wait for years. For the American engineer and contractor, though, there may be much of interest before long if the bigger schemes are carried out with labor-saving plant and rapid-construction organizations. In the town-planning schemes there will be interesting features. For example, on one of the developments the width for interior streets is only 30 ft. with carriageways of 13 ft. The houses, of course, must be set back from the property line. In fact, for three-story buildings (three stories being maximum height) the open-ground area for each plot must be twice the building area; for a two-story dwelling, one and three-quarter times the building area; and for a single-family dwelling, presumably two stories, one and one-half times the building area.

Commenting on the labor conditions, one director of housing recently remarked: "The working people who keep shouting for houses are the very ones who will not help us get them." His testimony agreed with that of others. The fact that they were building houses for their own use had not secured increased production. In one city the labor unions have proposed to take a contract to build a group of houses, but to date the plan has not materialized. The hitch came when the unions were asked, like any other contractor, to agree to a base price. They began to think twice when they could not secure a force-account contract—the community to foot the bill no matter what the cost might be.

Glasgow, May 28.

Proposed Municipal Milk Distributing Plant

The establishment of a milk distributing plant to be operated by the village is under consideration at Saranac Lake, N. Y. A project for both the production and distribution of milk by the city of Jamestown, N. Y., was kept before the people of that city by its Mayor for some time a few years ago.

Uniform Pressure on Building Foundation Beds

A Review of Practice and Code Provisions, with Numerical Comparisons for Typical Office Buildings, Followed by a Recommended Specification

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The failure of the foundations of a particular building led the writer into a review of foundations of buildings in general, and the problem of obtaining uniformity of pressure distribution in particular. Because this latter part of the inquiry revealed such wide differences of practice as to indicate a very unsettled state of engineering opinion, the review is summarized here as a suggestion for further discussion of the problem. A specification formulated by the writer as the result of his study is appended.

Early Chicago Practice.—For knowledge on the subject we naturally turn to Chicago. It is there that notable pioneer work was done and it is there that the art of coustructing foundations on compressible soils has been brought to its highest development. The method of having each column and wall in a building rest on its own foundation, independent of all others, was first advocated by Frederick Baumann, a Chicago architect. His pamphlet, "The Method of Constructing Foundations on Isolated Piers," published in 1872,[1] introduced a new era in foundation construction. The many-storied iron skeleton building on spread foundations came into being a few years later. Much of the early literature—articles by Jenney, Purdy and others—can still be read with interest and profit.

It is to be hoped that an engineer with the historic sense will some day collate the literature on the foundations of Chicago buildings and put forth his efforts in a book. A second volume of modest size, "Foundations after Twenty Years," would also be of great value. Have the foundations of . . . settled evenly? Is there still a slope in the sidewalk adjoining the . . . building? How has the adjustable column support of the Marquette building worked? Engineers outside of Chicago are at a disadvantage in obtaining answers to these questions.

It has been emphasized again and again that in foundation work settlement should be uniform. On compressible soils settlement comes slowly, but none the less surely, and if this settlement is not uniform, or nearly so, there will be cracks *somewhere.*

A great deal of study has been given to the foundations of high buildings and to those with unusual features. Difficult foundation problems have been solved successfully. Less consideration has been given to comparatively low buildings—say ten stories and under. What follows is written mainly with this class in mind.

Allowed Bearing Pressure.—As repeatedly stated three factors entering into foundation design are: The bearing capacity of the soil, the amount of the load, and the distribution of the load. To these should be added a fourth—the building code. It is often difficult to design foundations economically and at the same time in accordance with loading requirements of the building code.

[1]This pamphlet, revised by G. T. Powell and entitled "The Art of Preparing Foundations with Particular Illustrations of the Method of Isolated Piers as Followed in Chicago," is published as an appendix to Powell's "Foundations and Foundation Walls." 1879. 1884. 1889.

The maximum bearing capacities of soils specified in municipal building codes are usually 1 ton per sq. ft. on "soft wet clay," 2 tons on "ordinary clay," 3 tons on "dry clay" and 4 tons on "hard clay." Philadelphia and some other codes allow 6 tons on gravel. Milwaukee allows ½ ton per sq.ft. on quicksand and alluvial soils, while in Memphis 1½ tons is permitted. A number of codes are quite explicit in forbidding foundations to rest on made ground. In Chicago a wet clay underlies a stratum of hard clay or clay and sand, an unfavorable condition for heavy loads; the maximum bearing pressures, conditioned on the upper stratum being 15 ft. thick, are as follows: If of pure clay without admixture of any foreign substance other than gravel, 3,500 lb. per sq.ft.; if of pure clay, dry and thoroughly compressed, 4,500 lb.; if of firm sand without admixture of clay, loam or other foreign substance, 5,000 lb.; if of a mixture of clay and sand, 3,000 lb. per sq.ft.

Bearing Tests Desirable.—Too much reliance should not be placed upon bearing pressures allowed by the average building code. The values given are often copied from other codes, and not always with good judgment. It should also be remembered that "not more than" does not mean "as much as." Tests should be made: The code of New Orleans does not allow more than 1,400 lb. per sq.ft. on soil, the whole city being on an alluvial formation, but a few years ago the builders of a steel water tower just within the city limits decided after making tests that 650 lb. was the maximum pressure permissible at that particular site.

The Omaha code does not allow a greater pressure than 3,000 lb. per sq.ft. without preliminary borings being made under the direction of the building inspector. The Sioux City code limits the pressure for spread foundations to 2,500 lb. per sq.ft. unless "carefully conducted investigations and tests indicate that the soil will safely carry a greater load." The Toledo code specifiies, "It shall be ascertained that there is no underlying stratum of inferior material."

It is surprising how the matter of soil-testing is neglected. A slight expenditure of time and money would enable the designer to use accurate knowledge instead of guesswork. Caution should be exercised in making use of published tests. Wrong inferences may be drawn unless the conditions under which the tests were made are given. The Omaha code does not allow foundations to be proportioned for greater than one-half of the test load, "where such test load has not exceeded the satisfactory carrying capacity of the soil in question." The regulations governing tests in the Borough of Manhattan, New York, specify, "The accepted safe load shall not exceed two-thirds of the final test load." No intelligent comparison of results can be made, however, without a knowledge of the apparatus used and the regulations governing the tests.

What Are The Loads?—The loads coming upon the foundations of a building through the basement col-

umns are the dead load, the live load and the wind load. The dead load includes the steel frame, the walls and the floor construction, the weights of which can be determined with a fair degree of accuracy. The live and wind loads are usually prescribed by a building code. In this respect the codes are at hopeless variance with one another. For office buildings the range of live load for floors is from 40 lb. per sq.ft. (Milwaukee and Fort Worth) to 100 lb. (Boston and neighboring cities.)

Tables I and II are based on floor panels 18 x 18 ft., story heights 12 ft., exterior walls 12 in. thick carried by lintels at each floor above the first, 30 per cent of wall surface filled with glazing, weight of floor construction 70 lb. per sq.ft., roof construction 50 lb. per sq. ft. No wind loads are included. In each table "Col. 1" is a corner column, "Col. 2" an intermediate exterior column and "Col. 3" an interior column.

TABLE I. BASEMENT COLUMN LOADS FOR THREE TYPICAL OFFICE BUILDINGS

Stories	Column No.	Dead	Live	Total	Per Cent	Equivalent
6	1	138.0	35.9	173.9	20.6	65.6
	2	176.1	71.9	248.0	29.0	65.6
	3	152.3	143.8	296.1	48.5	65.6
8	1	189.4	44.2	233.6	18.9	61.9
	2	238.8	88.3	327.1	27.0	61.9
	3	197.6	176.6	374.2	47.2	61.9
10	1	240.7	51.1	291.8	17.5	58.1
	2	301.5	102.2	403.7	25.3	58.1
	3	243.0	204.5	447.5	45.7	58.1

Loads under "Dead," "Live," and "Total" are given in thousands of pounds.

Under "per cent" is given the per cent of total load calculated as live load.

Under "Equivalent" is given the average floor live load, in pounds per square feet over entire floor area carried by the column.

Table I, computed for typical average office-building conditions, follows the floor live load specified in 60 building codes which require for columns 75 lb. per sq.ft. on the top floor, 75 lb. less 5 per cent for the floor below the top floor, 75 lb. less 10 per cent on the next lower floor, the reduction increasing by increments of 5 per cent on each successive floor until 50 per cent is reached, which reduced load is used for all floors below. Roof live load is taken at 50 lb. per sq.ft. (These provisions are those of the former New York code.)

Table II follows the live loads of the present New York, Chicago and Boston codes. The New York code specifies 60 lb. per sq. ft. for floor load and 40 lb. for roof load; the reduction formula for column loads is the same as used in Table I. The Chicago code specifies 50 lb. live load for floors and 25 lb. for roof; for columns live loads are reduced to 85 per cent for the top floor and are 5 per cent less for each succeeding floor until 50 per cent is reached, which reduced load is used for each of the remaining floors. The Boston code specifies 100 lb. live load for floors and 40 lb. for roof; for columns in office buildings it allows a reduction of 15 per cent of the total live load where 2 floors are carried; of 20 per cent where 3 floors are carried; of 25 per cent for 4 floors, etc., the reduction increasing 5 per cent for each successive floor until 50 per cent is reached, which is used for 9 or more floors.

The dead loads for Table II would be the same as for Table I and are not repeated.

Computing Foundation Loads.—Building codes differ greatly in provisions for determining the area of foundation beds. The former New York code has been so widely used as a model in the compilation of other codes that it will be quoted:

The loads exerting pressure under the footings of foundations in buildings more than three stories in height are to be computed as follows: For warehouses and factories they are to be the full dead load and the full live load established by section 130 of this code. In stores and buildings for light manufacturing purposes they are to be the full dead load and 75 per cent of the live load established by section 130 of this code.

In churches, school-houses and places of public amusement or assembly, they are to be the full dead load and 75 per cent of the live load established by section 130 of this code.

In other buildings, hotels, dwellings, apartment houses, tenement houses, lodging houses and stables they are to be the full dead load and 60 per cent of the live load established by section 130 of this code.

Footings will be so designed that the loads will be as nearly uniform as possible and not in excess of the safe bearing capacity of the soil.

With variations in the percentage of live load these provisions are embodied in the building codes of a large number of cities. For office buildings 60 per cent is used in Atlanta, Detroit, Jersey City, Newark, Paterson; 40 per cent in Evansville, Memphis, St. Paul; 25 per cent in Baltimore; 20 per cent in New Orleans.

The present New York code specifies:

For the loads exerting pressure under the footings of foundations the full dead loads and the figured live loads on the lowest tier of columns, piers or walls shall be taken.

Footings shall be so designed that the loads they sustain per unit of area shall be as nearly uniform as possible and within the bearing capacities of soils established by this article, and that the stresses in the materials shall not exceed those fixed by this chapter. In proportioning the

TABLE II. BASEMENT COLUMN LOADS OF OFFICE BUILDINGS UNDER THREE DIFFERENT BUILDING CODES

		New York				Chicago				Boston			
Stories	Column No.	Live	Total	Per Cent	Equivalent	Live	Total	Per Cent	Equivalent	Live	Total	Per Cent	Equivalent
6	1	28.7	166.7	17.2	52.5	19.6	157.6	12.4	36.2	34.8	172.8	20.1	65.0
	2	57.5	233.6	24.6	52.5	39.3	215.4	18.2	36.2	69.7	245.8	28.4	65.0
	3	115.0	267.3	43.1	52.5	78.6	230.9	34.0	36.2	139.3	291.6	47.1	65.0
8	1	35.4	224.8	15.7	49.5	23.9	213.3	11.2	33.7	38.9	228.3	17.0	55.0
	2	70.6	309.4	22.8	49.5	47.8	285.6	16.7	33.7	77.8	316.6	24.6	55.0
	3	141.3	338.9	41.8	49.5	95.6	293.2	32.7	33.7	155.6	353.2	44.1	55.0
10	1	40.9	281.6	14.5	46.5	28.0	268.7	10.4	32.0	43.7	284.4	15.4	50.0
	2	81.8	383.3	21.3	46.5	55.9	357.4	15.6	32.0	87.5	389.0	22.5	50.0
	3	163.7	406.7	40.2	46.5	111.8	354.8	31.5	32.0	175.0	418.0	41.9	50.0
20	1	65.2	562.6	11.6	38.2	48.2	545.6	8.8	28.5	Boston Building Code prohibits buildings more than 125 feet in height.			
	2	130.4	745.3	17.5	38.2	95.4	711.3	13.5	28.5				
	3	260.8	730.6	35.7	38.2	192.8	662.6	29.1	28.5				

Loads under "Live" and "Total" are given in thousands of pounds. Under "Per Cent" is given the percentage of total load calculated as live load. Under "Equivalent" is given the average floor live load in pounds per square foot over entire floor area carried by the column.

NOTE—Since the above was written the Boston Building Law has been revised. The specified live load for office floor is now 75 lb. per sq. ft. However, several New England cities still follow the 100 lbs. of the former Boston code.

areas of footings for any building the dead load alone shall be considered, provided, however, that in no case shall the pressure under the footings, as determined in subdivision 5 of this section, exceed the safe load on the soil established by this article.

These provisions are in accordance with Schneider's "General Specifications for Structural Work of Buildings."

The Chicago code specifies:

The entire dead load and the percentage of live load on basement columns, piers and walls shall be taken in determining the stress in foundations.

In addition to the entire dead loads, not less than the following proportion of the percentage of live load on the basement columns, piers and walls shall be taken in determining the number of piles for pile foundations and the area of concrete caissons.

(The proportion ranges from 75 per cent for warehouses and stores to 25 per cent for churches, theatres and schoolhouses. For office buildings it is 50 per cent.) The first paragraph refers to the foundations themselves and not to the soil. The second paragraph really refers to concrete caissons, it being the Chicago custom to include the whole live load in determining the strength of piling. For spread foundations it is left to the architect or engineer to determine the amount of live load to be used to give uniform settlement throughout. One reason for this is that the nature of the soil is different in the various parts of the city.

The Philadelphia code speaks of "the loads upon the soil" but does not say how they shall be computed. Similary the codes of Boston and Milwaukee are non-committal on live-load reduction. But most good codes attempt to provide for uniformity of foundation loading in some way. Quotations from some of these follow:

Baltimore. The supporting areas of foundations and all other conditions determining their supporting power shall be proportioned to the full dead load, including the weight of the foundation itself, and in addition thereto one-half of the full live loads, as specified in Section 19 of this Article, for floors and roofs of warehouses, and one-quarter of the full live load specified for floors and roofs of other buildings.

Buffalo. Foundations shall be proportioned to the actual average loads they will have to carry in the completed and occupied building, and not to theoretical or occasional loads.

Cleveland. Each footing shall be designed to carry the full dead load plus the live load used for designing the lowest section of the column.

Indianapolis. The load carried by the soil shall be the total dead load and an average live load of not less than 10 lb. per sq.ft. of all the floor area of the building when used as an office building, lodging or tenement house and an average live load of not less than 20 lb. per sq.ft. of all the floor area, where building is used for mercantile purposes, and an average live load of not less than 60 lb. per sq.ft. of all the floor area, where such building is used as a warehouse.

Minneapolis. Foundations and their footings shall be proportioned to the actual loads they will have to sustain in the completed and loaded structure.

St. Louis. (Same as Indianapolis except for warehouses 50 per cent of the total of live load is to be used.)

South Bend. Foundations for buildings shall be proportioned to carry the entire dead load plus 50 per cent of the live load on the basement columns, piers, posts or walls. All footings and foundations for buildings shall be so designed that the loads they sustain per unit of area will be as nearly uniform as possible, and the dead load carried by the footing shall include the actual weight of the superstructure down to the bottom of the footing. In no case shall the load per square foot under any portion of any footing, due to the combined dead, live, and wind loads exceed the safe sustaining power of the soil as established by Sec. 195 of this code.

Dead load is actual load and can be determined with tolerable accuracy; it comes first upon the footing and remains there, a constant quantity. On the other hand the live load is not actual but assumed, and in many cases the assumed amount is much above any probable loading, is intermittent and does not come into action until after initial settling due to the weight of the structure has taken place. Moreover, the ratio of live to dead load varies for different columns. The problem is therefore twofold—to determine the combined dead and live load the footings are to support, and then distribute it so that settlement will be uniform.

A common method is to add for each column the dead load and the full assumed maximum live load, divide this by the allowable bearing pressure on the soil, and use the quotient for the area of the footing. If in process of time cracks appear in walls they are looked upon as incidental to building construction and to be no cause for surprise. It is true that the great majority of foundations proportioned after this manner have given no trouble. The writer has in mind a 20-story office building on a compact gravel soil in which this method was used and after a lapse of several years no evidence of unequal settlement is at hand. The method, however, is wrong in principle, and in practice has given troublesome results.

The "typical" office buildings of Table I, if on a weak soil, will settle unevenly during erection. The exterior foundations, having a greater pressure per unit of area by reason of carrying the walls, will settle more than the interior columns (which carry only the floor construction), thus leaving a lump in the interior of the building. This has happened where the final live loads brought upon the floors have been much less than those assumed. A number of codes meet the difficulty by prescribing lesser live loads for proportioning footings than those used for proportioning the lower sections of columns. (See the former New York code previously mentioned. Note also the codes of Indianapolis and St. Louis.) An objection to this method has been raised on the ground that if the reduced loadings were greatly exceeded, the allowable pressure on the soil might be exceeded sufficiently to produce further settlement of interior columns, leaving a hollow in the interior of the building.

Again, some architects and engineers choose a smaller soil load for wall columns than for interior columns. If the choice is arbitrarily made the method has little to commend it. It may be said here that foundations designed by "practical" men have often given trouble, more times, perhaps, than those designed by what some may be pleased to call "theorists."

In the early Chicago high buildings Jenney used (1884) for the footings of the Home Insurance Building the dead loads and a load of 18 lb. per sq. ft. for the average permanent load on all floors. The building was started 2½ in. above grade and when finished showed a total settlement of 2¼ in. and an extreme variation of only 1½ in. Purdy (1891) advocated that the dead loads only should be considered. He proportioned the footings of the Old Colony Building for a bearing value of 3,200 lb. per sq.ft. for dead

load, entirely neglecting the live load. The settlement 9 months after the building was finished varied from $4\frac{3}{16}$ to $5\frac{1}{4}$ in.

Crehore, in his chapter "Modern High Buildings" in DuBois' "The Stresses in Framed Structures" (1896), recommends a method that he had used for high buildings in New York City: that foundations be proportioned according to the ratio of the dead loads. The method is that of the present New York code and the Schneider specifications (1905, 1910). To quote the latter:

> The live loads on foundations shall be assumed to be the same as for the footings of columns. The areas of the bases of the foundations shall be proportioned for the dead load only. That foundation which receives the largest ratio of live load to dead load shall be selected and proportioned for the combined dead and live loads. The dead load on this foundation shall be divided by the area thus found, and this reduced pressure per square foot shall be the permissible working pressure to be used for the dead load of all foundations.

A criticism brought against this method is that it is too conservative and requires footings larger than needed. Crehore anticipited this charge, for he wrote:

> The method is rather rigid and, perhaps, wasteful in giving larger footings under interior columns where the dead load is much less than it is in the wall columns; but if the soil is of a yielding nature the principle of proportioning the footings according to the dead load should be closely adhered to.

Tucker, "Cyclopedia of Civil Engineering," Vol. V (American School of Correspondence), in order to equalize the settlement between wall and interior columns, uses as a basis for proportioning footings the dead loads and a percentage of the live loads—25 per cent in the example given. In other respects his method is similar to that of Crehore and Schneider. Ernest McCullough has long used a method similar to that of Crehore and Schneider, but the "index footing" is that under the column having the largest percentage of dead load. This brings the method in conflict with building codes that specify the unit load on any footing from columns fully loaded must not exceed the bearing pressure on the soil, for often a considerable excess will result. In Table III according to the McCullough method the soil pressure for total dead and live loads on the footing of Col. 3 in 6-, 8- and 10-story buildings is 9250, 9210 and 9130 lb. respectively, though the assumed allowable pressure is 6,000 lb.

Moran in his chapter "Foundations," in Kidder's 'Architects and Engineers' Pocket Book," 1916, reduces to rule his method of proportioning supporting areas. He proceeds in the manner of Schneider and Crehore except that he adds "one-half the maximum probable live loads" and "one-half the maximum probable wind loads" to the dead load, for proportioning the footings. Except for its inclusion of wind load the Moran method has much to be said in its favor, but it introduces a large variable element of judgment by dealing with "maximum probable" loading.

Objection to all these methods may be raised because of the wide difference in the live loads used in proportioning the footings and those in the columns directly above them. If, as Moran thinks, the probable maximum live load for an office building is an average of 10 lb. per sq.ft. over the entire floor area, the live load coming upon the footing of Col. 3 in the 10-story "typical" office building of Table I is 35,640 lb. while the column is proportioned for a live load of 204,500 lb. The "probable maximum live loads" assumed in Table III for the Moran method are 15 lb. per sq.ft. for the floors and 20 lb. for the roof. In the 4-story factory building which Moran gives as an illustrative example, he assumes the probable maximum live loads and wind loads on the footings to be 60 per cent and 50 per cent respectively of those used for proportioning the lower sections of columns.

Wind Load on Footings.—In proportioning footings should wind loads be included with live loads, as in the Moran method? Some building codes include them by specific mention, others by implication, others are ambiguous, and others exclude them by specifying that the live loads to be considered are those of a designated section in which no mention is made of wind loads. An instance is the former New York code previously quoted. The section 130 to which reference is made contains nothing about wind loads. Wind loads can be neglected in many buildings but, at least with respect to the strength of the frame, they should be considered in high narrow buildings and in structures where the materials of construction offer but little resisting moment to the wind. It seems reasonable to take account of them in the footing design. (See the writer's proposed specifications.)

It is of prime importance that the center of gravity of pressure on a foundation should coincide with the center of gravity of resistance. Bauman in his pamphlet lays down as one of the three fundamental rules in designing foundations that they must be made to support their loads centrally. The neglect of this rule is a frequent cause of foundation trouble. It is often a difficult matter to take care of exterior columns and party walls properly, especially where spread foundations are used. We are indebted to Chicago for the cantilever solution of the problem, said to have been first used in the Rand-McNally Building. For mathematical treatment of eccentric loading, cantilever girders and combined footings, the reader is referred to text-books, and for illustrative examples to the files of the technical press.

Table III is for reference and explains itself. It is based on an allowable soil pressure 6,000 lb. per sq. ft. By using it with Table I the unit pressures on footings for live, dead and total loads can easily be obtained.

The writer offers the following specifications for

TABLE III. AREAS OF FOOTINGS FOR TYPICAL OFFICE BUILDINGS

(Areas in Square Feet)

Stories	Column No.	Dead Plus Live	Dead Plus 60 per Cent Live	Crehore and Schneider	Tucker	McCullough	Moran	Proposed Method
		Method of Proportioning						
6	1	29.0	26.5	44.7	38.5	29.0	41.3	37.0
	2	41.3	36.5	57.0	50.8	37.0	53.6	49.0
	3	49.3	39.8	49.3	49 3	32.0	49.3	49.3
8	1	38.9	36.0	59.8	51.6	38.9	55.3	49.6
	2	54.5	48.6	75.4	67.4	49.9	70.9	65.3
	3	62 4	50.6	62.4	62.4	40.6	62.4	62.4
10	1	48.6	45.2	73.9	64.3	48.6	68.2	61 8
	2	67.3	60.4	92.4	82.9	60.9	86.9	80.5
	3	74.6	60.9	74 6	74.6	49.0	74.6	74.6

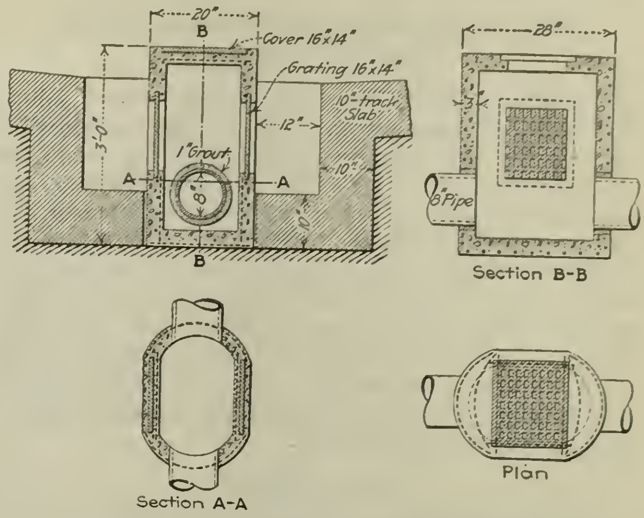
NOTE: Same buildings as those of Table I.

determining the areas of footing courses of foundations in buildings:

The live loads on foundations shall be assumed to be the same as those on the lowest sections of columns. No wind load, however, need be considered unless it exceeds one-half the sum of the live and dead loads on the column. In case of excess, the excess shall be considered a live load.

The areas of footings shall have the same ratio to each other as the dead plus one-third live loads coming upon them. That footing which receives the largest percentage of live load shall be proportioned for the combined dead and live loads. The dead plus one-third live load on this footing shall be divided by the area thus found, and this reduced pressure per square foot shall be used for the dead plus one-third live load of all foundations.

It is thought that the proposed specifications are well adapted to the general case of foundations. However, the foundation problem is one that is always with us and requires trained judgment and technical skill to meet the many special forms in which it is constantly appearing.

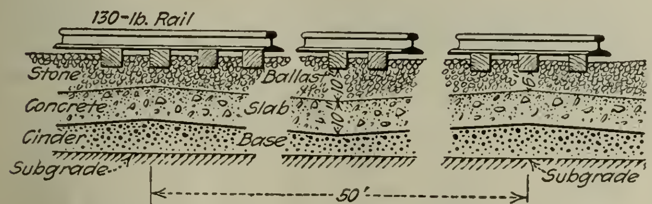


DRAIN INLET FOR TRACK ON CONCRETE

Concrete Base Track Approach for Chicago Union Station

Roadbed Near Water Level Blanketed with Concrete To Prevent Settlement of Ballast—Heavy Track Construction

TO REDUCE maintenance work under heavy terminal traffic, a concrete slab foundation will be placed under the tracks and crossovers at the south approach to the new Chicago Union Station, thus distributing the load on the subgrade and preventing the ballast from settling into the earth. This four-track approach not only carries exceptionally heavy traffic but includes a series of double crossovers with slip switches by which any one of the main tracks can be connected to any one of the station or platform tracks.



CONCRETE SLAB SUPPORTS BALLASTED TRACK

The pounding of heavy engines in passing through the crossovers and crossing frogs would soon work the ballast into the roadbed, which is necessarily somewhat soft since the rail level is only about 4 ft. above the water line of the Chicago River, which flows close to the tracks. With ordinary track construction in this case there would be continual work in surfacing and lining the tracks and complicated special work. In the station there will be a concrete deck or floor with recesses for wood blocks carrying the rails, as in the underground terminal station of the Pennsylvania R.R. at New York and the elevated union station at Indianapolis, Ind.

From the end of this deck, at Harrison St. the concrete slab with ballasted track will extend about 800 ft. to Taylor St. The width of slab varies from 100 ft. at the station to about 56 ft. at the further end. It was built in three longitudinal sections, as only part of the approach could be vacated at one time. The construction is similar to, but heavier than, that employed under the crossovers in the Long Island R.R. terminal yard at Jamaica, N. Y., as described in *Engineering News-Record* of April 22, 1920, p. 826.

On the subgrade was laid a 12-in. bed of cinders, which was compacted by rolling and the surface of which was formed in drainage planes. Upon this base was laid the 10-in. concrete slab, of uniform thickness and following the surface of the cinder bed so that it is sloped to form a series of transverse valleys about 50 ft. wide between ridges and 4 in. deep. The concrete is a 1 : 2½ : 5 mix, made with broken stone. In order to prevent shrinkage cracks it is reinforced at the middle with a sheet of wire netting and transverse rods. Each section was built as a monolithic block 800 ft. long, and was left for at least seven days before the ballasted track was placed upon it. A small portable mixer was used for the work.

Provision for Drainage

Under the slab are 8-in. transverse tile drains which are intersected by a 12-in. longitudinal drain having sewer connections. Inlets and manholes extend through the slab and ballast and have iron covers at the level of base of rail. The inlets have iron gratings in the sides and stand in recesses or drainage sumps formed in the surface of the slab, as shown by the drawings. Electric conduits are also placed under the slab. They consist of fiber ducts embedded in concrete and have manholes at intervals.

Track of heavy construction is used, further to reduce maintenance. The ballast is of 2½-in. broken stone, 6 in. and 10 in. thick under the ties at the ridges and valleys of the concrete slab. In this are bedded ties of creosoted red oak, 7 x 9 in., spaced 20 in. c to c. Rails of the 130-lb. Pennsylvania R.R. section are laid on steel shoulder tie-plates and are secured by ordinary 6-in. cut spikes. The tie-plates are fastened to the tie by similar spikes, independent of those which hold the rails. Manganese steel will be used for the special work of the crossovers, which will have 18-ft. switch rails and No. 8 frogs. The main tracks are spaced 13 ft. c. to c.

Design and construction of this track system were under the direction of J. d'Esposito, chief engineer, and A. J. Hammond, assistant chief engineer of the Chicago Union Station Co.

New Experiments on Riveted Joints of Ship Plating

DETERMINATIONS of the slip of riveted joints, intended primarily to apply to ship construction, were carried out recently by James Montgomerie for the Committee of Lloyd's Register of Shipping. As described in the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland, April, 1920, the experiments show rather high values of load at first slip, though it should be noted that static loading only was employed. Comparison of pneumatic, hydraulic and hand-driven rivets showed no appreciable difference in either the elastic qualities or the ultimate strength of the joints; and in fact iron rivets behaved substantially the same as steel rivets.

Test Material

The test material included six triple-riveted lap joints of plates 23½ in. wide by 0.44 in. thick connected by twenty-seven rivets of ⅞-in. diameter; and six quadruple-riveted joints of plates 17 in. wide by 0.58 in. thick connected by twenty rivets of ⅞-in. diameter. In the former, slip occurred at loads ranging from 16,000 to 20,000 lb. per square inch of rivet area, or 18,000 to 22,600 lb. per square inch of what is designated as "unpierced plate."

In the second series the slip loads were somewhat lower, ranging from 15,000 to 17,700 lb. per square inch of rivet cross-section, and from 18,000 to 21,700 lb. per square inch of section of unpierced plate. The tests were not extensive enough to give very precise averages, as in each series of six tests there were two specimens with hydraulic-driven rivets, two with pneumatic-driven rivets, and two with hand-driven rivets, and in each pair one specimen had steel rivets and the other iron rivets. In effect, therefore, the tests of the riveted joints were all individual.

Dr. Montgomerie concluded from his observations on the test that the load does not distribute evenly among the rivets, and the stress distribution in the joint is by no means uniform; that the contact face of the plate carries nearly double the average stress; that up to the point where slip begins the joint behaves as an elastic solid; that the iron and steel and the different methods of riveting give results that could not be differentiated in these tests; that the load at first slip may be taken to be 17,000 to 18,000 lb. per square inch of rivet section; and that subsequent to slip "the joint recovers its power of adhesion" and on retesting after an interval it will be found to give the same results as were obtained in the first test.

Congress Would Pay Engineers Less Than Engineering Council

ON MARCH 12, 1920, the Congressional Joint Commission on Reclassification of Salaries presented its report to Congress. Ever since this report was made public, discussion concerning it has been rife, and naturally much misunderstanding about the recommendations regarding salary schedules and employment policies has gained currency. In an endeavor to clear up these misunderstandings and in order to present an analysis of the commission's report, Engineering Council's Committee on Classification and Compensation of Engineers has prepared a "Comparison of Report of the Congressional Joint Commission on Reclassification of Salaries with the December, 1919, Report of Council's Committee." From that report the accompanying table is reproduced herewith:

COMPARISON OF CLASSIFICATION AND COMPENSATION OF ENGINEERS AS SUGGESTED BY ENGINEERING COUNCIL'S COMMITTEE AND BY CONGRESSIONAL JOINT COMMISSION

	Engineering Council						Congressional Joint Commission							
				Annual Salary Range						Annual Salary Range				
Grade	Title	Educational Equivalent	Minimum Experience in Years	Minimum	Maximum	Estimated Average	Title	Educational Equivalent	Minimum Experience in Years	Minimum	Maximum	Estimated Average	Present Average Yearly Salary (Note)	Average per Cent Increase or Decrease (Note)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8	a. Junior aid, office...... b. Junior aid, field.......	High School	0	1,080	1,560	1,240	a. Copyist draftsman... b. Junior engineer'g aid.	High School Common School	0	840	1,260	980	1,215	—19
7	a. Aid, office............ b. Aid, field.............	High School	2	1,680	2,400	1,920	a. Draftsman......... b. Aid...............	High School	2	1,200	1,800	1,400	1,533	— 9
6	a. Senior aid, office....... b. Senior aid, field........	High School	5	2,520	3,240	2,760	No corresponding grade	......	.. ..	....	....	....	.....	....
5	Junior assistant engineer..	Degree	0	1,620	2,580	1,940	Junior engineer......	Degree	0	1,800	2,160	1,920	1,959	— 2
4	Assistant engineer........	Degree	2	2,700	4,140	3,180	Assistant engineer.....	Degree	2	2,400	3,000	2,600	2,402	+ 8
3	Senior assistant engineer..	Degree	5/1*	4,320	5,760	4,800	Associate engineer.....	Degree	5/1*	3,240	3,840	3,440	3,128	+10
2	Engineer	Degree	8/3*	5,940	....	....	Engineer.............	Degree	8/4*	4,140	5,040	4,440	3,801	+17
1	Chief engineer..........	Degree	12/5*	8,100	....	....	a. Senior engineer......	Degree	12/8*					
							b. Commissioner, director, chief engineer, chief, superintendent, etc...	Degree	8/..*	....	....	....	5,867	....

NOTES

Columns 4 and 10. *Years in responsible charge of work.

Columns 7 and 13. Estimated average salary is the minimum plus one-third the difference between the minimum and the maximum. This relation was found to hold approximately for positions in the Federal Service, and was assumed in the studies conducted in connection with the salary schedules of the Reclassification Commission.

Column 14. Present average yearly salary, including bonus, of employees in sixteen bureaus in civil establishments of the Federal Government. The bonus is $240 for salaries of $2,500 and under; for salaries above $2,500, it is the amount, if any, necessary to make a total of $2,740.

Column 15. Average percentage increase (+) or decrease (—) in pay per employee under schedule proposed by Congressional Joint Commission over present schedule, if distribution of employees within each grade remains unchanged. The estimated increase in the salary roll which would be caused by putting the Commission's recommendations for all branches of the Civil Service into effect is, as estimated by the Commission, 8 to 10 per cent—probably 8.5 per cent.

Hydraulic Control of the Red River of the North

Detention Basin, Channel and Drainage Ditches at Head of 300-Mile Flat Valley—Project for Interstate Action

TO CONVERT Lake Traverse into a detention reservoir by a dam with permanent outlet, to straighten and improve the Bois de Sioux River for nearly 30 miles from this outlet to the Otter Tail River, and to construct main ditches to drain the land below the reservoir, are the preliminary steps of an interstate project for drainage and flood control in the valley of the Red River of the North, which last stream is formed by the junction of the other two streams between Breckenridge, Minn. and Wahpeton, N. D. The proposed works are shown on the map, Fig. 1.

As Lake Traverse, the Bois de Sioux and the Red River constitute the boundary between Minnesota on the east and South Dakota and North Dakota on the west, these three states have a mutual interest in the problems of securing outlets for drainage and flood waters. On the other hand, they have certain conflicting interests, since it has been claimed that channel improvements and drainage works along the Mustinka River in Minnesota have increased the discharge into Lake Traverse, causing floods on the western lands. The two Dakotas, therefore, have combined in a damage suit against Minnesota. This suit is now before the Federal courts.

The Red River of the North flows almost directly north, crossing the Canadian boundary and discharging into Lake Winnipeg. Although the direct distance from Breckenridge is about 290 miles, the length of the river is over 500 miles owing to the tortuous windings of the channel, which windings do not extend more than five miles on either side of the direct line. The slope varies from 0.3 to 1 ft. per mile, but in the Bois de Sioux the former is the average. The annual run-off averages about 3 in. for the Minnesota drainage area and less than 1 in. on the Dakota side.

Owing to the slight slope and a run-off insufficient to cause much scouring, the channel has not developed sufficiently to carry the flood waters. In fact, at the outlet from Lake Traverse there is practically no channel. In the Bois de Sioux the elevation is about 970 ft. at the lake and 945 ft. at its junction with the Otter Tail. The lake has a drainage area of 1,300 sq.mi. and a water area of about 30 sq.mi. A peculiar condition noted by Prof. E. F. Chandler in his pamphlet on "The Floods of the Red River Valley" is that while the country along the river (below Breckenridge) is flat it is several feet above the low water channel, so that normally it is dry and not swampy. But when the channel overflows a wide area is covered with shallow water of sluggish flow, and after the river recedes this water remains for a considerable period.

Serious floods at various points along the river in the summer of 1916 led the Commercial Club of Fargo, N. D., to request the U. S. Department of Agriculture to have a survey made for the purpose of determining some means of relief. After a study of the situation by S. H. McCrory, chief of drainage investigations, Bureau of Public Roads, it was reported that relief could be secured only through concerted action by the three states, and that an examination would be made by the

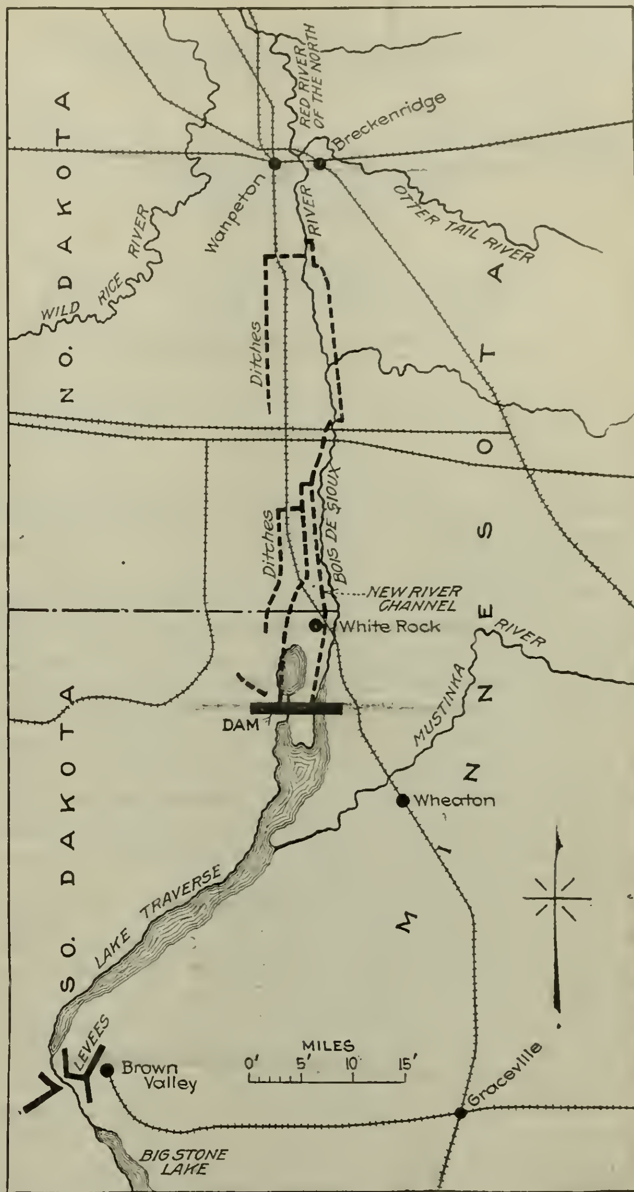


FIG. 1. DRAINAGE AND FLOOD CONTROL WORKS FOR RED RIVER OF THE NORTH

Bureau if funds were raised to defray certain expenses. In the meantime, the North Dakota Flood Control Commission had been appointed by the legislature and in 1918 the necessary money was raised largely through this commission. Field work was carried out during 1918 and 1919, and early in 1920 a progress report was made on the conditions at Lake Traverse and the Bois de Sioux River, as these called for immediate attention. A later report will deal with the conditions of the Red River proper.

As the channel of the Bois de Sioux River is too small to remove the water from heavy rains and melting snow much lowland is flooded periodically and thus obstructs the drainage of higher land. The flood waters either drain off slowly through the inadequate channel and outlet or remain until evaporated. Spring floods delay planting and summer floods cause serious damage to crops. The soil is alluvial and very fertile. The western portion of the drainage area and a strip extending about 30 miles east of the lake and the Bois de Sioux is prairie land with an easy slope. About 80 per cent of this prairie land is under cultivation. The eastern

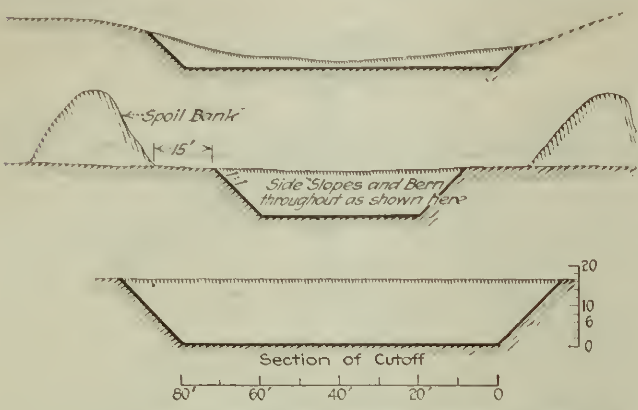


FIG. 2. CHANNEL IMPROVEMENT OF BOIS DE SIOUX RIVER

portion is rough and originally was covered by forests, but only about 10 per cent of the total drainage area is now wooded.

On both portions the natural drainage is poorly developed. Many drainage ditches have been constructed and in some places these have modified the natural drainage considerably. There is very little tile drainage. From the investigations of the drainage systems it was concluded that with excessive rainfall or rapid melting of snow the ditches may increase the rate of run-off when the drainage area is impervious from being frozen or saturated. This increased run-off may tend to increase flood heights along an unimproved portion of the stream having an inadequate outlet.

An annual run-off of 23,430,000,000 cu.ft. was determined as a maximum for the drainage area of Lake Traverse. To control this by converting the lake into a detention reservoir, it is proposed to build an earth dam about 2¾ miles long and 15 ft. high across the two outlets at the northern end, four miles south of White Rock, S. D. A concrete sluiceway would provide for normal discharge. A spillway for maximum discharge would have its crest at El. 983, with capacity for discharging 2,000 cu.ft. per second when the lake level reaches El. 985. The combined capacity of culvert and spillway would be 4,000 cu.ft. per second, which is far in excess of any probable requirements. At the south end of the lake, levees would be built for the protection of low lands. The reservoir capacity would be 9,849,000,000 and 12,035,000,000 cu.ft. at the two elevations mentioned.

Below the outlet a defined and direct channel would be built along or near the present winding course of the Bois de Sioux, with levees on each side to retain flood discharge. Typical cross sections are shown in Fig. 2.

These proposed improvements are designed to control the run-off from the upper drainage area of 1,335 square miles above the dam. This control would be effected in three ways: by storing in the reservoir all the run-off during March and April; by storing after May 1 any flow in excess of the 1,000 cu.ft. per second discharged through the control outlet; by storing all the run-off that occurs during any summer period when the run-off from territory below the dam fills the discharge channel.

To drain the reclaimed land on either side of this channel, or the straightened Bois de Sioux River, there would be main ditches practically parallel with the channel and having a fall towards the north. These ditches would serve also to relieve the upper part of the channel from the run-off of the adjacent land, below the dam. Drainage works under the plan proposed would provide outlets for water from 112,370 acres below the dam, this area having at present no adequate outlets. The lake and the Bois de Sioux constitute the drainage outlet for 1,200,000 acres or 1,875 square miles, the drainage from which affects that of the smaller area served by the ditches. Of the 112,370 acres, there are 31,140 acres in Minnesota, 75,160 acres in North Dakota and 6,070 acres in South Dakota. The plans do not include lateral drains in this territory, as it is considered that these should be provided under the drainage laws of the individual states rather than as part of the joint or interstate project.

The total cost is estimated at $1,400,000, the main items being as follows: Earth dam, $107,950; outlet culvert and approach, $93,660; spillway, $66,960; levees at south end of reservoir, $39,970; Bois de Sioux channel, $394,770; ditches $198,900; bridges, $89,260; flowage rights, $284,760. If this cost is assessed against the area of 112,370 acres directly affected, the cost would be $12.50 per acre, which is considered reasonable. But this amount could be reduced by assessing part of the expense against the 1,087,630 acres, which comprise the upper portion of the drainage area of the lake and Bois de Sioux, this portion being affected indirectly by the improvement.

The progress report which has been mentioned, and from which the above information has been compiled, is by P. T. Simons, senior drainage engineer, U. S. Department of Agriculture, who has been in charge of the investigation, assisted by F. V. King and Guy L. Smith, drainage engineers. The report was prepared under the direction of S. H. McCrory, chief of drainage investigations, U. S. Department of Agriculture. Before constructive action can be taken, some form of local organization must be perfected to finance the project and to assume charge of the construction and operation of the works. Interested property owners are making efforts to form such an organization and to secure co-operation in the three states.

Unusual Conditions in Side Launching

A steel river barge was launched at Stillwater, Minn., with a drop of 11 ft. from floor to water surface, in 3 ft. of water. The officials of the Minneapolis Steel & Machinery Co., builder of the barge, expected possible difficulties on account of the shallow depth, but the barge went into the water successfully and received no damage. For launching with a high drop this event is believed to set a record in respect of shallowness of water.

Last year the water in the St. Croix River was exceptionally low and on Sept. 13, when the barge was to be launched, there was less than 2 ft. depth at the end of the ways. A scraper hauled by a line from the derrick and guided by two men wading was used to dredge out a basin, and in addition a few charges of dynamite were set off in front of the groundways to make holes that would provide for the cradles getting clear. Still it was thought possible that the leading bilge would strike the bottom and that the cradles might jam between the barge and the ground and damage the hull when the inshore bilge struck the water. No damage resulted, however, and the barge floated clear after entering the water.

Three Factors Affecting the Construction Industry

THE three factors most vitally affecting the construction industry—transportation, prices and labor—are discussed in a recent issue of the Associated General Contractors' bulletin by W. A. Rogers, president of the association and of the Bates & Rogers Construction Co., Chicago. His views on the stabilization of the construction industry through treatment of these factors are reproduced herewith:

In order that any program of construction may be developed for the coming six months, we must first devise ways and means to (1) adjust transportation conditions; (2) establish sound price levels for construction material; and (3) secure from labor its full efficiency. In direct proportion to the extent to which these questions are settled will

Ultimately, the transportation problem is largely one of rates and control. With adequate rates assured at the earliest possible date, the equipment and facilities of the roads can be maintained in relation to the demands being made upon them; and wages commensurate with the service rendered can be paid. It will take time, however, to repair present equipment, build new rolling stock and increase facilities. Meanwhile, we shall have to adopt some plan of sharing present facilities with other industries in proportion to the need for each. Since rates cannot be shifted like prices, according to supply and demand, some other means must be adopted in apportioning transportation facilities. This means the re-establishment of priorities sooner or later in some form or other. Already this has been started. From present indications, if construction is not to be practically suspended in some sections of the country, construction materials must be given the right of way over other less essential commodities, second only to food and fuel. With inadequate facilities at hand, only by curbing the distribution of luxuries which have jammed our freight houses and made use of cars which should have gone to more essential needs can the present situation be handled and construction proceed.

Sound price levels are fundamentally a matter of publicity, for, with confidence in the justice of present prices restored which would follow full publicity of costs and profits, fear that a slump may be just around the corner will be removed. Then normal buying will be restored by the knowledge that lower prices can only be had as a result of slowly deflating the world's currency and slowly increasing the world's production, processes which will require time to accomplish. Without such knowledge, investors will hesitate to build and banks to finance new projects.

The increased efficiency is mainly to create a new ideal in industry—the ideal of increased production. But such an ideal is of little value without an incentive behind it. During the war patriotism and the spirit of teamwork for a common aim supplied that incentive. If workmen continue to demand increases in wages, shorter hours and decreased production, they may automatically create such an incentive in the competition among themselves for jobs, because of a slowing down in construction. Better, if means could be devised, to increase the efficiency of all construction labor at rates satisfactory to all!

The elimination of restrictions on output is fundamental. Moreover, if some plan could be worked out by which there would be restored the mutual confidence between the contractor and the employee by means of which it would be impressed on both that their interests were identical and that in the long-run decreased production costs the workman as much as it does the employer, then a long step in the right direction will have been taken.

In spite of these things, however, there is one outstanding feature in the present outlook for construction: The need for new public works of all kinds, which are subordinate only to the need for food and fuel. The proportion of these which will be undertaken during the coming six months will depend upon the extent to which we solve the three major problems outlined above.

Notes from Foreign Fields

ENGINEERING SOCIETY ORGANIZATION IN GREAT BRITAIN

BY
E. J. Mehren
EDITOR, ENGINEERING NEWS-RECORD

BECAUSE of the ferment in the organization of engineering societies in the United States the American visitor in Britain naturally inquires what the situation is here. Is there agitation for changes in the older societies? Is there demand for greater activity? Are there efforts to organize for civic and welfare work?

Young men are the same the world over. One must expect everywhere a certain amount of dissatisfaction among them. The older societies here are not free from the criticism that they might be more active. That criticism, however, is not of the same volume as we find in the States, nor does it take on the same degree of asperity.

The older societies, with long traditions and the confidence that comes from a sound policy successfully pursued during many years, are little disturbed by such criticisms, recognizing that youth expects too much and is not always sound in its proposals. That does not mean that older societies are indifferent to the demands of the changing years. In fact, as will be instanced, one of these regarding which I have specifically inquired—the Institution of Civil Engineers—has changes in hand that will increase the service rendered its members.

Among the younger men there is under way at present the organization of a society much on the lines of our American Association of Engineers. It bears the name of the Society of Technical Engineers, and since it was formed to further the welfare of its members, it must, under the British law, be registered as a Trades Union. This does not mean that it has any affiliation with the manual trades unions. In fact it distinctly has no connection with them. It is a trade union merely within the construction of the British law, under which even an association of employers banded together to promote their personal welfare would be considered a trade union.

The mention here of trades unions brings to mind the efforts that the labor leaders in Great Britain made some time ago to bring about an affiliation between labor and the professional classes. Some of the young men of the Sidney Webb school of thought—a socialistic group which has very great influence in England with the labor leaders—called a conference of professional societies in February with the hope and purpose of securing the passage of resolutions definitely allying the professional men with the labor movement. The meeting was held, but as might have been expected from a body truly representative of professional men, the labor leaders were unable to get from the meeting the resolutions they desired. In other words, in a clear and direct test professional organizations have refused to ally themselves with the labor movement. The reason for that is the very same which Morris L. Cooke advanced when he protested against the alliance of the

American Society of Mechanical Engineers with a strictly capitalistic organization, the National Industrial Conference Board, namely, that the engineer, the professional man, must have alliances with neither party, but must be in a position to act as mediator and conciliator between them.

Of the federation of engineering societies here I have heard no talk whatsoever. There is no such body as our Engineering Council, but apparently on important questions the societies appoint special committees for cooperative effort.

NEW MOVEMENTS IN THE INSTITUTION

Mention has been made of internal developments in the Institution of Civil Engineers. First and foremost of these is the discussion now under way looking to the registration of engineers. As readers of *Engineering News-Record* know, the members of the Institution by letter ballot indicated their approval of the proposal to have introduced in Parliament a registration bill. Accordingly a measure was drawn up and submitted for discussion to the leading engineering institutions. There was much criticism among the smaller societies, mainly because these smaller bodies objected to the Institution being the sole body to determine what were the proper qualifications for an engineer. Members of other institutions to whom I have talked, while feeling that there should be a joint body to lay down the qualifications, admitted freely that the Institution of Civil Engineers was the only body in Great Britain which could take the leadership in furthering a registration bill.

For the present the matter is in abeyance, due to the inability of Parliament to consider at this session any but the most pressing national measures. Representatives of the leading engineering institutions are conferring on the preliminary draft, insuring vigorous and harmonious effort when the Parliamentary machinery will permit of the introduction of the measure.

It should be made perfectly clear for the information of our people that this is in no sense a licensing bill. Its purpose is not to say who shall practice the profession of engineering, but merely to protect the title, Civil Engineer. In other words, one may practice engineering, should this measure as planned by the institutions prevail whether he be registered or not, but without such registration he may not designate himself as a Civil Engineer. Dr. Tudsbery expressed the view that it would be improper for the Institution to ask for restrictive legislation. If the Government, in the interest of the public, should think it necessary to prohibit anyone from practising engineering until he had been licensed, it would be for the Government to assume the initiative. This is a far more conservative position than has been assumed by those engineers in the United States who have promoted licensing laws.

It is particularly important that this matter be correctly understood in the United States. At one of the meetings of the New York Section of the American Society of Civil Engineers it was definitely stated that the Institution's proposed bill would prohibit American engineers from practising in Great Britain. On the authority of Dr. Tudsbery himself, I am able to state positively that such would not be the case. If, however, a registration bill along the lines under discussion should prevail an American could not use the designation, Civil Engineer, unless he qualified and was properly registered.

Of the other new activities of the Institution that of expanding its present local students branches into general branches has resemblance to developments in the United States. Thus far the Institution has had only student branches. From now on members in any grade will be admitted to the branch organization, but the subsidy from headquarters will be confined to the junior part of the branch membership. The older members will have to finance that part of the activities which is due to their own participation.

Another development which will have interest for us is the arrangements soon to be put into effect by which the great library of the Institution will become a loan library. Until now it has been a reference library, and books could not be borrowed. Henceforth, a member may borrow any of the volumes, thus removing the criticism that the most valuable asset of the Institution was not of service to the members at a distance.

From what has been said therefore, it will be apparent that the Institution has a forward looking point of view, that it is intent on increasing its service to its members.

The Institution, however, like our American Society of Civil Engineers, believe that its best service to its members can be rendered only by steadfast adherence to its technical purposes. So strongly is that felt that when it became apparent some years ago that there was need for what we would call an "employment bureau," some of the leading members of the Institution formed an independent organization, known as the Civil Engineers' Appointment Board, feeling that it would be an erroneous step for the Institution to depart from its technical functions and go into employment work. The Board is supported almost entirely from the fees paid by those who secure positions, but the Institution gladly donates certain clerical services, while Dr. Tudsbery in a private capacity and not as Secretary of the Institution, holds membership in the board. The board maintains its own offices a short distance from the Institution's home and in every way maintains its separate identity.

This arrangement indicates that the leading engineers of Great Britain are alive to the demands that may arise, and when they deem them sound are ready to erect separate organizations for them if the activities go beyond what they believe to be the proper scope of the Institution. Obviously their judgment as to what is sound will not agree with that of all engineers, particularly of the restless men in the younger group—but have we not ourselves worked to the conclusion that for men of many minds there must be different organizations?

London, May 21.

Will Try Concrete Parapets on Elevated Railway Stations

Four station platforms in Frankford, of the new Frankford elevated line built by the city of Philadelphia, have a concrete parapet or railing. This is lower in cost than steel inclosure, and will not need painting. H. H. Quimby, chief engineer of the Department of City Transit, states in his 1919 report, just issued, that these concrete parapets are considered somewhat of an experiment, and their performance will be compared with that of the steel parapets on the other platforms.

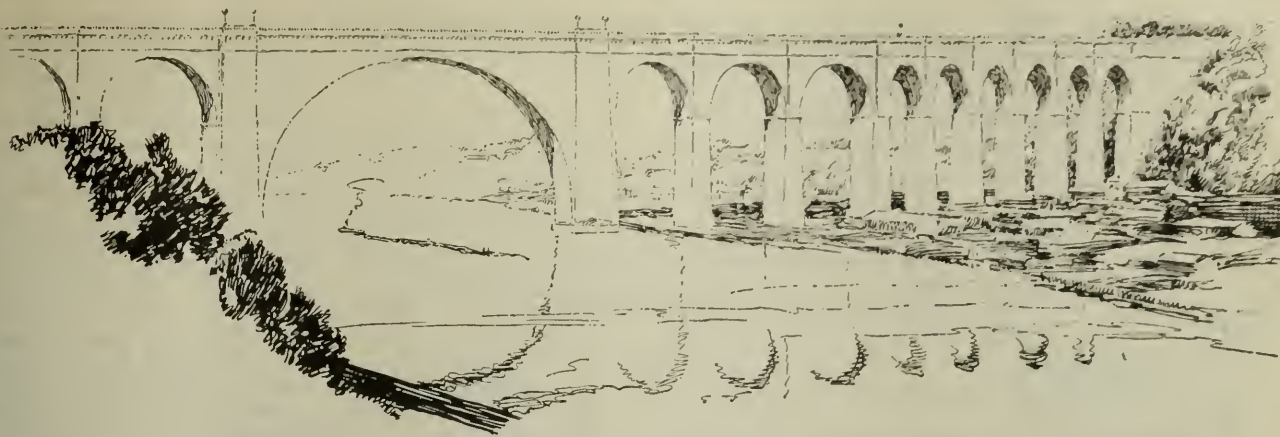


FIG. 1. SKETCH VIEW OF HIGH BRIDGE WITH RECONSTRUCTED RIVER CROSSING AS PROPOSED BY WILGUS COMMITTEE

Suggested Plan for Reconstructing Aqueduct High Bridge

Consulting Engineers' and Architects' Societies Join in Plan to Save Aqueduct Bridge Built by J. B. Jervis

DEMAND has been made by the U. S. War Department that the river piers of High Bridge, the crossing of the first Croton aqueduct over the Harlem River at New York, be removed in the interest of navigation. Out of this situation there has now developed a project for reconstructing the bridge by building a single large span to cross the river, and so avoiding its demolition. The American Institute of Consulting Engineers and the New York Chapter of the American Institute of Architects joined in working out the project and bringing it to the attention of the city authorities. As representative of the joint committee of the two societies, Col. W. J. Wilgus calls on engineers for support of the movement to save the bridge not only because of its value as a reserve conduit in the aqueduct system of New York City, but also because of the historical importance of the structure as one of the great engineering works of an early period of American engineering and as one of the prominent works of John B. Jervis, railroad builder and chief engineer of the Croton Aqueduct Commission, one of the pioneers of American civil engineering.

A perspective sketch of the bridge as it would appear after the proposed reconstruction is reproduced in Fig. 1 herewith. The existing spans are semicircular arches of 80 ft. in the clear. The reconstruction according to the committee's plan would substitute a single 231-ft. span of semi-elliptic form for three of the present spans. Enough of the structural problem has been worked out to make it possible to outline the general procedure to be followed in the reconstruction, and to enable cost estimates to be made. The large arch is to be carried on foundations that in appearance are extensions of the existing pier foundations, but actually are independent of them, so that settlement of the new part will not injure the old work. The additional pier masonry also is separated from the old masonry by a vertical slip joint with regard for possible settlement. As indicated in the drawing, Fig. 2, a horizontal concrete strut below ground level would anchor the abutment pier on the Manhattan or west bank, which stands on piles, to the rock of the adjacent hillside.

When the War Department made its demand for removal of the river piers of High Bridge, six months or more ago, complete removal of the bridge was advocated by the city's Department of Plant and Structures, which has charge of bridges, while on the other hand the

FIG. 3. HIGH BRIDGE AS ORIGINALLY CONSTRUCTED AND AS IT APPEARS TODAY

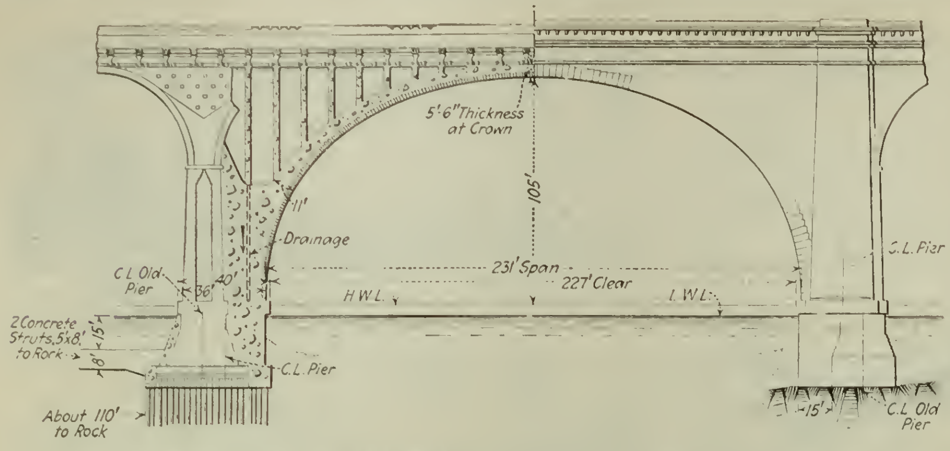


FIG. 2. CONSTRUCTION OF LARGE ARCH FOR HIGH BRIDGE CROSSING OVER HARLEM RIVER

Department of Water Supply urged that the structure be preserved for its value as an emergency reserve to supplement the tunnel crossing of the aqueduct under the Harlem River. To meet the latter demand E. A. Byrne, chief engineer of the Department of Plant and Structures, proposed a method of reconstruction which involved removal of alternate piers and replacement of successive pairs of arches by steel plate-girder spans masked by a masonry shell in the shape of a flat arch.

At this time a group of members of the American Institute of Consulting Engineers, headed by Colonel Wilgus, interested themselves in the matter with the object not only of preventing the demolition of the famous old bridge but also of maintaining its structural and esthetic character as nearly unchanged as possible. Through action of this group, a committee of the Institute was appointed to study the problem and recommend a solution, made up of Colonel Wilgus (ch.), C. W. Leavitt, Ralph Modjeski, and Allen Hazen. Because of the esthetic phase of the matter and the importance of applying trained perception of form to the rather difficult task of combining new and old parts of a structure of different proportions in a harmonious way, the committee secured the co-operation of a committee of the New York Chapter, American Institute of Architects, comprising Henry Bacon, A. W. Brunner, and Ernest Flagg. The project shown by the illustration herewith is the result of the joint work of these committees aided by C. E. Chase of Mr. Modjeski's office. It has been laid before the Finance Committee of the city's Board of Estimate.

At present the bridge has a width of only 21 ft. There is opportunity for widening it slightly by providing a slab roadway deck overhanging the sides of the arch and supported by brackets. This would enable the bridge to be utilized as an automobile roadway between Manhattan and Bronx boroughs. The traffic value of the bridge as well as its historical importance is touched upon in the following extract from the memorandum accompanying the plans when they were submitted to the Board of Estimate:

High Bridge from the utilitarian standpoint serves the purpose not only of safeguarding the city's water supply but also of a means of connection for pedestrians between Manhattan and the Bronx, and as such is an important adjunct to High Bridge Park. Moreover, it offers promise of ultimately becoming an important thoroughfare for automobiles between the two boroughs through a slight modification of the top of the viaduct so as to serve both vehicles and pedestrians. As there is a distance of over a mile without a street connection between the two boroughs from the Macomb's Dam Bridge at 155th St. to the Washington Bridge, at 181st St., it will be seen that this possibility of utilizing the High Bridge viaduct as an intermediate street connection is a weighty argument in favor of the retention of the structure, especially when the inconsiderable expense of so doing is contrasted with the contemplated expenditure by the states of New York and New Jersey of some $14,000,000 for a roadway of no greater width from lower Manhattan to Jersey City.

However, it is not only from a utilitarian standpoint that this structure should be considered. In an historic sense it is one of the city's most striking monuments in marking the inauguration three-quarters of a century ago of the Croton water supply, and, second, in honoring the memory of one of America's most famous engineers, J. B. Jervis, who was the constructive genius of the Erie Canal, the Croton water supply, and the Hudson River R.R., three public works that have had so much to do with the prosperity of this city.

From an artistic standpoint it would seem that every effort should be made to preserve this structure, which is one of the few examples of esthetic engineering in America. Its design places it in the same class as the famous Roman aqueducts, the remains of which are among the chief attractions of the Old World.

It is estimated that at present prices the cost of carrying out the project here shown would be $830,000. Demolition of the bridge would cost $500,000. Reconstruction of the river portion by removal of alternate piers and substitution of masked plate-girder spans for pairs of the present spans would be intermediate in cost between the two. The plans for a single span arch as shown has been approved by the U. S. Engineer Officer of the New York District, Colonel Edward Burr, as being satisfactory from the standpoint of navigation.

Poor Policy To Boast of Low Engineering Costs

The following extracts are from a paper "Some Problems of the Practising Engineer," by John W. Cunningham, presented June 4 before the Oregon Chapter of the American Association of Engineers:

Engineers have unwittingly worked against their own interests by quoting and in fact boasting of low engineering costs for work done under their direction. While those costs may have been the result of efficiency, they also may have been governed by several other factors, and equal credit might have been secured in other ways, by pointing to the excellence of the design and construction and to low total cost.

The legal and medical professions have long ago learned that it was poor policy to emphasize the low cost of their services. A lawyer will point with pride to difficult cases won, but does not say how cheaply they were handled. Similarly, in the medical profession, the only individuals who publicly advertise the inexpensiveness of their work are those so-called "specialists" who are in fact unscrupulous quacks and are condemned as unethical by the rest of the profession. It is perhaps through unwise advertising by engineers themselves that the public has become accustomed to thinking that engineering costs should average about 5 per cent without regard to their character.

Letters to the Editor

Gasoline Tax Fairest, Says H. G. Shirley

Sir—I read Mr. Mehren's article on p. 4 of the July 1 issue of *Engineering News-Record* with a great deal of interest. I noted carefully the recommendation for the abandonment of the gasoline tax by the road authorities of Great Britain. Personally, I think the fairest tax that can be levied is a gasoline tax, for the man that uses the road the most pays the most, and this looks equitable and fair.

The question as to the method of levying this tax is one that presents quite a number of problems and has greatly deterred putting into effect such a tax in this country. I am firmly convinced that the taxes such as privilege tax, license tax, property tax, and now resignation tax on motor cars should be eliminated and there should be one flat tax to cover the entire field. I feel that a proper gasoline tax would greatly simplify the entire matter and relieve the motor vehicle owners and users of much worry and trouble they are put to unnecessarily in the judgment of the writer. We are suffering very much in this country for the want of a uniform vehicle law and a uniform vehicle tax. I feel that if it is not worked out on a gasoline consumption basis it should be worked out on some logical basis, and that one tax should suffice and be of such amount as would properly provide for the maintenance of the highways.

H. G. Shirley,
Washington, D. C. Secretary, Federal Highway Council.

New York City's Growth

Sir—The editorial note in your issue of June 10 entitled, "The Largest City," seems to be written from the wrong viewpoint. Increasing the population of New York and other large cities parallels the decrease in population in the rural communities. It seems to me that the unprecedented gain for a decade in city population is more a matter for grave concern than applause. What will it profit the country to boast of the largest city in the world, when we have such a large untenanted farm land area, so vital to the immediate and future subsistence and welfare of the nation? With vast farm land areas going unplanted, and with millions of fertile acres without crops, there may be very little consolation in the remarkable increase in New York and other city population.

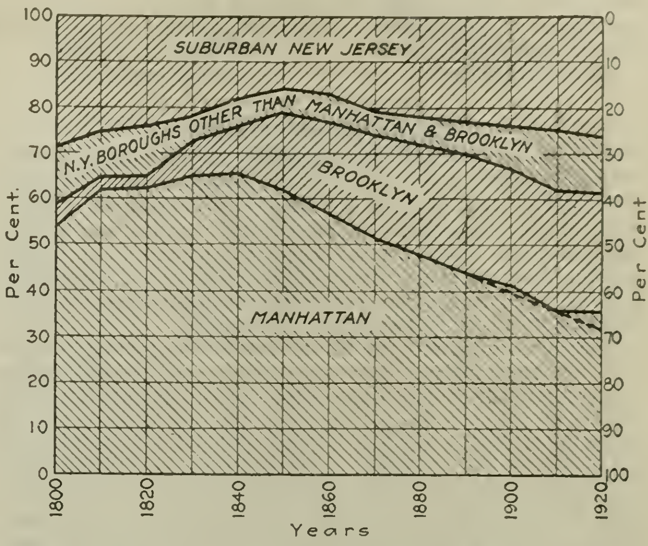
G. E. Warren,
Chicago. Manager.

[The sole intent of our note was to show New York's present rank in population. The flow of rural population to the cities and its effect upon agricultural production is another story. Doubtless a large percentage of New York's 854,000 increase in population came from cities large and small rather than from farms.—Editor.]

Sir—Referring to the comment and surprise indicated in the public press over the population of New York City, and its constituent boroughs, as announced by the Director of the Census, there need be no surprise as the announced figures indicate what has long been predicted by students of the movement of population in cities. Claims that the census figures must be wrong are freely made. While there probably may be errors, these are not likely to be of sufficient magnitude materially to affect the ultimate result.

The accompanying diagram indicates the relative percentage of population in the area occupied by the present boroughs of the city, and in the corresponding tributary communities in New Jersey from 1800 to 1920. This diagram (up to 1910) first appeared in a paper on "City Passenger Transportation in the United States" presented by the undersigned to the Institution of Civil Engineers in 1913.

A study of this diagram indicates that the relative population of Manhattan increased up to 1840 and since then has steadily been decreasing. In fact, if it had not been for the war retarding the normal development of the city the relative population of Manhattan would have been still less, as indicated by the dotted line in the diagram.



RELATIVE PERCENTAGE OF POPULATION OF GREATER NEW YORK AND SUBURBAN NEW JERSEY
Based on the United States Census

A quotation from the paper above referred to follows:

"In the early days the city was confined to the lower end of the Island of Manhattan, now also the Borough of Manhattan, and the growth was northward within the limits of the island. From 1800 to 1850 between 55 and 65 per cent of the population of what may be called the Metropolitan District of New York was confined to the Island of Manhattan. With the development of steam-propelled ferries in the third decade of the nineteenth century the growth of Brooklyn and the towns in New Jersey was much more rapid than that of the central city, so that at the present time only about 35 per cent of the population of the greater city is in Manhattan. This is indicated graphically in the accompanying diagram, and if the tendencies indicated by the curves in this diagram are continued in the future, the Borough of Manhattan will soon cease to lead the others in population and will become a social, commercial, shopping, and amusement center, with a relatively small sleeping population. This tendency is not confined to New York but is characteristic of most modern cities, in which the central area is decreasing in population as the transportation facilities are improved; the tendency being for the city to segregate into areas devoted almost exclusively to commerce, amusement, manufacturing and residence. The census of 1910 indicated that four of the central wards of Manhattan, and five wards in Brooklyn, had lost population in business and manufacturing districts. On the other hand, of the increase of 483,000 in the population of Manhattan in the preceding ten years, 330,000, or 68 per cent, was confined to a single ward in the north end where improved transportation facilities have been provided; and, further, while the population of the city as a whole had increased 39 per cent in that decade, the population of the borough of Bronx had increased 115 per cent in the same period, owing to the extention of the subway."

Engineers who have been studying city planning and transportation have been looking forward to the time when most of the city population will work in the central areas but live in garden communities in the suburbs, which will be a great improvement from the medieval city conditions of living over one's shop, from which we are emerging.

This transition has been checked by the post-war conditions, making it impossible at present to continue the construction of transit facilities, but sooner or later, city development will be adjusted to these new conditions and

the construction of transit facilities and the centrifugal movement of population be resumed to the increased comfort and advantage of all.

GEORGE D. SNYDER, Consulting Engineer.
New York City.

Free Engineering Advice

Sir—To assume the attitude taken in the column headed "Free Engineering Advice" in the *Engineering News-Record*, July 1, 1920, p. 21, is to take a very narrow view of the engineering profession. Disinterested engineering advice such as comes from the investigations of the U. S. Reclamation Service, the Bureau of Standards, the Geological Survey, etc., and from the research laboratories of the nation's universities should be encouraged.

The same is true of the researches of the manufacturers who are constantly endeavoring to improve as well as to sell their product. To oppose the free distribution of the results of these investigations, just because some one may be losing a fee, is to take a labor union view; is to offer poor recognition of merit; is to discourage a service par excellence. Where would the engineering profession be without its researches in science? What private firm could afford to make the thorough and extensive geological and hydrometric surveys as carried out by the Government? What individual drainage district could or would make an extensive, thorough, and comprehensive study of the entire stream extending through several states?

Moved by a sordid spirit, perhaps one might feel that the broadcast distribution of engineering facts and data would curtail his business. But in engineering as in any other business, the more publicity, the more propaganda, the better. There is no more danger of losing a fee through the distribution of a Government bulletin, or a steel handbook, than there is through the sale of the engineering journals at the newsstands. Until the layman has seen a few samples of real engineering and until he realizes what risks he may be taking without the services of an engineer does he even think about an engineer? In fact, the average farmer on a drainage district, say, doesn't even know why he needs an engineer until he gets interested in a few Government bulletins.

Jackson, Mich. WILBERT BERNHARDT.

What Canal Freight Carriage Costs the People of New York State

Sir—The following reports for the year ended June 30, 1918, contain considerable data that is of interest in connection with the question as to whether the New York State Barge Canal will prove to be an economic success: Report of the Comptroller, Report of the Comptroller on the Expenditures of the Canals, Report of the State Superintendent of Public Works for both 1918 and 1919.

Figures given in the tabulations on p. 342 to 346 inclusive in the first mentioned report, and on p. 131 of the second report show that from 1905, when work on the enlarged canal was begun, to 1918 inclusive, the total cost for bond charges, maintenance and operation was $111,472,796.26; deducting $13,270,196.66 for interest received on bank deposits makes the net cost of the entire canal system but not including construction, for that period $98,202,599.60, while the tonnage carried was 35,743,270 tons, making the average cost per ton to the taxpayers of the state $2.75.

From the same tabulations it can be shown that it cost the state $11.50 per ton for the 1,159,270 tons carried in the fiscal year ending June 30, 1918.

Even if the Erie Canal had carried the 10,000,000 tons which the State Engineer said it could carry, and in addition the 491,896 tons, which the branch canals carried, the cost per ton for the year would have been $1.28.

Now, even if the canal had prevented said rates from being materially higher, which Mr. Wotherspoon, the then Superintendent of Public Works, said the canal would do, and which did not prevent them from being 40 per cent higher than the canal rates, would not $1.28 per ton, be a pretty large price to pay for that result, to say nothing of the $11.50, which it actually cost for the tonnage transported in 1918?

According to figures given in *Engineering News-Record*, Feb. 20, 1920, and April 24, 1919, the national Government expended $4,091,800 for equipment for the New York Canal.

In connection with this large expenditure for equipment by the national Government, the following extracts from the 1918 Report of the Superintendent of Public Works are pertinent to the question of whether the canal will prove to be an economic success.

On p. 19: "Before the Federal Government took hold, the field was carefully investigated by the National Committee on Inland Waterways, and while several companies at that time claimed a corporate existence, none were ready to actually engage in business without considerable financial aid from the government.
* * *

On p. 20: "No undertaking dependent largely on governmental aid can be permanently successful. It is therefore of the utmost importance to the future of the canal, that freight carrying companies should soon be in operation. * * *

On p. 21: "The ultimate success of the improved system depends entirely on whether energetic and able men, with sufficient capital at their disposal will enter the field. * * * Surely a sufficient number of enterprising citizens, who recognizing the opportunities for a profitable undertaking, will take advantage of them."

The writer believes that when Mr. Wotherspoon refers to the ultimate success of the canal he means an economic success, but as the new and enlarged Erie Canal and branches has been paid for by the State of New York, and as the national Government found it necessary to extend financial aid of more than $4,000,000 for equipment, was it not because "energetic and able men with sufficient capital at their disposal" had not entered the field to any great extent, and does it not therefore follow, according to Mr. Wotherspoon's statement above quoted, that the Erie Canal, even with the large amount of aid extended by both state and national Government, has not and never will be permanently or even temporarily an economic success?

It seems to the writer that Mr. Wotherspoon answered this question affirmatively, when he said in his report quoted above, "No undertaking dependent largely on Governmental aid can be permanently successful."

That energetic and able men have not entered the field to any great extent is shown by the following statement made by Edward S. Walsh, the present Superintendent of Public Works, in his report for the year ending June 30, 1919:

Except for a few so-called "new" type barges the boats in service were the old Erie Canal or "240-ton" type which were operated by their individual owners.

During the navigation season of 1919, under somewhat unfavorable conditions as the type of boats used were not designed for Barge Canal navigation, conclusive evidence of abnormally low cost of transportation on the improved canal was revealed, a steamer and consort carrying cargo for New York to Buffalo accomplished the trip in a little more than four days at an operating cost of 1.21 mills per ton mile. The cargo paid a rate of $1.50 per ton, thus the net earning of the trip was more than $1 per ton.

There can be no question as to the ability of the canal transportation companies to earn a handsome profit.

Mr. Walsh evidently means a handsome profit to the boat owner, which is possible because the taxpayers bear all operating costs and bond charges. Now, what would these items amount to for the trip from New York to Buffalo?

The writer has not the data for 1919, but if the trip had been made in 1918, the reports of the Comptroller and Superintendent of Public Works for that year contain sufficient data to determine what the cost to the taxpayers would have been. The first mentioned report on p. 11 gives the total canal boat mileage as 576,731 miles, and the second report shows that the net cost of the canal to the taxpayers was $13,333,943.

By dividing this last sum by 576,731, it will be found that the average cost per boat mile would have been $23.22 if the trip had been made in 1918 instead of 1919.

As the distance by the canal from Albany to Buffalo is 363 miles, the total cost of the trip to the taxpayers would have been $23.22 × 363, or $8,428.66.

It seems to the writer that this trip, which Mr. Walsh gives as evidence of "the ability of canal transportation companies to earn a handsome profit" and "of the abnormally low cost of transportation" was possible only because of the large part of the cost paid by the taxpayers.

The writer would like to have some advocate of the canal transportation explain how, taking into consideration the figures given above, the Barge Canal and branches can prove to be an economic success.

Pittsburgh, Pa. W. G. WILKINS.

HINTS FOR THE CONTRACTOR

Stocking Stone With Conveyor Loader

By Henry H. Wilson
Resident Managing Partner, Winston & Co., Muncy, Pa.

IN THE construction of state highways at Muncy and Picture Rocks, Pa., it was necessary, on account of the uncertainty of future shipments, to stock crushed stone in advance of the laying of concrete pavement. For this purpose a conveyor loader, supported on a cribbing of railroad ties was used, as shown in the accompanying illustration. About thirty cars were stocked at each of the above-mentioned places, the stone being handled direct from elevator to stockpile at a very reasonable cost. With an elevator, it was possible to stock as high as 50 tons per hour by this method. By moving the discharge end of the loader radially it would have been possible to stock a much larger amount than was actually handled.

FIFTY TONS STONE PER HOUR HANDLED BY METHOD SHOWN

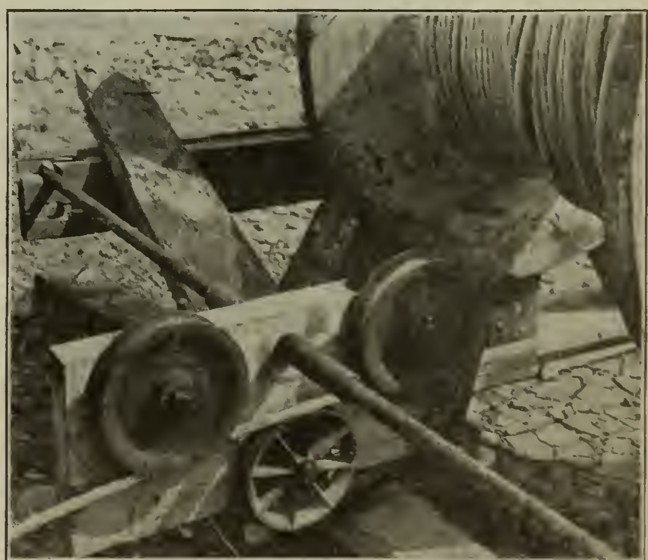
Questions Which the Drilling Boss Should Ask Regularly

EFFICIENT superintendence of rock drilling operations requires constant and systematic interrogation by the superintendent or foreman who is directing the work. Based on mining experience, a list of questions is given by Edwin H. Higgings in the *Engineering and Mining Journal* of June 26, 1920, as follows:

(1) Are the drills of suitable type for the ground? (2) Is the drill equipment standardized as far as possible? (3) Are facilities for drill repair so systematized that it is unnecessary for the men to go to surface to secure parts or to have repairs made; (4) As a preventive of lost time, are the men at the face well supplied with gaskets for drill connections, good wedges and foot blocks, oil cans or cadgers and a box for the storage of tools and extras? (5) Are a few extra water tubes kept on every working level? (6) As a time saver, have the men tried carrying with them an ordinary hat pin for dislodging obstructions in the water tube? (7) Is the jackscrew nut (of the column bar) supplied with grease at intervals? (8) Is 1-in. air hose used with Turbo, Leyner and DR-6 machines? ($\frac{3}{4}$-in. hose is too small). (9) Are $3\frac{1}{2}$-in. columns used with modern water-hammer drills? The old 4-in. or $4\frac{1}{2}$-in. bars should be discarded on account of their weight. (10) Do the men realize the importance of properly lubricating machine drills? (Grease for the chuck end and castor oil or liquid grease for the rear lubricators). (11) Is it realized that for $1\frac{1}{4}$-in. round hollow steel the shank length should be $3\frac{13}{16}$ in., and for $\frac{7}{8}$- and 1-in. hexagon steel the shank length should be $3\frac{1}{4}$ in.? The water-hammer drill of today has a short piston travel. Hence, when lugs or collars become badly worn they allow the steel to enter the machine too far, thereby "short-stroking" the hammer. Likewise, when the end of the shank becomes worn shorter through constant use it does not enter the machine the proper distance and the hammer cannot deliver its full blow. In both cases efficiency is greatly impaired. Hammers and anvil blocks will soon be destroyed if the bearing surface of the shank end of the drill is allowed to become badly battered or chipped. (12) Are the side rods on the machines kept uniformly tight? (3) Is improvement possible in the number, pointing or depth of drill holes? (14) Is sufficient air pressure maintained at the drill? (15) Is there undue breakage of drill steel? (16) Is the proper type of bit being used for ground drills? (17) Are the sharpening and tempering satisfactorily done? (18) Is there a man especially qualified to repair drills?

Home-Made Device Removes Reel Kinks From Wire Rope

REEL kinks are being successfully removed by the simple device illustrated, in preparing wire rope for concrete block revetment at vulnerable places on the improved Miami River channel at Dayton, Ohio. This rope, cut to lengths of 20 ft. or more, has to be threaded through holes in precast concrete blocks and it is important that it shall lie straight to facilitate the threading operation. As indicated by the illustration the reel of rope is suspended on an axle on a timber frame so as to unwind from the bottom. In front of the reel three pulleys attached to an axled plank, as



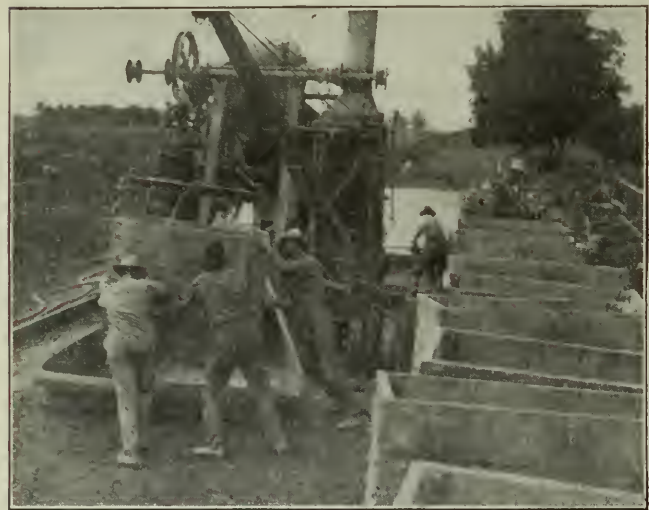
WIRE ROPE STRAIGHTENED BY THREE PULLEYS STAGGERED

shown, constitute the straightening device. The entire arrangement, fashioned of material on the job by Price Bros., Dayton, Ohio., contractors, cost very little and has served its purpose excellently. The Dayton channel improvements are a part of the flood protection works of the Miami Conservancy District.

Paver Places a Batch of Minute-Mix Every 75 Seconds

SYNCHRONIZED mixer operation was an important factor in securing an unusually high rate of speed in building concrete road near Oliver, Ill. The complete cycle of mixer operations, charging, mixing 1 min., and discharging, averaged between 1 min. 10 sec. and 1 min. 12 sec. A length of 744 ft. of 16-ft. road, 8 in. thick was constructed according to the specifications of the Illinois Division of Highways in 9½ consecutive hours. A four-bag batch with a ¾-cu.yd. Smith paver was employed. It is to be noted that the output given is the high rate for a day and not an average speed.

The action of the mixer was so synchronized that the discharging time exceeded the skip raising time by about one second. This means that the operator began to raise the skip at the same time he pulled the discharge lever and the drum was completely emptied by the time the skip was fully raised. It was this fact, principally with the perfect co-ordination of the supply crew, that made possible the record.



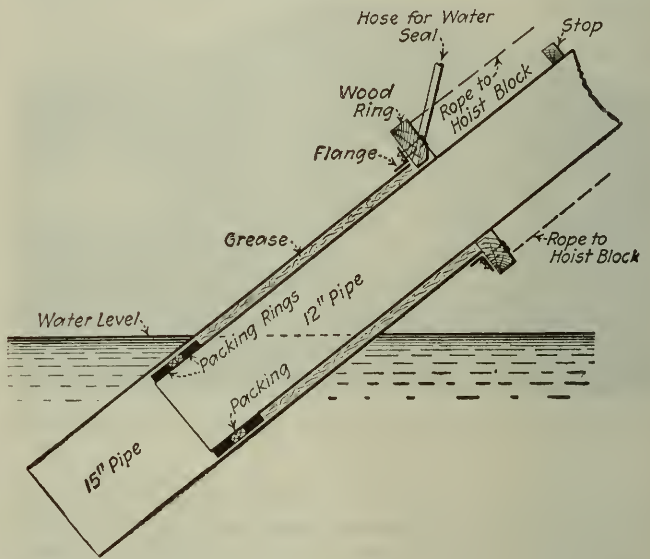
BATCH-BOX SWING TIMED EXACTLY WITH LOWERING OF SKIP

Another fact that contributed materially toward the record was the ease with which the batch boxes were handled. The derrick operated on the same cable as the skip and as the loaded skip was raised the derrick lowered and was hooked onto a loaded batch-box. While the skip was being lowered the batch-box full of material was being raised and swung into position, so that by the time the skip reached the ground this batch was ready to be dumped into it. This allowed ample time, while the material in the drum was being mixed, to spot the batch-box cars in position for the next batch.

The mixer was supplied by two gasoline locomotives each pulling ten cars, or twenty batches, with a run of slightly over a mile. At no time during the day was there any delay in waiting for the train to pull into position. During the 9½ hours that the mixer ran, 22 train loads, carrying 440 batches, were used. The entire crew was 35 men, including the men at the material bins, the cement house, on the industrial railroad, on the grading and sub-grade, at the mixer, and on the tamper. The contractor was Allen J. Parrish, Paris, Ill.

Slip-Pipe Suction Reduces Liability of Choking

TENDENCY to choke at the suction, in pumping from a sump to construct the hydraulic-fill dam at Lockington for the Miami valley flood protection work, was greatly decreased by a slip-pipe arrangement devised on the job and illustrated by the accompanying diagram. At this dam material from the borrow pit is sluiced to the sump and occasionally there is a rush of solids into the sump which, for a few minutes, is beyond the capacity of the pump to handle and the sump is filled. In such instances the 12-in. suction pipe is liable to choke and become plugged. This means a shut down and much disagreeable work to clean out the plug. With the slip-pipe arrangement improvised, when the sump begins to fill the operator, by means of the hoist blocks, pulls the 15-in. pipe up out of the accumulation of solids and keeps it clear until the delivery from the sluice slacks down. Then the slip-pipe is eased back until the sump is cleared and solid material is being delivered in normal volume by the sluices. It is found that since the slip-pipe has been used delays due to plugged suction pipes have been materially reduced. The Lockington dam is a unit in the flood protection works being constructed by the Miami Conservancy District.



SUCTION PIPE ARRANGEMENT FOR DREDGE PUMP

Arthur E. Morgan is chief engineer, Chas. H. Paul, assistant chief engineer and C. H. Locher, construction manager respectively, of the Miami Conservancy District. Barton M. Jones is the division engineer at Lockington Dam.

City Planning Commission at Los Angeles

A City Planning Commission of 51 men and women has been created by the City Council of Los Angeles.

NEWS OF THE WEEK

New York, July 29, 1920

Discuss St. Lawrence Waterway Project

Oratory Loses in Contest with Consideration of Economic Facts on $750,000,000 Improvement

(Reported for Engineering News-Record by Dr. F. H. Newell)

An encouraging sign of the times is that a waterways congress has been held and governmental appropriation urged for a project on its engineering and economic merits. This is in strong contrast with the so-called "pork barrel" claims from the localities where the appropriations were to be expended under old-time River and Harbor Acts.

The president of the Great Lakes-St. Lawrence Tidewater Association, H. C. Gardner, is an engineer; the program for the meeting in Detroit in cooperation with the Board of Commerce, held July 21-24, was arranged largely by engineers and participated in by economists, not, of course, to the exclusion of the politicians, but to a degree sufficient to afford real information concerning the merits of the scheme.

The object of the meeting was largely educational, to attract public attention and to diffuse information concerning the importance and practicability of providing a waterway or channel in the St. Lawrence River such as to permit ocean-going vessels to come up into the Great Lakes.

This enterprise has been commented upon favorably by Charles Whiting Baker, in his series of articles in *Engineering News-Record*, January 1 to 29, 1920. The papers and discussions at Detroit amplified many of the points concisely stated by Mr. Baker and brought out clearly the fact that while this great international enterprise is one which should be undertaken jointly by Canada and the United States, yet it has sufficient merit to justify the assertion that private capital can be found adequate to build the hydro electric works and at the same time provide for navigation needs.

The belief is strong, however, that this great undertaking, involving both navigation and power development and which, as described by Gardner S. Williams, may cost upward of $750,000,000, should not be left wholly to private enterprise, but should be initiated and financed in larger part the two governments concerned.

Definite engineering data on the alternative projects and costs were not available at the time of the meeting, because of the fact that the International Joint Commission, having the

(Continued on p. 237)

Railway Engineers Not Included in Labor Board's Award

Assistant engineers and draftsmen in railway service were not granted an increase in compensation under the Railway Labor Board's award of July 20. A bulletin of the American Association of Engineers quotes this statement from the Board: "Civil engineers as such had no submission presented for them and hence no question as to them has been decided." Several railway sections of the A. A. E. have initiated negotiations with the railway managements for salary adjustments and if these fail to produce satisfactory results the association will appeal to the Labor Board for a hearing.

New Financial Basis for Chapters of A. A. E.

An order promulgated as of Aug. 1 by the board of directors of the American Association of Engineers and effective Sept. 1, provides for a new percentage of income allotted to the chapters of the association. Chapters with 600 or more members will receive 60 per cent of the entrance fees and dues received from members of the association residing in their respective territories. Such chapters will constitute one of four classes into which chapters are to be divided on the basis of membership and assumption of duties. This class of chapters will handle employment service, qualification committee work, and other local activities. They will maintain offices and paid staffs.

Chapters comprising the other three groups will receive a percentage of income carrying from 50 per cent to 35 per cent, depending upon the size and duties assumed. Chapters with from 350 to 600 members will get 50 per cent and will maintain offices with paid secretaries or managers. Chapters with from 100 to 350 members will get 40 per cent of income and will have paid stenographic help. Chapters with less than 100 members will receive 35 per cent of the income and will function on volunteer help only.

This order will be effective unless protested by chapters of the association comprising 1,500 or more members. The same order carries with it an increase of dues for all members except student members to $15 per annum, an advance of $5 over present dues, effective Jan. 1, 1921. It is expected that at least 20 chapters of the association under these provisions will be able to engage full time paid secretaries. In addition to the five district secretaries, the association already has paid employees in several chapters.

Constitutional Amendments at Am. Soc. C. E. Convention

Five Proposals on Dues, Local Sections and Number of Directors To Come Up for Discussion

At the Portland, Ore., convention of the American Society of Civil Engineers, Aug. 10 to 12, five recently proposed constitutional amendments are to be discussed. They deal with matters that have been very active in society circles, including local sections and the allocation of all members to such sections; the election of directors by the members resident in the respective districts, and the relation of the secretary to the Board of Direction. Increase of membership dues is also proposed. Two minor improvements are proposed in separate amendments.

One of the amendments is presented by the Questionnaire Committee and purports to crystallize into law the opinions on internal affairs expressed by the membership of the society in the questionnaire held in March and April of the current year. R. H. Humphrey, member of the Development Committee and later chairman of the Joint Conference Committee, is among the signers of another amendment, closely similar to the Questionnaire Committee amendment but differing in some vital details.

According to the requirements of the constitution, the amendments must be submitted to letter ballot of the membership as amended by the convention or (if not amended) in their original form. However, in case the convention refers an amendment to a special committee, action is deferred until the annual meeting in January, at which the committee must submit its report. The five amendments, arranged in the order as printed by the society (this being according to date of receipt at the secretary's office), are summarized in the following:

A—Percival Clow, C. E. Haywood, W. S. St. John, W. J. Heiser and A. W. A. Eden propose increasing the annual dues for all members to the amount now paid by resident members (corporate members $25, associates $15, juniors $15), and striking out the present provision for additional dues to be paid by resident members. Life membership dues are revised.

B—The Committee of the Board of Direction appointed Jan. 22, 1920 (A. N. Talbot, Leonard Metcalf, R. A. Cummings, M. S. Ketchum, John C. Hoyt, C. C. Elwell, Harry Hawgood) to prepare a questionnaire to the membership on the Development Committtee's re-

port and to formulate suitable amendments from the results of the questionnaire, now proposes a change in the annual dues, a change in the statement of the society's objects, establishment of compulsory local sections, and nomination of directors by districts. The committee states that according to legal advice election of directors by districts would not be lawful, as the New York corporation law contemplates that directors shall be elected by the votes of all members.

tor selected by the ballots of the several districts. Voting on this committee is to be in proportion to membership.

C—A modification in the method of electing honorary members is proposed by a committeee appointed by the Board of Direction a year ago to nominate honorary members, this committee consisting of A. N. Talbot, Leonard Metcalf, R. A. Cummings, Arthur P. Davis, George H. Pegram, Fayette S. Curtis, H. S. Crocker, and C. D. Marx. The present constitution requires unan-

What Five Am. Soc. C. E. Amendments Would Accomplish

A. Dues—Abolish the distinction between "resident" members and others by raising the dues for the latter, all dues becoming: for corporate members $25, for associates $15, for juniors $15—[Clow, Haywood, St. John, Heiser, Eden].

B. Objects
Dues
Local Sections
Nominations

(a) Add to objects of the society as a secondary object, co-operation in important public movements. (b) Increase the dues of non-resident corporate members to $20, non-resident associates to $15. (c) Provide for establishment of local sections to comprise the entire membership (member's choice, otherwise assignment). (d) Provide for nomination of directors (18, as at present) by the local sections of the several districts; nomination of other officers by representatives of the districts as chosen by the local sections.—[Talbot, Metcalf, Cummings, Ketchum, Hoyt, Elwell; the Questionnaire Committee named by the Board of Direction last January and instructed to propose amendments corresponding to the result of the questionnaire.]

C. Honorary Members—Change requirement for election of honorary members from unanimous vote of board to vote of two less than whole board. Eliminate provision for change in composition of board when voting on honorary members.—[Talbot, Metcalf, Cummings, Davis, Pegram, Curtis, Crocker, Marx, a committee appointed by the Board of Direction in June, 1919, to nominate candidates for honorary membership.]

D. Eligibility to Office—Make members of the nominating committee ineligible to any other office during their service.—[Lucas, Holland, Gilman, Rumery, Reeves.]

E. Local Sections
Board of Direction
Secretary
Resident Officers
Nominations
Annual Conference

(a) Provide for establishment of local sections to comprise the entire membership (member's choice, otherwise assignment). (b, c) Reduce membership of Board of Direction from 30 to 23, by reducing directors from 18 to 14, past presidents from 5 to 3, and removing secretary from Board. Allot two directors to District 1, and one to each of other twelve districts. (d) Eliminate requirement that one vice-president and six directors must be "resident" members. (e) Provide for nomination of directors by the local sections of the several districts; nomination of other officers by representatives of the districts as chosen by the local sections. (f) Create an annual conference of the representatives of the local sections, which, besides making the nominations for officers, is to consider the welfare of the society and its members and report thereon to the Board of Direction.—[Franklin, Easby, Quimby, Humphrey, Frommer.]

The statement of the object of the society as contained in the present constitution is amplified by adding a secondary object "to co-operate in important economic, industrial, and civic movements in which the members of the society are particularly well qualified to advise the public." Membership dues are to be increased to $20 for corporate members, $15 for associates, and $10 for juniors, and $5 additional for resident corporate and junior members.

One or more local sections are to be established in each of the thirteen districts to "stimulate active interest of their members by giving reasonable representation upon the active committees, by encouragement of discussion of the general problems of the society, by arranging excursions to works of engineering interest, and by promoting social intercourse." Every member must join a section or he will be assigned to one. Each local section chooses a representative for nomination of officers, and the representatives within a given district nominate one or more candidates for director to represent that district, which are then balloted on by the members in the district. Subsequently all the local section representatives meet as a nominating committee and nominate officers for the society for the coming year, including on the ticket the candidates for direc-

imous vote of the Board to elect honorary members, but under the amendment a vote of two less than the full Board will elect.

D—Members of the nominating committee are to be ineligible for other office during their term of service, under an amendment proposed by G. L. Lucas, C. M. Holland, Charles Gilman, R. R. Rumery, and W. F. Reeves.

E—Local sections and nomination of directors are dealt with in a way slightly different from that adopted by the Questionnaire Committee (Amendment B, above), in amendments proposed by B. Franklin, William Easby, Jr., H. H. Quimby, R. L. Humphrey, and Charles Frommer. These also propose to establish an annual conference of representatives of local sections, "to consider the welfare of the society and its members and to report thereon to the Board of Direction." No change in dues is proposed. The representation of District 1 on the Board of Direction would be cut down to two, reducing the number of directors to fourteen, and the number of past presidents on the Board would be reduced from five to three. At the same time the secretary would be removed from the Board, and the Board of Direction thus left with a membership of 23 (at present thirty).

Under these amendments membership in local sections is obligatory. Representatives of the local sections in each district meet as a district board to nominate candidates for directors, selection from among these candidates being by letter ballot of the members within the district. Subsequently the representatives meet in annual conference of representatives of local sections, to nominate officers for the society and to consider the welfare of the society as already noted.

Chicago Bascule in the "Movies"

An opening ceremony for the Chicago River bascule bridge of the St. Charles Air Line R.R. (see *Engineering News-Record* of Dec. 25, 1919, p. 1056) was staged June 23 for the benefit of a moving picture concern, a number of engineers being present. A woman fireman from the engine of the special train of the Illinois Central R.R. drove a so-called "last spike," the director of the scene apparently assuming track work to be part of a fireman's duties. Then the engine proceeded across the bridge, with a woman sitting on the bumper beam to cut a ribbon barrier with a pair of nice large office shears. It may be explained that the bridge has been in service for some time.

Advise Street Cleaning and Refuse Collection by Philadelphia

A change from contract to municipal street cleaning and the collection of garbage, ashes and rubbish at Philadelphia is recommended by a committee of three appointed by Mayor Moore on authorization by the City Council. The committee consisted of E. B. Morden, chief of the Bureau of Street Cleaning; James W. Follin, engineer, Philadelphia Bureau of Municipal Research, and J. H. Neeson, principal assistant engineer, Bureau of Highways. Mr. Neeson recommends postponement of the change to city collection of ashes and rubbish until Jan. 1, 1922, but the others advise that it take effect Jan. 1, 1921. The recommendation for city collection of garbage is conditioned on obtaining bids for disposal separate from collection. The committee advises that bids be invited on or before Aug. 1 for garbage disposal on alternate plans for one- and five-year contracts; also that the Bureau of Street Cleaning be expanded to "include an adequate engineering personnel to study continuously and to plan improvements in methods of doing work, and such other personnel as is requisite to carry on intensive continuous educational and law-enforcement campaign." Garbage disposal by feeding to hogs is favorably mentioned in the report.

Since the report was submitted, Col. Morden has resigned as chief of the Bureau of Street Cleaning and Mr. Neeson has been made acting chief. It is reported that Mayor Moore has advised that bids for street cleaning for the calendar year 1921 be secured before Oct. 1.

Municipal Improvements Meeting at St. Louis Has Local Support

Local engineers, contractors and others interested in making a success of the convention of the American Society for Municipal Improvements at St. Louis, Mo., Oct. 11 to 15, have organized six committees for the purpose, with a plentiful representation of the municipal engineering and other city departments, including W. W. Horner, vice-president of the society and chief of the St. Louis Division of Sewers and Paving. Henry W. Kiel, mayor of St. Louis, has sent out a general call to mayors and municipal officials all over the country to attend this meeting, and it is expected that special conferences will be arranged between mayors of various classes of cities. E. R. Kinsey, president of the Board of Public Service, has sent a similar invitation to over three thousand engineers in various parts of the country.

St. Lawrence Waterway

(Continued from p. 235)

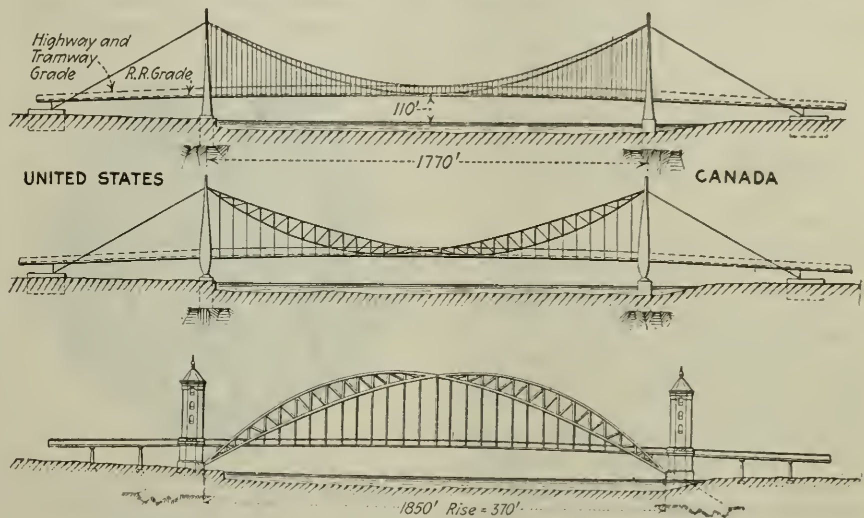
investigation in charge, had not yet received the reports from its engineering staff. There was no doubt expressed, however, by the well informed economists and engineers but that the results would justify any probable cost, also that the waterway thus made available would contribute for all time to the prosperity of the cities along these great inland seas. With a deep channel and with dams and locks overcoming the difficulties in the St. Lawrence River, increasing the navigable depth from 14 to 26 ft., the inland cities would receive facilities for oceanic shipping equal to those of the cities on the Baltic or Black Seas.

Especial emphasis was placed on the need of immediate action because of the increasingly difficult conditions resulting from congestion at the available sea ports, especially at New York. The opposition of this latter city and of the State to the St. Lawrence project has been just strong enough to arouse thoroughly the entire Great Lakes region, and to make it apparent that New York will not be able to obtain any favors nationally for its projects unless its representatives assume a broader and more unselfish attitude toward the development of the resources of the nation.

The choking of commerce at Buffalo and New York for the benefit of these cities, already dwelt upon by Mr. Baker in his article, was emphasized in many ways. At the same time the fact was brought out by Dr. Roy S. MacElwee, director of the United States Bureau of Foreign and Domestic Commerce, that, from the standpoint of sound economics, a large proportion of the ocean-going vessels at present in use or probably to be used in the future, could pass up into the Great Lakes and could discharge and obtain loads far more economically than at the congested port of New York.

Detroit Bridge Prospects Bright

At a meeting of twenty-five Detroit and Windsor capitalists held July 15 steps were taken to speed up the progress of the enterprise for a bridge across the Detroit River to connect the two cities. Studies for such a crossing have been carried on by Charles Evan Fowler, constructing engineer, for the past eight months, funds for the investigation being supplied by the interests represented at the latest meeting. On presentation of his report the meeting decided to go ahead with the remaining preliminaries looking toward immediate construction, and committees were named to direct the work.

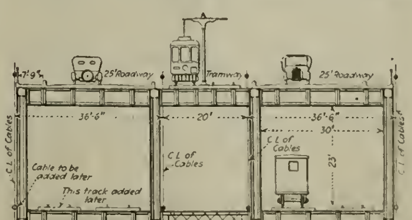


THREE PRELIMINARY DESIGNS FOR DETROIT-WINDSOR BRIDGE; SUSPENSION TYPE FOUND PREFERABLE FOR ECONOMY AND SPEED OF CONSTRUCTION

It has been found that the best location for the bridge is just above 24th St., Detroit, where a span of 1,770 ft. is practicable. A highway bridge here would cost nearly twelve millions, while the addition of accommodations for railway trains (four railway tracks, two street-car tracks, two 28-ft. roadways, two 7-ft. sidewalks) would make the cost $28,000,000.

An understanding has been reached with the Great Lakes Carriers Association that for a clear span between harbor lines the vertical clearance should be 110 ft. at the center and 100 ft at the sides; this will provide for all wireless masts for lake or ocean craft. At the pier locations, rock is found at 90 to 100 ft., and pneumatic foundations are to be used.

Traffic studies showed minimum yearly totals exceeding ten million passengers, 500,000 autos, 70,000 auto trucks, and 15,000 teams. With the bridge in service the estimated increases in five years are 100 per cent, 600, 600 and 600 per cent for these four classes of traffic. Over one and a half million freight cars cross the river, and it is believed certain that over a million could with economy use the bridge. Approximate estimates for the cost of tunnels of capacity equal to that of the bridge give figures of more than $60,000,000 for the 24th St. site and $80,000,000 for a site at Woodward Ave.



PROPOSED DOUBLE-DECK ARRANGEMENT OF DETROIT BRIDGE SHOWN IN CROSS-SECTION

Several of the preliminary study designs are shown herewith. The cable suspension bridge shown by the upper elevation is considered cheapest and safest in erection.

Shipment of Water Purification Chemicals Delayed

Owing to delays in the shipment of chlorine, alum, and other materials used in water treatment, health officials of New York, Pennsylvania, and four other states recently applied to the U. S. Public Health Service for its aid. Notwithstanding a request by the Secretary of the Treasury to the Interstate Commerce Commission, and representations of the Surgeon General, the commission, according to Public Health Reports of June 25, deemed "it inadvisable to give general priority to these essentials in public health work, but is willing to act upon requests, giving full particulars, in cases of individual shipments, [and] to use its best efforts to expedite the movement of such shipments." The Public Health Service therefore suggests that all requests for the expedition of water purification chemicals be sent direct to the Interstate Commerce Commission, giving full particulars for each individual shipment "including the name of the railroad and the shipping and destination points."

Schenectady Bridge Foundation and Pier Contract Let

On July 21 the State canal board of New York awarded the contract for foundations and piers of the new Mohawk River bridge to connect Schenectady and Scotia, to the American Pipe & Construction Co., Philadelphia. The total of the bid price is $961,963, which is about 50 per cent above the original estimate for this part of the work, made in 1918. The available appropriation for the bridge is $1,700,000. At present the approaches are being built by Dubois, Bennett & Son, of Schenectady, the total of this contract being about $230,000. Contracts 3 and 4, for arches and paving, respectively, are still to be let.

In order to protect itself against claims arising from the fact that the total present appropriation might be insufficient to build the bridge complete, the canal board has stipulated in the contract that its members shall not be liable to the contractor for any payments.

The bridge is to be known as the Western Gateway Bridge. It will be 4,436 ft long over approaches, and its main part will consist of 23 concrete arch spans of 106 to 120 ft. clear width, and a 212-ft. arch span over the Barge Canal channel. A description of the bridge with perspective view was printed in this journal June 26, 1919.

May Use Airplanes to Map Texas-Oklahoma Boundary

The vagaries of the Red River in its flow eastward from the panhandle of Texas are affected, the suit now pend-dred miles to Texarkana has resulted in a dispute between Texas and Oklahoma as to the boundary of these states. Although twelve counties of Texas are affected, the suit now pending before the United States Supreme Court, which will be heard at the December term, affects particularly only twelve square miles. This portion of land is of special significance because over $200,000,000 worth of oil rights are involved.

Extensive engineering and mapping work, contemplated in preparation for the suit, is now being arranged for by Arthur A. Stiles, Texas state reclamation engineer, who has been discussing the matter with the U. S. Geological Survey, the General Land Office and the Air Service of the Army. It is expected that some of the mapping work will be done by airplane through the co-operation of the Air Service.

The expenses of this survey work will be shared probably on an equal basis by the State of Texas and the Federal Government. Ample appropriations for the state work were provided in the recent act of the legislature which placed the technical portions of this problem in the hands of the state reclamation engineer, who was thereby designated to assist the attorney general of Texas in prosecuting the case.

Emblem Chosen for Society of Military Engineers

The Society of American Military Engineers has adopted the emblem illustrated herewith. The shield is symbolic of its policy of national defense. In the center of the shield stands the figure of the Spirit of Victory adopted for the World War Medal. Its feet rest on the cogged wheel, symbol of mechanical engineering, which

EMBLEM ADOPTED BY SOCIETY OF AMERICAN MILITARY ENGINEERS

has its application in war in such a myriad of forms. Electrical engineering is represented by the thunderbolt of Jove held in the eagle's talons. Underlying all is a bastioned fort—the strong point of military defense—representing the constructive skill of the civil engineer applied to military purposes. The entire badge is surrounded by a laurel wreath indicative of past success and future aspirations. Although these three branches of engineering are the fundamentals of military engineering, they by no means cover the entire field of military science, and membership in the society is open to all engineers of suitable military qualifications. Arrangements are being made for the distribution of the emblem among members to be worn as a pin, lapel button or charm.

C. A. Houston, of the Bureau of Engraving and Printing, United States Treasury Department, is responsible for the artistic form of the emblem.

Miss King To Represent A. A. E. at Scientific Congress

At the Pan-Pacific Scientific Congress to be held in Honolulu, Hawaii, Aug. 2-20, the Chicago Chapter of the American Association of Engineers will be represented by Miss Florence King, a consulting engineer and patent attorney of Chicago, who is the only certified woman member of the association. Miss King is sailing at once for Honolulu and will attend all of the sessions of the congress.

During an experience of 25 years, Miss King has been engaged as consulting engineer in machine design and construction, as attorney and as solicitor of patents.

Power Commission Cannot Form Own Organization

The new Federal Power Commission must depend on the War, Agriculture and Interior Departments to do the work that the commission proposes, according to the following ruling of the Comptroller of the Treasury.

"I think it is reasonably clear that the provisions of the Act negative the suggestion of any intent to vest in the Commission authority to build up an organization of employees, either by original appointment or by transfer from other branches of the government service.

"The responsibility for the work of this Commission is placed by law upon the Secretary of War, the Secretary of the Interior, and the Secretary of Agriculture, and each of these secretaries is authorized to use the personnel and other facilities of his department to accomplish such work. If the personnel of the three departments concerned is not adequate to perform properly the regular work of said departments and also the work of the Commission, it is for the three secretaries, who are also the members of the Commission, to determine what work shall be accomplished and what shall be left unperformed.

"When Congress provides a lump sum appropriation for the expenses of a commission or board it usually stipulates that the appropriation is available for the employment of personal services, if the employment of such services is contemplated, and specific authorization is required by law if personal services are to be employed by the commission at the seat of government. The comparatively small appropriation made for the expenses made necessary by this Act, contains no such provision, although it expressly mentions other items such as rent and transportation and subsistence. This is another indication that the appropriation for the expenses of the Commission was not intended to be available for the payment of any salaries other than the salary of the executive secretary."

No Changes in Division Heads of Construction Service

Col. Warren W. Whiteside, who has been placed in charge of the construction service in its new status as a part of the Quartermaster Corps, as announced in these columns last week, is a Regular Army officer. A considerable portion of his experience, however, has brought him into direct contact with construction. During the past year, he has been serving with the Construction Division under General R. C. Marshall. He served in France throughout the war with the 89th Division.

Under the new administration the subdivisions of the construction service will remain the same. Major C. L. Corbin is continued as administrative officer; Lt.-Col. L. L. Calvert is con-

tinued in charge of the building division; Lt.-Col. F. B. Wheaton, in charge of the engineer division and Major R. H. Case, the contract division.

The real estate division of the Quartermaster Corps has been added to the construction service as one of its subdivisions. The head of that subdivision is Major Carl F. von dem Bussche.

In order to decentralize, as much as possible, the work of the construction division, district offices have been opened at San Francisco, at San Antonio, and at Washington, D. C.

Society of Military Engineers Selects Officers

At a meeting of the temporary board of directors of the Society of American Military Engineers, held in Washington, D. C., June 2, preliminary organization was perfected. Due to the lateness of the season and to the fact that a period of 60 days is required to call a meeting of the society, it was decided that the organization should continue to function until after the first annual meeting, which is scheduled for the Friday preceding the third Wednesday in January, 1921.

The following officers were elected to serve until the annual meeting: President, Maj.-Gen. William M. Black, retired; first vice-president, Col. William Barclay Parsons, second vice-president, Col. Charles Keller; secretary, Capt. D. L. Weart; treasurer, Major William O. Tufts.

The following directors were named: Cols. F. V. Abbot, F. A. Molitor, George D Snyder; Lt.-Cols. C. H. Birdseye, A. H. Brooks, J. H. Finney, H. S. Graves, W. W. Kirby, George B. Pillsbury, Glenn Smith, Evarts Tracy, G. A. Youngberg; Majors Percy E. Barbour, P. S. Bond, J. J. Kingman, Max C. Tyler, E. Tufts; Capt. D. McCoach.

The executive committee comprises Maj.-Gen. Black, Cols. Parsons, Keller, Molitor; Lt.-Cols. Brooks, Graves, Major Tufts and Capt. Weart.

The committees are as follows: Development, Major Bond, chairman; Cols. Molitor, Snyder; Lt.-Col. Finney, Major Barbour. Design of Emblem, Lt.-Cols. Youngberg and Tracy. Membership, Lt.-Col. Youngberg, Majors Edwin H. Marks, William J. Shea and Capt. Thomas H. Messer.

American Reconstruction Unit Leaves for France

One of the first officially recognized groups of American engineers and landscape architects who will engage in reconstruction work in the devastated area in France sailed from New York July 8 under the name of the Harvard Reconstruction Unit. The organization consists of twenty members, headed by Reginald Coggeshall, Department of Government, Harvard University, who was appointed by President Lowell to take charge of the unit after it was organized by Robert Buell and Guy H. Lee of the graduate school of landscape architecture at Harvard.

The membership of the unit is made up largely of post-graduate students as follows: Harvard, fourteen; Massachusetts Institute of Technology, two; Columbia, one; Yale, one, and Princeton, one. Almost all of the members are former A. E. F. men. Town planning work in co-operation with the French authorities covering a period of three months has been outlined, the American unit serving without compensation, but with expenses while in France paid by the French Government and the Department of the Meuse to which it has been assigned. Its work will be carried on in the Argonne district. The temporary address of the organization is Harvard Reconstruction Unit, c/o Guaranty Trust Co., 1 Rue Des Italiennes, Paris.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Portland, Ore., Aug. 10-12.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Sept. 13-17.

The Engineers' Club of Seattle, Wash., was recently addressed by Col. H. P. Warren, of the Alaska Engineering Commission, in charge of Supply Division at Seward, Alaska. His subject was "The United States Railroad in Alaska."

The Oklahoma Association of Members, Am. Soc. C. E. has been organized, with headquarters at Oklahoma City, and with the following officers: President, H. B. Hinckley; vice-presidents, E. S. Alderman, C. M. Pritchard, E. M. Graham, F. D. Brown, H. F. Layton and M. L. Cunningham; secretary, F. H. Craddock.

The Association of Professional Engineers of Alberta held its first general meeting at Calgary, July 10, which was called for the purpose of completing the organization formed in April by act of the Legislature of the Province of Alberta. The association starts with a membership of more than one hundred practicing professional engineers. The following officers were elected. President, F. H. Peters, commissioner of irrigation, Reclamation Service, Department of the Interior, Calgary; vice-president, L. E. Drummond, consulting engineer and manager, Mountain Park Coal Co., Edmonton; registrar and secretary, R. S. L. Wilson, professor of civil and municipal engineering, University of Alberta, Edmonton. Councillors were elected as follows: S. G. Porter, superintendent of operation and maintenance, Department of Natural Resources, Canadian Pacific Railway Co., Lethbridge; R. J. Gibb, acting city engineer of Edmonton; R. A. Brown, city electrical engineer of Calgary; R. B. Baxter, engineer and plant superintendent, Alberta Government Telephones, Edmonton; W. G. Gray, chief engineer of power plant, Medicine Hat; F. W. Hobson, chief engineer, Steam Boilers Branch, Alberta Government Department of Public Works, Edmonton; O. E. S. Whiteside, manager, International Coal & Coke Co., Coleman; N. C. Pitcher, professor of mining engineering, University of Alberta.

Personal Notes

Frank H. Caven has been appointed director of public works of Philadelphia, Pa.

R. W. Berry, of the United States Geological Survey, has completed the mapping of the Seven Devils Canyon of the Snake River and transferred his party to Ellensburg, Wash., to resume the work of mapping the Trinidad quadrangle.

J. V. Neubert, since 1909 engineer of track of the New York Central R.R. Lines east of Buffalo, exterior zone, has been appointed engineer, maintenance of way, of that region, with headquarters at New York City, succeeding G. W. Vaughan, deceased.

U. Stephens, formerly city engineer of Waco, Tex., and more recently assistant to the bridge engineer of the Texas State Highway Department, has been appointed resident bridge engineer for Runnels County, Tex., and now is in charge of the construction of a reinforced-concrete and steel-span bridge across the Colorado River near Ballinger, Tex.

T. A. Russell, of Toronto, has resigned as a member of the commission to investigate and report on the Ontario hydro-radial system, and is succeeded by General C. H. Mitchell dean of the Faculty of Applied Science, University of Toronto.

Ralph Cureton, recently civil engineer with the Southern Power Co. in North Carolina, is now engaged in private engineering business in Greenville, S. C.

William F. Strouse, assistant chief engineer, has been made chief engineer, of the Public Service Commission of Maryland. He succeeds the late Charles G. Edwards. From 1887 to 1903 Mr. Strouse was employed on the preparation of plans and estimates on the Pennsylvania and Baltimore & Ohio railroads, and from the close of that period until 1909 he was assistant engineer of the Washington Terminal Co., in charge of construction of the Washington terminal improvements. From 1909 to 1918 he was assistant engineer with the Baltimore & Ohio Railroad Co. in charge of con-

struction work between Philadelphia and Cumberland, and during the war was supervising engineer, Quartermaster Department, Fort Howard, Md.

PROF. S. C. SHIPLEY, who has been in charge of the mechanical engineering shops at the University of Minnesota, Minneapolis, has resigned to take a similar position in Roberts College, Constantinople. Prof. Shipley and his family will sail for Turkey, from New York, Aug. 14. His acceptance of the European position closes an association of thirteen years with the College of Engineering of the University of Minnesota.

XAVIER A. KRAMER has resigned as state engineer of Mississippi.

DEAN G. EDWARDS has been appointed by the Transit Construction Commission of New York City to be director of construction on the defaulted subway contract of the Intercontinental Construction, covering about 1½ mi. of line in Brooklyn. The work will be completed by the city on a force account basis. Mr. Edwards had been chief engineer for the contractor on this contract.

LT.-COL. EARL B. MORDEN has resigned as chief of the Bureau of Street Cleaning of Philadelphia, after filling that office for three months.

BRIG.-GEN. FRANK T. HINES, chief of the Bureau of Transportation, War Department, has been made head of the Inland and Coastwise Waterways Service, which has been established, under the new Transportation Act, to assist in the development of inland water routes and lines.

JOHN H. NEESON, principal assistant to Fred C. Dunlap, chief of the Bureau of Highways, Philadelphia, has been made acting head of the city's Bureau of Street Cleaning owing to the resignation of Lt.-Col. Earl B. Morden.

F. H. JOYNER, formerly with the Massachusetts State Highway Commission and recently in charge of road construction as county road commissioner for Los Angeles County, Cal., has resigned and will hereafter act as consulting engineer for the Willite Paving Co. and other corporations in Los Angeles. G. W. Jones, of the county road commissioner's office, has been temporarily appointed to succeed Mr. Joyner.

R. J. MCLELLAND has resigned as city engineer of Kingston, Ont., after eighteen years' service.

O. M. LELAND, of the J. G. White Engineering Corporation, New York City, has been appointed dean of the College of Engineering and Architecture and the School of Chemistry of the University of Minnesota. He succeeds Prof. Lauder W. Jones, who resigned to go to Princeton University. Col. Leland was born in Michigan and graduated from the University of Michigan in 1900. During the Spanish War, in 1898 and 1899. he was chief clerk and draftsman to the United States Surveyor-General in Florida. He was aid and computer in the United States Coast and Geodetic Survey in the United States, Alaska and Porto Rico from 1900 to 1903, at the close of which period he became a member of the faculty of the College of Civil Engineering at Cornell University, a position which he held from 1903 to 1920, having charge of the department of topographic and geodetic engineering. During the present year he has acted as engineering supervisor with the J. G. White Engineering Corporation. From 1904 until 1911, Col. Leland had charge of the demarcation of various portions of the boundary between Alaska and Canada, resulting from the arbitration between the United States and Great Britain, and from 1911 to 1913 served as a member of the commission of engineers in the arbitration of the boundary dispute between the Republics of Panama and Costa Rica, having been appointed to that position by Chief Justice White of the United States Supreme Court. During the recent war he was lieutenant-colonel of engineers, serving with the 303rd Engineers, 78th Division, in the St. Mihiel and Meuse-Argonne offensives in France, and later with the 314th Engineers, 89th Division, with the Army of Occupation in Germany.

OBITUARY

R. B. PIPER, city engineer of Medicine Hat, Alta., died in that city on July 19.

WINFIELD S. CADWALADER, for many years superintendent of streets of Trenton, N. J., died July 17 in that city.

HERBERT WATSON HATTON, consulting engineer of Wilmington, Del., died in that city July 13; he was 38 years old. He was born in Downingtown, Pa., and received his civil engineering education from the International Correspondence Schools of Scranton, Pa. During the early part of his professional career he was with T. C. Hatton as chainman, rodman, transitman and leveler. From 1903 until he took up private consulting practice in 1910, he was in charge of the construction of sewers and sewage-disposal plants at Milford, Del., Hyattsville, Md., Bedford Springs, Mt. Carmel, Pa., and Charleston, W. Va. At Berwick, Pa., he was engineer in charge of constructing a dam, reservoirs, roads, bridges, reinforced-concrete conduit, pipe lines and gate houses. As chief assistant engineer on design and construction, with T. C. Hatton, during 1909 and part of 1910 he waterproofed the reservoir at Owego, N. Y., and was in charge of designs for the drainage system for Atlantic City, N. J., and of the extension of that city's water system. In the past ten years, as consulting engineer, he designed and made extensions to sewer systems, water-works and street pavements in many cities. He also acted as consulting engineer for the Equitable Guarantee & Trust Co. of Wilmington, on the construction of a dam, bridge and flood gates at Silver Lake, Milford, and on the appraisal of the Georgetown (Del.) Water Co.'s plant.

BUSINESS NOTES

R. C. TRIG, formerly with the Berger Manufacturing Co., Canton, Ohio, is now chief engineer of the sales promotion department, National Pressed Steel Co., Massillon, Ohio.

JOSEPH S. STULL, JR., formerly general superintendent of Pusey & Jones Co., Gloucester, N. J., has been appointed assistant manager of ship construction, shipyards and drydocks of the United States Shipping Board.

THE PARSONS CO., manufacturer of trench excavating machinery, Newton, Iowa, has opened a branch office in the Lumber Exchange Building, Chicago, Ill. Its Chicago territory includes the States of Michigan, Illinois, Indiana and Ohio and the eastern section of Missouri. The new office is in charge of James McElroy, central district sales manager.

THE F. C. AUSTIN MACHINERY CO., INC., Chicago, in addition to the Linderman Steel & Machine Co., the F. C. Austin Drainage Excavator Co. and the Municipal Engineering & Contracting Co., has included in the consolidation announced in these columns April 15, p. 794, the Toledo Bridge & Crane Co. Hereafter the organization will be known as the Austin Machinery Corporation.

Pump Testing Plant Completed at Anderson, Ind.

A plant with all facilities for testing centrifugal pumps up to 48-in. size and also for testing the various types of reciprocating pumps made by the Hill Pump Division of the Mid-West Engine Co. has recently been completed at Anderson, Ind. Capacities up to 25,000 gal. per minute or 36,000,000 gal. in 24 hr. can be handled. Beneath the testing laboratory are three concrete tanks with calibrated weirs and a deep sump, the latter being used to test deep well and sump pumps. Provision is also made for checking each test by a Venturi meter and manometer. Motors of various sizes for different speeds and currents are at hand and also steam turbines with torsional dynamometers. Various other accessories are provided. About 5,000 sq.ft. of floor space is available in the testing room and there are facilities for handling five units simultaneously.

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DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

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An Irrigation Triumph

EVEN after allowing for the picturesque hyperboles of Southern California, the story of recent shipments of canteloupes and less mouth-watering products from the Imperial Valley must be accepted as valid testimony to the triumph of irrigation. Other sections also bear witness to the marvels of irrigation but the appeal to the imagination made by the products of a once-dreaded desert far below sea level is perhaps the strongest of all. There if anywhere water is king and the engineers who bring the life-giving water to the dead or sleeping land perform little short of a miracle.

Lake Cities All Coming to Filtration

TIME was when any question as to the quality of the water supplied to a city from the Great Lakes was thought to be fully met by building a longer intake. Then chlorination came as a safeguard against typhoid. Rising standards demand filtration. Detroit and Milwaukee are now falling into line after Toronto, Cleveland and many smaller places in providing complete water purification plants. Chicago, among lake cities large and small, stands almost alone without filtration. Sooner or later she also will fall into line—perhaps sooner than she expects.

Water-Testing Stations Still Pay

SIMPLE as the lake-city water treatment problems seem when the relatively clear waters from their mammoth settling, aerating and bleaching reservoirs are compared with the turbid and stained waters of other sections, a number of lake cities have nevertheless found it prudent to build and operate testing stations before working out the details of their water-treatment plants. This has been done successively by Cleveland, Detroit and Milwaukee. Some of the leading features of the Milwaukee tests are given on p. 257. The data show anew how many problems there are to be studied in each water purification case and that notwithstanding the many advances in our knowledge of water treatment yet water testing stations still continue to pay their cost.

Ozonization Not Yet Practicable

WITH the relatively clear lake waters, if at all, ozonization as a bacterial finishing process might be expected to work well and cheaply. The Milwaukee tests mentioned above are most discouraging in this respect. After these and other trials, both working-scale and experimental, ozone seems farther than ever from being practicable, both as a matter of plant detail and of cost. All that it can do, it appears, can be done at least as well, and with far less trouble and expense, by chlorination. Yet ozonization continues to lure on the promoter and with his aid to charm the layman. Experienced water engineers are generally skeptical as to ozone treatment, as well they may be in the light of experience. Nevertheless it is well to have a mind sufficiently open to accord a test now and then to new ozone apparatus in the hopes that a practicable ozonization plant has at last been devised.

A Personal Contract

CONTRACTS for engineering construction work are in their form impersonal, but every such contract has most obviously a personal element, and we think it is well for the sound conduct of the business transacted between engineers and contractors that this element should not be suppressed or lost sight of. Explicit recognition of the personal relation, such as is found in the Miami Conservancy District levee protection contract, is strikingly novel, however. We recall no precedent. In view of the limitations affecting such a contract it has no doubt a rather peculiar status in law. Yet we think it is clear that the essential purpose of a contract, namely, to embody the meeting of the minds of the contracting parties, is most fully realized by the form of contract under consideration, through the very fact that it gives expression to the personal relation. The case is worth taking careful note of. To make its circumstances more clear to those who may want to consider its application elsewhere one point might be added to the information given in the article on p. 247 of this issue, namely, that because the same contractor had previously done work for the district there was a direct knowledge of personalities on both sides, and this established the basis for the personal relation expressed in the present contract.

The Neglected Gusset Plate

A DETAIL study of two truss joints presented on p. 259 directs attention to an element of structural and bridge practice that has remained in a state of unfortunate neglect, namely, the gusset plate. While we have talked and thought at great length and to good purpose about main members, loads, secondary stresses and a variety of similar engineering questions, the gusset plate has been allowed to remain on a purely empirical basis. In common practice joint plates are designed by the simple process of finding out how much space is required to accommodate the necessary rivet lines and then sketching in the smallest plate that will circumscribe these rivet groups. This is unscientific. It assumes quite confidently that the smallest possible plate will be strong enough to take care of all the tearing and shearing stresses set up in it by the pulls and pushes and twists which the several members connected exert. No attempt to compute or estimate these stresses has appeared in public discussion for a long

time past. Yet it is obvious that the same principles of designing for adequate strength that control truss or girder design, for example, are valid also for gusset plates. It does not appear logical to let these important detail elements go on faith, in the view that simply because we have had no particular trouble with them hitherto therefore we need not worry about them. The principle underlying modern designing is to approximate a quantitative estimation of the stresses throughout the structures we build, and be sure they are conservative and yet involve no large waste of material. Such analyses as that of Professor Wilson lead in the direction of a study of gusset-plate stresses, and when this is once fairly in hand the structural art will be measurably nearer perfection than it is today.

Earth Road Upkeep Made Part of Paving Construction Program

TRACTOR-GRADER and drag road work in Iowa is part of a permanent-road construction program. By working machine graders systematically to plan much widening and ditching and a material amount of longitudinal grading can be accomplished in the regular course of keeping up earth roads, thus creating a base for future permanent roads. By this notable results have been accomplished. Considering the five years previous to Jan. 1, 1919, when the paved main-traffic-route program now in progress in Iowa was inaugurated, the physical accomplishment had been as follows: With 105,000 miles of earth roads and an expenditure of less than $100 per mile, exclusive of permanent bridges and culverts, nearly 3,000 miles of road grade had been completed ready for hard surfacing, over 13,000 miles additional were completed partly to permanent grade and the entire mileage was kept in condition for traffic. In places requiring major longitudinal grade changes other construction operations than those described on p. 269 were required, but, speaking generally, the results enumerated were accomplished by tractor-grader and drag operations.

With the results described to its credit, the process may not be overlooked as a possibility elsewhere. Indeed, for the large-mileage agricultural states of the South and the West the plan has distinctive merit. It is essentially a process of building roads from the bottom up, and it is cumulative. In the first respect it is fundamentally sound road construction engineering, and in the second it is within the financial ability of any community. In the present craze to spread hard surfaces over great mileages of road the qualifications named require to be kept closely in mind.

With the best that a liberal public can do in financing "permanent" highway types not one mile in ten of the roads in the agricultural states of the South and West can be hard paved for many years. But meanwhile the roads should be fit to carry a growing traffic. To do this they must be built up and maintained. Perhaps $50, and possibly $100, a mile each year will be the average expenditure which is permitted. By the plan and the methods described, experience in Iowa proves, approximately one-half of this annual expenditure can be made to contribute to permanent structure, and in time the accretions will have produced all that enters into a permanent paved road except the hard surfacing.

The Increase of Railroad Rates

WITH the end of the Government guarantee, Sept. 1, the railroads will find themselves on an independent basis of earning power with a new rate level that should insure the restoration of their credit sufficiently to bring about much needed development of the country's transportation system. The sums involved in the decision of the Interstate Commerce Commission to increase rates from 25 to 40 per cent are unprecedented in the history of railroad ratemaking under private operation. The lesson to the country that service cannot continue to be furnished at less than cost must be obvious. Certainly this is recognized by the Commission in assuming, in its calculations, that maximum rather than the minimum rate of return in view of current high rates of interest. It is significant that the decision not only embodies the routine carrying out of provisions of the Transportation Act, but also indicates a new spirit of liberality, and a recognition of the vital necessity of adequate railroad service, on the part of the governmental regulating body.

While the construction industry may be hard hit by such a sudden and large proportionate increase in the cost of hauling bulk materials—particularly those used in road building—engineers and contractors will be quick to realize that the effect may be such a development of transportation facilities that incalculable benefit to the industry will result. One item of the rate decision that remains unexplained is that refusing to grant a lower rate allowance on certain bulk materials as sand, gravel, and stone, while iron ore will be shipped at a rate lower than that indicated by the percentage increase. Probably of greatest immediate importance to constructors in railroad work is the likelihood of a tremendous volume of construction, long held in abeyance, being released through the re-establishment of railroad credit.

More than ever the public will realize the importance of the valuation of the railroads which has been so long under way. While the Transportation Act does not indicate what basis of "value" shall be used in establishing rates, it is accepted as practically certain that the results of the physical valuation, as fast as they become known for a large portion of mileage, will be used to determine "value" for rate-making purposes under the Act. In the present instance the Interstate Commerce Commission, following the mandate of the new law, has considered the "book value," or property investment account, only in the light of supporting evidence and not as conclusive. The sum designated as the temporary aggregate "value" by the Commission falls short by some 10 per cent of the aggregate "book value" which the railroads desired should be used. Since 1907, when uniform railroad accounting was established by law, the property investment accounts are accurate for purposes of comparison, but both the carriers and the Commission realize the frailties of these accounts previous to that time. As yet insufficient mileage of standard roads has been covered by the physical valuation to indicate definitely the relation between "book value" and the various bases of value called for by the Valuation Act. The need for rapid completion of the valuations is apparent.

Included in the estimates for the rate increases is allowance for the $600,000,000 wage grant of the Railway Labor Board, which was the cause of the railroads'

adding various items to their original proposals. Now that the carriers have been granted so nearly what was asked railroad credit should in large measure be restored and development go forward. Responsibility now rests with the railroad managements themselves to bring our transportation system up to that point of efficiency that the country requires and demands for its normal development. Considerable time will be required to bring all this about, but plans for such a large volume of work are already complete that the question of financing alone should stand in the way of an almost immediate beginning of actual construction.

Mounting Society Convention Expenses

THE expenditure of time, energy and money on engineering conventions has become so heavy as to raise serious question as to the justification not only of the expenditures but also of the conventions themselves. The burden, for such many feel it to be, has various causes. First, is the multiplicity of societies. For this there is an obvious though heroic remedy. Next there is the heavy expense that conventions entail. Part of this is within the control of society directors and of members who attend conventions but much of it is beyond society or personal control, since it is due to increased railroad and hotel charges and other elements in the present high cost of living.

No complete analysis of the situation just outlined has yet been attempted, nor can it be essayed here, but some light is thrown on the subject by a recent report made by a field secretary of a national society who analyzed the convention expenses of his organization six weeks after adjournment. He wanted (1) to get impressions for the guidance of the next convention; (2) to see to what extent the local organization had been stimulated and whether its energies had been increased by the contagious enthusiasm of outside delegates. He found the local had profited not at all. His cost analysis and accompanying comments would probably fit many other organizations. Summarized they are:

For an attendance of 150 at the convention there was spent about $1,600, of which 42 per cent went for banquet and lunches; *16 per cent for badges;* 12 per cent for decorations, music and flowers; 10 per cent for printing programs and for incidentals (no advance papers); 8 per cent for cigars, 7 per cent for booths and signs, 3 per cent for tips, and 2 per cent for typewriting. The banquet cost was largely borne by the delegates. This was not an organization of brakemen nor miners nor undertakers, but a regularly established engineering society, whose meeting was decidedly a success by all present-day standards.

The expenditure in question is only a small part of the real tax on the association. In addition, each delegate had his expenses paid by the local he represented. The secretary of the society estimates an average expense account of $100. So the $1,600 becomes $16,000. This all falls on the individual members, through their dues. In view of such a total for a single convention of only one of our many engineering societies, it is evident that engineers are paying large sums for society support.

The day before the field secretary's report came to our attention an interview was had with a veteran society joiner who supports thirty different organizations and says he has not been free from director's duties in some one of them for the last twenty years. After reading the report just mentioned he remarked:

"There are too many societies. Too much money is frittered away on inconsequental meetings. Nearly every organization I know is in financial difficulties. Money for new work cannot be diverted from existing activities and leave anything worth while. Many a society is being crucified on the printing press. Printing costs have tripled. I have helped solve society problems for thirty years and the new problems do not look any smaller than those of the past. Money is the problem now and a lot of societies ought to go out of existence and let their members lend support to the smaller number that would remain. This every engineer now sees or should see. Stern financial necessity may force the issue but if the number of engineering societies decreases through financial starvation, will it be the fittest societies that survive?"

These remarks will find wide acceptance. If they stress too much the financial burden on the societies, that is not surprising in view of the fact that finances are for the moment uppermost. But the demands which the multiplication of societies make upon the time and energy of the engineer must not be overlooked. These demands tend to a divided allegience and scattering of effort that often leads to paralysis.

Coming back to the financial burden entailed by engineering society conventions, the question that demands attention is what sort of expenditures are warranted and how can society funds best be apportioned between legitimate objects of expenditure? To answer the question is a task for the societies rather than for us. But a few questions may properly be raised for consideration: Is "42 per cent for banquet and lunches" and that with "the banquet cost largely borne by the delegates" (meaning the locals that sent them) reasonable? And how about "16 per cent for badges"? Are badges, other than a possible name slip in a penny frame, of any possible use at an engineering convention? The percentages that went for the remaining items will bear restating: Decorations, music and flowers, 12; printing and incidentals (no advance papers), 10; cigars, 8; booths and signs, 7; tips, 3; typewriting, 2 per cent. A liberal ruling would class as essentials only the printing and incidentals, booths and signs, the tips and the typewriting. These total 22 per cent or $352, compared with 12 per cent or $252 for badges. The item of 2 per cent for typewriting, on its face, indicates a small total output of convention results to be recorded, but perhaps the proceedings were recorded by a secretary or staff stenographer whose salary is not included in the expense summary.

We have commented on this percentage division of expense not so much to criticise any one item or group of items as to direct attention to the mounting burden of engineering society convention expense and to suggest that officials of other societies might well analyze their convention expenditures. But they should not stop with mere analyses. They should balance each item against the result it yields and see how many and which are found wanting. Then as each convention approaches, both the expense budget and the technical and business program should be framed with a view of obtaining the greatest good to the largest number from every dollar of society and personal expenditure at the convention.

Improvement Work on River Murray in South Australia

Longest River on Island Continent Now Being Regulated Mainly for Navigation by Locks and Dams

By Robert C. Cutting
Constructing Engineer, River Murray Works, Blanchetown, South Australia

RIVER improvement work, comparable in many ways to that being carried out on the Ohio River, has been under way for some years on the River Murray in South Australia. In spite of setbacks due to the war construction has been regularly pursued and the first structures are reaching completion.

The River Murray with its tributary streams, the Darling and Murrumbidgee, forms the longest river system in Australia, having, under favorable conditions, a combined navigable length of 3,212 miles. The discharge varies with the seasons of the year, being least from February to July and greatest from August to January. During the periods of low water navigation is suspended, except on the lower 175 miles of the Murray. The slope, and therefore the current, of the river is very gentle. In the upper reaches a maximum of about 9 in. per mile is found, decreasing until at the lower end it is only 2½ in. per mile. A large area of inland country is served by these rivers and considerable traffic of wool and wheat is carried by steamers and barges plying the waters.

These streams have their headwaters in the coastal ranges of New South Wales, Victoria and Queensland. After leaving the highlands they pass through some of the most fertile regions of the continent. The rainfall over these areas is not generally sufficient for agriculture but with the aid of irrigation valuable crops of fruit, vines and cereals can be obtained The irrigation of these lands was started some years ago, but with the great development of the industry it has become necessary to adopt means for further conserving the water for both irrigation and navigation, so as to make possible the closer settlement of the river valleys.

In New South Wales the Burrinjuck Dam on the Murrumbidgee, storing 771,000 acre-feet, is nearing completion. From it water will be supplied to a large area, while in Victoria and South Australia there are many thriving settlements irrigated by water from the Murray or its tributaries.

FIG. 3. FINISHING LOCK NO. 1 ON RIVER MURAY IMPROVEMENT, SOUTH AUSTRALIA

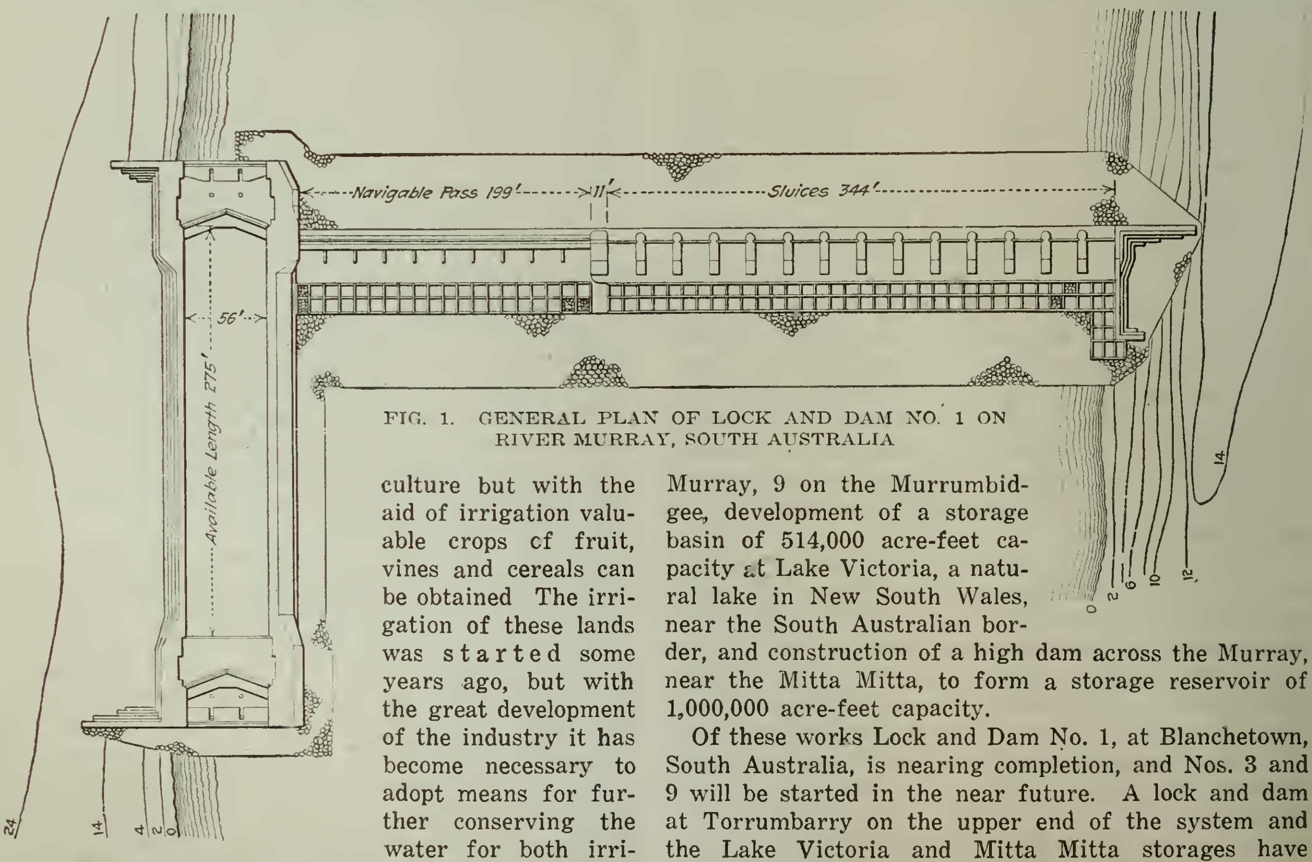


FIG. 1. GENERAL PLAN OF LOCK AND DAM NO. 1 ON RIVER MURRAY, SOUTH AUSTRALIA

The projected works include 26 locks and dams on the Murray, 9 on the Murrumbidgee, development of a storage basin of 514,000 acre-feet capacity at Lake Victoria, a natural lake in New South Wales, near the South Australian border, and construction of a high dam across the Murray, near the Mitta Mitta, to form a storage reservoir of 1,000,000 acre-feet capacity.

Of these works Lock and Dam No. 1, at Blanchetown, South Australia, is nearing completion, and Nos. 3 and 9 will be started in the near future. A lock and dam at Torrumbarry on the upper end of the system and the Lake Victoria and Mitta Mitta storages have recently been started.

The general plan of Lock and Dam No. 1 is shown by Fig. 1. It is typical of the other dams to be con-

structed. The work comprises a lock, a navigable pass, fourteen sluices and an abutment. The lock is 378 ft. long over all. It has an available length of 275 ft. and a width between the walls of 56 ft. The walls are 24.5 ft. high above the lock floor and have a 5-ft. freeboard above the full upper pool. A concrete floor 3 ft. thick, reinforced with 1¼-in. twisted steel bars, extends over the area covered by the lock. Slots or keyways were left in this floor in the vicinity of the walls to provide a suitable bond and the walls were then built on the floor slab. In order to limit the upward pressure which might accumulate under the floor, due to springs or small leaks, a system of 12-in. drain pipes, surrounded by crushed stone, was laid and connected with the lower pool at the downstream end of the lock.

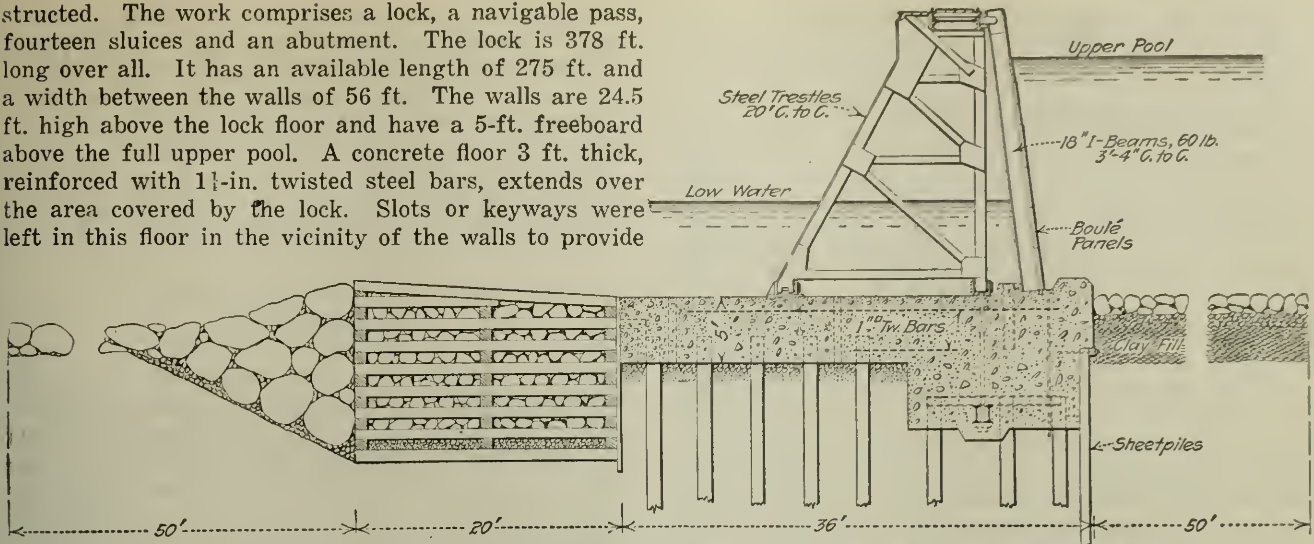


FIG. 2. CROSS-SECTION THROUGH NAVIGABLE PASS ON RIVER MURRAY IMPROVEMENT

The lock walls are of concrete, built in monoliths 26 ft. long with vertical keys between the monoliths. The land wall is 16 ft. wide at the base and 5 ft. wide at the top with vertical face and stepped back. The river wall is 17 ft. wide at the base and 6 ft. wide at the top with vertical lock face and battered outer face. Both walls are widened at the upper and lower ends to provide for conduits and give sufficient mass to resist the thrust of the gates.

The lock is filled through conduits in each wall which take the water from the forebay above the upper gates and discharge it into the lock through five 3-ft. square openings in each wall. Each conduit has three openings at its upper end closed by 6 x 3-ft. butterfly valves which are opened and closed from the top of the walls by handwheels operating worm gears. Similar valves are provided at the lower end of the lock for emptying.

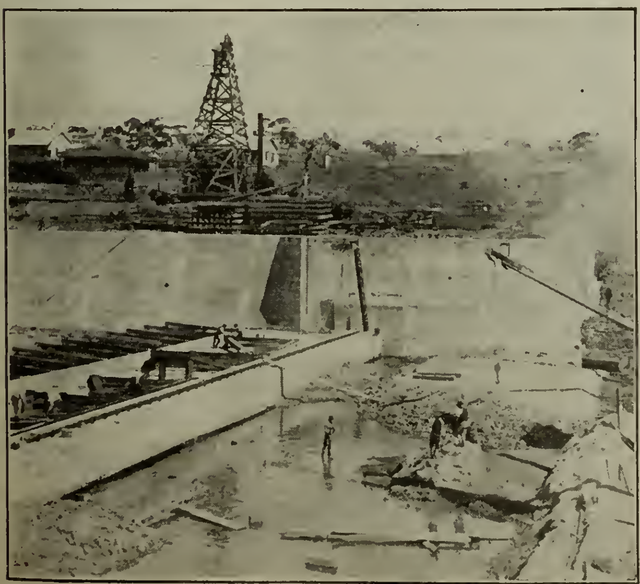


FIG. 4. PLACING CLAY BLANKET ABOVE NAVIGABLE PASS

The mitering lock gates are constructed of ironbark timber (*Eucalyptus leucoxylon*). They are horizontally fromed, the beams being placed clos together at the bottoms of the gates, but near the top they are separated by jarrah filler blocks. The openings caused by the fillers are closed on the water face by 2 in. California red pine sheathing, placed vertically and calked, while on the backs they are covered by 2-in. jarrah sheathing, laid diagonally with ¼-in. open joints. Heavy steel straps hold the timber courses together. The heels of the gates rest in cast-iron hollow quoins set in the concrete of the walls, the bottoms closing against 12-in. by 12-in. jarrah miter sills. The gates are operated by spars and wire lines by the aid of small hand capstans.

At each end of the lock, above the upper gates and below the lower gates, anchorages have been provided for two of the steel Boulé trestles from the navigable pass. By the use of these trestles and using the stop logs from the sluices as needles a cofferdam can be easily constructed, thus enabling the lock to be pumped out in case repairs are required. A sump is provided at the lower end for the pump suction.

Riprap has been placed at the upper and lower ends of the lock and along the outer face of the river wall to prevent undermining in case destructive currents are set up from any cause.

Both the upper and lower lock sills are placed at the same elevation (El. 99), which gives a minimum depth over them of 7.8 ft. when the river below the dam stands at low water stage (El. 106.8).

The navigable pass, that portion of the dam through which the traffic passes when the dam is down, the river being sufficiently high to permit open river navigation, has a width of 199 ft. and its sill, the highest projecting part when the dam is lowered, is at El. 101.0 or 5.8 ft. below low water. Fig. 2 is a cross-section of the navigable pass. Steel trestles, spaced 20 ft. c. to c., support steel plate girders 19 ft. 11½ in. long laid on their sides; 18-in. 60-lb. I-beams, having their upper ends resting against the upstream edges of these girders and lower ends resting in steel castings set in the concrete foundations and spaced 3 ft. 4 in. apart carry the Boulé panels, which are of the ordinary type. This is an unusual arrangement of a Boulé dam, which

generally has a separate trestle between each set of panels. In the present case, however, the aim was to eliminate as far as possible all submerged iron and steel work which could not be readily removed for painting, as the water of the River Murray, especially at low stages, is highly charged with mineral salts which have a very destructive action on iron and steel. The arrangement adopted substitutes for a large number of trestles of light section a comparatively few trestles of heavy section, thus greatly reducing the surface area subjected to the corrosive action of the water.

The sluices or section of the dam between the navigable pass and the abutment is composed of a series of concrete piers, each 6 ft. wide, on a concrete foundation slab. These piers are placed 25 ft. c. to c., leaving a waterway 19 ft. wide between each pair of piers. At the upstream end of each pier vertical slots are provided to hold the horizontal stop logs for closing the openings. The bottom course of logs are 12 x 12 in., while near the top 10 x 10-in. logs are used. Horizontal timber beams carrying a footway and rails for operating winches are provided. This arrangement was adopted in conformity with the policy used throughout the design of eliminating as far as possible all submerged metal work which would not be readily accessible for painting. The design, involving a number of narrow piers, was rendered possible by the fact that no ice and very little drift is found in the Murray. The native timber, mostly of the Eucalyptus family, is of too high specific gravity to float, except when absolutely dry.

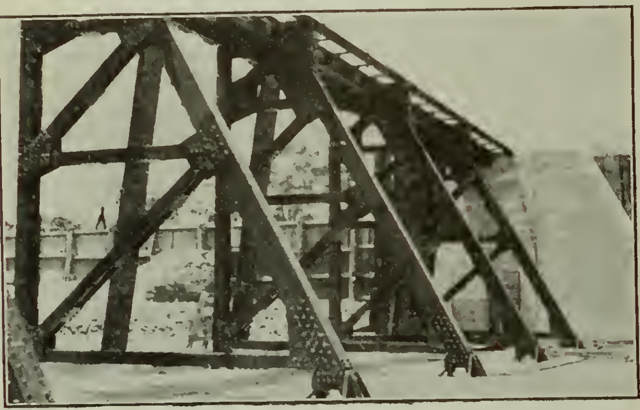


FIG. 5. CLOSE VIEW OF NAVIGABLE PASS TRESTLES

The abutment is of the ordinary shape used in similar construction, consisting of a retaining wall with wing walls reaching back into the bank.

With the exception of the land and breast walls of the lock, which are founded on rock, all foundations are provided by timber piles of Australian stringy bark (*Eucalyptus obliqua*). The piles varied in length from 12 ft. near the land wall of the lock to 30 ft. near the location of the sluices. A continuous line of timber sheetpiles was driven along the outer face of the river wall, being carefully sealed into the upper and lower breast walls. A similar line of sheetpiles was driven along the upper face of the navigable pass and sluices and along the outer faces of the abutment walls. These sheetpiles are of a special type as shown in Fig. 6. They were very carefully driven in order to maintain a perfect interlock and good alignment. A water jet was freely used and the piles were driven to the rock underlying the site. After the piles were driven the grooves between the adjacent ones were filled with grout, composed of equal parts of portland cement and sand, deposited by a pneumatic grout mixer and ejector.

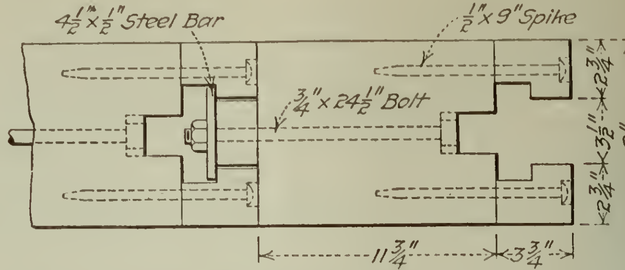


FIG. 6. CROSS-SECTION OF WOOD SHEETPILE AT NAVIGABLE PASS

For all concrete a 1 : 2½ : 5 mixture was used. The cement was from a mill located in South Australia, the coarse aggregate was crushed granite from a quarry developed especially for the work, 70 miles by river below the lock site, and the sand was obtained from the river near the work. Where reinforcement was required in the concrete it was supplied in the form of square twisted bars.

All permanent timber work except the lock gates and bearing piles was constructed from jarrah grown in Western Australia. This is an excellent hardwood and is readily obtained in large sizes. For forms and other temporary work Oregon fir from the Pacific Coast of the United States was used. There is comparatively little softwood native to Australia and Oregon fir is largely used where light construction is required.

The steel and iron work was fabricated in the state. Some of the structural shapes were rolled at the new steel works at Newcastle, N. S. W., but most of the material had to be imported, some from the United States and some from England. Prevailing war conditions made the procuring of this material very difficult, both on account of the scarcity of shipping and the shortage of material available for civil work.

Before any work was possible a construction plant had to be accumulated. Some of the items required, such as boilers, narrow-gage cars and barges, could be constructed locally but the major items, including cableway, hoisting engines, derricks, dredge, derrick-boat machinery, steamboat, piledriving equipment, etc., had to be imported from England and America. The machinery for the 1½ cu.yd. dipper dredge was secured in the United States and assembled on a locally built hull. As there were no suitable steamboats on the river a stern wheel, steel hull steamer, similar to those used on the Mississippi and tributaries, was secured. This was sent from America in pieces and assembled on the river.

A well-equipped machine shop capable of dealing with nearly all repair work likely to be required was also supplied. This was necessary because of the isolated location of the work. Connected with the machine shop is a wood-working shop, with sawmill, universal woodworker and band saw, where all machine work connected with manufacture of sheetpiles and concrete forms is done.

The preparation for construction work was started in 1914, just before the declaration of war, consequently some serious delays occurred in securing plant. In addition to this there were three years of extremely high water in the river, during much of which time no

work was possible; also the labor and material shortage, due to the war, has greatly hindered progress.

In 1912 Col. E. N. Johnston, Corps of Engineers, U. S. Army, was engaged by the South Australian government, as consulting engineer, to report and furnish plans for the improvement of the river between the mouth and Wentworth, N. S. W., and in 1914 the writer was engaged as constructing engineer to supervise the construction work. It is expected that Lock and Dam No. 1 will be completed this year.

Specified Manager Made Essence of Contract

Unusual Clause Calls for Personal Services of Contracting Company's President on Miami Work

POWER to terminate the agreement at once upon the disability of a specified individual to direct construction is a unique feature of the contract for levee revetment at Dayton, O., which the Miami Conservancy District has with Price Bros., general contractors. A form of cost-plus contract was written which, besides providing definitely that the president of the contracting firm must personally direct the work, contains a number of stipulations which are not usual. Perhaps the most uncommon of these is that the contractor's fees are based on estimated unit costs of the principal items.

The work to be performed is 10,000 cu.yd. of monolithic slab revetment concreted in place and the placing of a flexible mattress of precast concrete blocks strung on a steel cable. The blocks are 24 x 12 x 5 in., and 175,000 are required in the mattress. Construction cost is defined so as to include all items entering into the expense of the work except the contractor's salary, his personal charges, and his central Dayton office charges,, and except the cost (f.o.b. cars or in storage) at Dayton of cement, reinforcing steel, expansion-joint material, wire rope, sand and gravel, which are furnished by the Conservancy District. The allowable costs are to be determined from the contractor's vouchers and pay rolls by the district's auditors.

By agreement, the estimated costs, based on the wage scales prevailing at the date of the contract, are established as: $1 a cubic yard for excavation, $8.25 a cubic yard for monolithic slab revetment and 15½c. a block for laying flexible-slab mattress. At the date of the contract the wage rate paid by the District for common labor was $5.06 a ten-hour day. Should this rate increase or decrease the estimated costs are to be increased or decreased in the same ratio. The contractor's fees are based on the estimated costs as follows:

At the end of each month a determination will be made of the total actual quantities of each item of work mentioned in this schedule completed to the end of such month. The sums of the amounts obtained by multiplying each such quantity by the corresponding unit price as named in the schedule will be termed the base price. Should the actual construction cost up to the end of each month be equal to the base price, the contractor's fee shall be 9 per cent of the base price. Should the actual construction cost exceed the base price, the contractor's fee shall be reduced by 25 per cent of the excess cost up to an excess of 10 per cent of said base price and by 50 per cent of all additional excess cost above 10 per cent of said base price, provided, however, that the contractor's fee shall not be reduced to less than 3 per cent of said base price. Should the actual construction cost be less than the said base price, the contractor's fee shall be increased by 25 per cent of the saving in cost below the base price up to a saving of 10 per cent of said base price and by 50 per cent of all additional saving above 10 per cent of said base price.

It is provided that required materials and supplies shall be approved by the District and furnished by the District at a charge into construction cost of actual cost plus 15 per cent. Equipment whether provided by the district or by the contractor is charged into construction cost at 2 per cent per month on the agreed value of tne quipment. This charge begins when the equipment is put on the job and continues while the equipment is held on the job. Until a reserve of $2,500 is reached the contractor receives only 50 per cent of each month's fee and on completion of the work full payment, including the reserved amount, is made.

It is the essence of this agreement that the work provided for herein shall be carried on with the greatest efficiency and economy. To this end it is understood that the president of the company shall devote his attention to the work in all its details to obtain an efficient organization, a control over materials and supplies and the reduction of all waste. . . . This agreement may be terminated at once by the District upon disability of the present president of the company.

Cut-and-Dried Conduct of Society Elections

Incisive comment is passed in a recent issue of the *Engineering and Mining Journal* (July 3, 1920, p. 3) on the custom prevalent in engineering societies of establishing official nomination lists containing the name of a single candidate for each place to be filled. Contesting nominations from within the body of the membership are rare, and in substance the custom amounts to election of the officers by a nominating committee. We reprint the editorial without abridgment:

We have before us a ballot from the Harvard Engineering Society, to vote for officers. There is to be elected a president, a first and second vice-president, a secretary, a treasurer, and five governors. In the case of all but the governors, we are instructed to "vote for one." There is in each instance only one to vote for. In voting for the board of governors we are instructed to "vote for five." Only five candidates are given. We can go through the formality of voting the excellent ticket, which has been carefully selected by someone for us, or of throwing the documents in the wastebasket. In the interests of efficiency we shall do the latter.

According to the way of looking at it, this sending out of ballots, with no choice of candidates, to free and independent Americans, to ascertain their choice, is a meaningless courtesy of the Spanish type, a piece of stupidity, or an impertinence. What a waste of costly paper, perfectly good stamps, and clerical work there is here!

Engineers should stand for efficiency. If they get a Department of Public Works they are going to show the folks what efficiency is. Also, they should stand for honesty. Cut out, then, such meaningless ballots. If the form of your society (we are speaking to all engineers) is oligarchic—if a small group selects the officers and decides what the society shall do—simply advise those of us who are too busy to indulge in false motions who the officers are to be, and do not insult our intelligence as engineers and Yankees by asking which is our choice of one.

We do not intend to critize the oligarchic system as practiced by preference by engineers and scientists—although we should like each society some day to experiment with democracy. We are speaking now only from the standpoint of conservation of energy, and of efficiency. In the organizations in which we hold membership, we hereby appoint the secretary of each society which follows this system to cast our vote by proxy for all the candidates who will be appointed (elected) anyhow; and this proxy is permanent.

High-Speed Block-Laying on Miami River Levees

Trained Crew Weaves Concrete Mattress Blocks on Steel Cables at Rate of One a Minute—Only Hand Tools Employed

FLEXIBLE concrete mattress construction by stringing precast concrete blocks on steel cable, as beads are strung on a thread, is being done at remarkable speed in improving the channel of the Miami River at Dayton, Ohio. Four men carry and string, as a daily stint, 500 blocks, and they have placed as many as 800 blocks in ten hours Normally the stint is completed in eight hours. The area of mattress formed by 500 blocks is 1,000 sq.ft., each block being 24 x 12 x 5 in. and weighing about 118 lb. The ingenuity of the contractor in devising methods, his personal direction of the work and a skilled crew of old employees are the agencies chiefly responsible for this exceptional success of operations.

As indicated by the view, the task was to weave a 20-ft. ribbon of cast blocks on steel cable and after weaving to fasten the inner edge of the ribbon to the toe-wall of the slope paving and to hem its outer edge with heavy anchor blocks. The procedure adopted was: (1) With a special crew working well in advance of the revetment crews, to drive the sheet and foundation piles; (2) to string the blocks with the cable ends left projecting, and (3) to mold in place the slope slabs and to pour the toe-wall, cut-off walls and anchor blocks so as to embed the projecting cables and bind the blocks together.

As explained in *Engineering News-Record* of Aug. 21, 1919, p. 356, the blocks were molded and stored in a central yard. Block distribution by wagons, with a special body, was found to be most economical owing to the scattered locations of the placing operations, the steep descents from the levee tops to the beach and the rough and soft roads. A wagon to haul a load of 50 blocks, about 5,900 lb., was devised. It has a flat body hung between and below the axles by means of goosenecks so that loading and unloading requires the least lifting of the blocks. The blocks are distributed along the work in the numbers required, so as to keep short the distance they must be carried in placing; in practice this distance averages perhaps 20 ft.

Wire rope on reels is hauled to a point on the levee top, central to the operation in progress. Here the reel is suspended on an axle and the rope, as required, is unwound between three pulleys staggered so as to remove the kink due to reeling. The straightened rope is cut into lengths twice the width of the mattress and enough longer to provide a loop for anchorage to the toe wall and "pig tails" at the free ends for anchorage to the edging blocks. Since the cut ends of the rope have to be threaded through holes in the blocks, a method of cutting which would prevent the wires from "brooming out" was essential. A torch was successful but the operation was too slow. A quick method was then found to be the provision of opposite semi-circular notches in the blades of an ordinary hand shear. The radial squeeze due to the notches, bends in and clinches the wire ends at the cut and forms an excellent rope end for insertion into the holes in the blocks.

With a form plank set to line and grade to mark the

FOUR MEN STRING REVETMENT BLOCKS ON CABLES FOR MIAMI CHANNEL IMPROVEMENT

inner edge of the mattress, block-laying is begun. The lengths of wire rope are folded to U-shape, like a wire hairpin. A rope is laid perpendicular to the mattress with the loop end up the slope and the free ends resting on the form plank. Two men with long-handled tongs, which permit them to grasp and carry a block without stooping, fetch a block from the pile and swing it sidewise toward the form plank, where a third man inserts the rope ends into the holes and adjusts the block to position. Then a fourth man standing behind the block layer pushes the two strands of rope through the holes and about a foot beyond. A second block is brought and threaded onto the rope and so on. As the blocks are laid to break joints across the mattress, several sets of rope are in process of being threaded and the blocks have to be laid in a prescribed order, the working face taking a diagonal direction across the width of the mattress.

With practice the block-laying has become almost machine-like in regularity and also astonishingly rapid, as is indicated by the fact that the daily stint of 500 blocks in eight hours is a rate of over 60 blocks an hour. This fast work is due first to the fact that the men are skilled old employees and second, o the arrangement in force by which the daily stint is a day's work, however quickly it is completed. Frequently the block-laying crew completes its six days' stint in five days and can either lay off on Saturday or continue work and draw seven days' pay for a six-day week. Another factor in the progress being attained is the personal direction of the work by a contractor ingenious in devising methods and in maintaining close relations with his workmen.

About 175,000 blocks and 10,000 cu.yd. of molded-in-place slab and wall concrete are included in the revetment and mattress work at Dayton. The contractor is Price Bros., Lansing, Mich. The operation is a part of the flood-protection work of the Miami Conservancy District, Arthur E. Morgan, chief engineer, Charles H. Paul, assistant chief engineer, and C. H. Locher, construction manager. J. H. Kimball has general charge of channel improvements and C. A. Bock is the division engineer on the Dayton channel work.

Alaska Railroad Costs

The average cost per mile of several sections of the Government Alaskan Railroad is indicated in figures recently submitted by Colonel Frederick Mears, chairman of the Alaskan Engineering Commission. The estimated average costs per mile for completed railroad vary from $43,000 as shown below.

AVERAGE COSTS PER MILE OF ALASKA RAILROAD

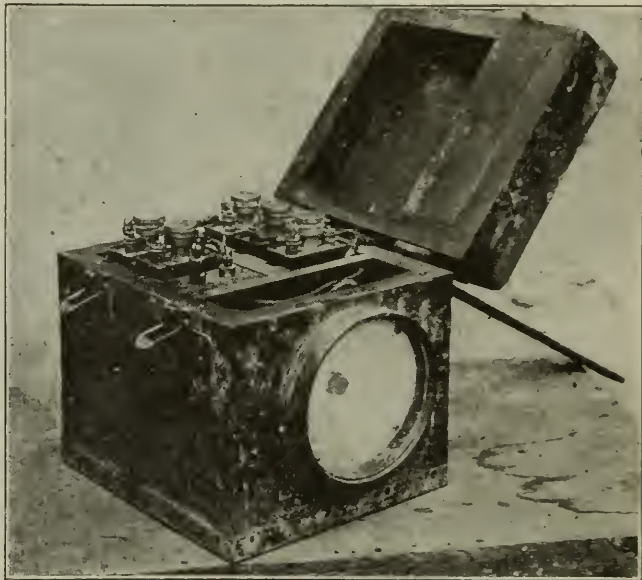
Section	Cost per Mile to Dec. 31, 1919	Estimated Average Cost per Mile to Complete	Estimated Average Cost per Mile Upon Completion
Mile 1 to mile 70.7, Seward to Kern Creek (70.7 miles)	$59,457	$13,120	$72,577
Mile 70.7 to mile 114.3, Kern Creek to Anchorage (43.6 miles)	112,865	6,500	119,365
Mile 114.3 to mile 150.9, Anchorage to Matanuska Junction (36.6 miles)	44,400	365	44,765
Matanuska branch (37.7 miles)	60,506	878	61,384
Mile 150.9 to mile 203.3, Matanuska Junction to Sheep Creek (52.4 miles)	46,256	2,700	48,956
Mile 203.3 to mile 264.1, Sheep Creek to Susitna River Crossing (60.8 miles)	42,700	23,100	65,800
Mile 264.1 to mile 290, crossing of Susitna River to Honolulu Creek (25.9 miles)	(1)	120,000	120,000
Mile 264.1 to mile 290, crossing of Susitna River to Honolulu Creek (25.9 miles)	(2)	70,820	70,820
Mile 290 to mile 315, Honolulu Creek to Summit of Broad Pass (25 miles)	....	56,640	56,640
Mile 315 to mile 334.6, summit of Broad Pass to Carlo Creek (19.6 miles)	....	63,275	63,275
Mile 334.6 to mile 347.3, Carlo Creek to Riley Creek (12.7 miles)	....	70,000	70,000
Mile 347.3 to mile 358.2, Riley Creek to foot of Nenana Canyon (10.9 miles)	....	157,080	157,080
Mile 358.2 to mile 411.2, foot of Nenana Canyon to Nenana (53 miles)	[3]67,560	6,825	74,385
Mile 411.86 to mile 467.7, north bank Tanana River to Fairbanks (55.8 miles)	30,700	13,000	43,700

[1] Includes 2 steel bridges. [2] Not including bridges. [3] Cost per mile includes Nenana River bridge.

Storage Battery for Sewer Work

TO BUILD a storage battery light that could be conveniently carried in one hand and which would provide adequate illumination for men engaged in repair or construction work in sewers, which could stand rough usage and which would require only simple and inexpensive maintenance, was the request made of the city engineer's office at San Francisco some time ago. The urgent need for such a light had become apparent after there were several accidents in the sewers due to the presence of explosive gases such as illuminating gas, gasoline vapor, etc. After designing several types and trying them out in actual service the city has adopted a light which satisfactorily meets all requirements for work in the sewers.

As first built the light consisted of a small wooden

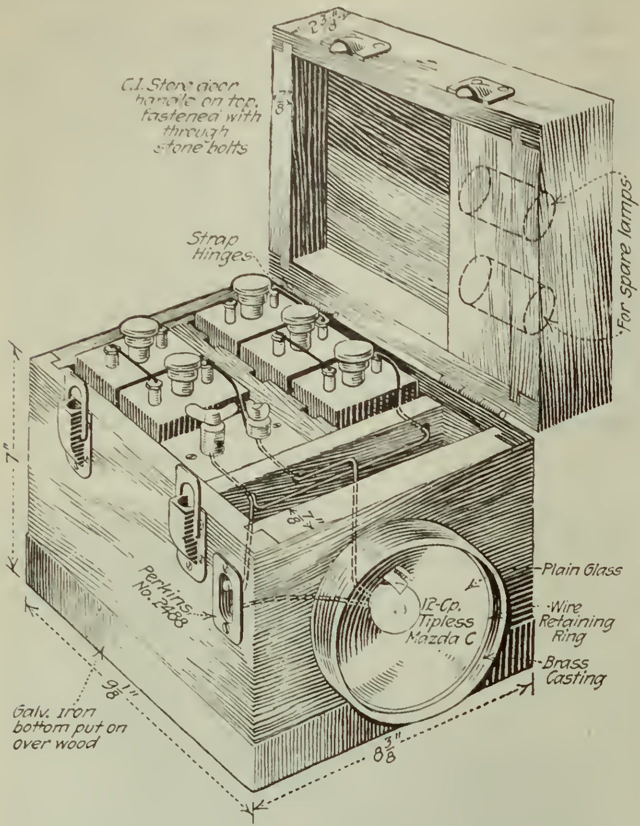


PORTABLE STORAGE BATTERY LIGHT USED FOR SEWER WORK IN SAN FRANCISCO, CAL.

box containing five storage cells with a 12-c.p. lamp in a silvered reflector fastened to the handle of the box. The cells were the Edison storage battery M-20, 12-ampere hour, motor-cycle type with rubber insulation. This arrangement was but partly satisfactory and later the lamp proper was attached to the box itself with a spun metal reflector coated with white enamel. This reflector gave a wider angle to the beam of light and did away with the "spottiness" and glare which was an objection in the earlier type using silvered reflectors.

After about a year's service of 12 of these lights it was found that the rubber insulated cell was likely to give trouble. The boxes were sometimes tipped over and filled with sewage and unless they were properly washed out and dried after such an accident, electrolysis made holes in the metal cell containers.

Accordingly, 24 lights having the same type of cells were built, but without soft rubber insulation. Hard rubber buttons attached to the cells were used to hold the latter in grooves cut in the sides and parti-



DETAILS OF SAN FRANCISCO SEWER LIGHT

tions of the box. These lights were provided with an automobile type of push-button switch mounted so as to be operated from the outside of the box. The same enameled reflector was used as in the previous design. In place of a plug and jack, as used in the first designs, new terminals in the form of binding posts of dissimilar character, which will fit only corresponding wire terminals, are used in charging. The dissimilarity of the terminals on the charging cord insures proper polarity. Lights of this design, as shown in the accompanying illustration, have been in service for some time and are reported to be entirely satisfactory.

Set Weighs 18 Lb.

The power of the light they give is quite sufficient to work by and yet does not consume a large amount of current. In fact, the lights are ordinarily used for three days' work without recharging. The set complete weighs 18 lb., which is considered rather heavy but it was thought worth while to make the box out of full 1-in. material and to reinforce it as much as possible so it would stand a great deal of abuse.

The recharging of the cells is done in the storeroom of the Board of Public Works. At first small motor generator sets were used for this purpose but it was later found more desirable to connect the cells directly to the direct-current circuit, using resistance units and a rheostat so that a varying number of cells could be connected in series and the current regulated to a strength of 2½ amp. With this arrangement the recharging of the cells is very simple and requires no expert attention.

Fire on Williamsburg Bridge

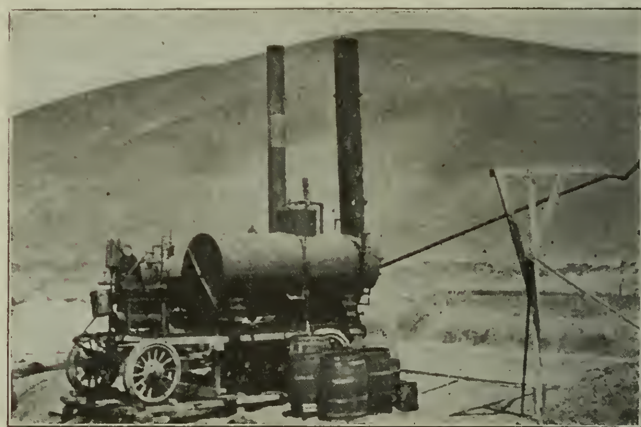
The Williamsburg Bridge over the East River, New York City, was damaged by the burning of a portion of the floor woodwork July 29.

Semi-Portable Oil Heating Plant for Surfacing Roads

Inexpensive Scheme Devised in California Reduces Delay and Cost in Heating and Delivering Oil

THE California Highway Commission has made a decided improvement in the means of unloading oil for surfacing roads. At first the practice was to install an oil heating plant at the railroad siding nearest the center of the stretch of road to be paved. The plant consisted of a steam boiler mounted in a brick setting, the necessary steam and oil piping systems and pumps for heating the oil and pumping it out of tank cars and a storage tank usually consisting of a pit lined with concrete.

Oil used for road surfacing in California always



CALIFORNIA HIGHWAY COMMISSION DEVISES NOVEL ROAD OIL HEATING PLANT

requires heating before it can be pumped from tank car or storage pit, but for installation such as described above, the cost is well over $1,000, exclusive of the equipment installed. If adequate time was allowed for the cement to set, it could hardly be built and made ready for service in less than a month or six weeks. As a result these plants were only put in at points from which a considerable mileage of work could be served, which meant long hauls for hot oil and perhaps superheating.

Where short stretches of surfacing or repair oiling had to be done some more flexible scheme was desirable. A semi-portable outfit built to suit this need has become standard. It is a self-contained unit that can be moved from place to place by motor truck at 10 miles per hour on good roads and which can be actually pumping oil within two hours after arrival at its destination. With it each tank car is now heated on the siding nearest the particular stretch of road which it is to supply and the oil is delivered at any temperature desired. By paying demurrage on a tank car for a day or two the necessity for constructing the storage pits is eliminated in most cases. Where storage pits are already in service, this outfit is used to heat the oil for delivery from the pit and when finished at one pit can be quickly moved. The term "semi-portable" is used to distinguish this plant from the portable oil patching outfit which carries its own supply of oil and is used only for very small patching jobs.

The outfit consists essentially of a steam boiler and

a retort, both mounted on the same automobile trailer chassis. All the necessary pumps and connections are grouped conveniently on the same frame, the arrangement being so balanced that there is less than 100 lb. difference in the weight carried by the two sides of the chassis. The outfit was assembled largely from parts of old equipment which were found in the Commission's store yards.

The steam boiler is of the marine type and is rated at 20 hp. It is 4 ft. in diameter and 9½ ft. long with a removable stack 10 ft. high. The retort was made from an old boiler shell $\frac{5}{16}$ in. thick, 3 ft. in diameter, and 10 ft. long. From this the steam dome was removed and the opening covered with boiler plate. The stack opening was increased from 8 in. to 12 in. and two horizontal slots were cut in each head of the boiler shell to permit the upper and lower tiers of coil pipes to project through so that the connections between the coil pipes could be made outside the shell. To support the coils further 1-in. angle irons are bolted to the heads along the lower edge of each slot.

Upper and lower pipes of the coil are connected at the rear by bolted flanges and at the front by unions, thus permitting any single pipe to be removed independently. The retort is insulated by a 1-in. layer of asbestos covered by a 16-gage galvanized iron jacket held in place by ⅛ x 1-in. iron strap. This jacket projects far enough to the rear so that the connecting flanges on the back of the retort may be inclosed in a false or extension head.

The invert of the retort is lined with firebrick and the burner deflects the flame downward against the brick to prevent burning the coils. Boiler and retort are attached by riveted connections to I-beams bolted across the frame of the chassis, and both have 10-ft. removable stacks.

The road oil is handled by a 6 x 4 x 6-in. steam jacketed pump mounted on a low bracketed platform hung at the front end of the plant. When the plant is set up ready for operation a 4-in. road-oil suction pipe with flexible connections is attached to the pump intake and connected with the discharge valve of the car. This suction line contains a 1-in. steam line with flexible connections for preventing the line from "freezing up" during any stoppage of the pumping. There is also a 1-in. steam line attached directly to the heating coils of the tank car. Under the arrangement used positive circulation of steam through the heating coils of the car does not depend upon the pump exhaust but is forced by a ½-in. jet of live steam, thus eliminating back pressure on the pump.

In this manner the oil in the tank car is quickly raised to a temperature at which the pump will handle it and when the oil begins to circulate through the pump and the retort it is for awhile returned to the tank car so that operations can be hastened by using the heated oil to warm up the remainder of the oil in the car. When the desired temperature has been reached, usually 250 to 300 deg. F., a three-way cock on the delivery line turns the heated oil into the loading spout.

The fuel-oil system consists of a 3 x 2 x 4-in. steam pump mounted at the rear end of the plant, and provided with a pressure regulator, a heating reservoir and a return overflow as a release for the pressure regulator. This pump takes fuel oil either from drums or from a tank wagon connected to the pump supply line and delivers it at the desired pressure to burners in the retort as well as in the steam boiler. The rate of fuel consumption averages about 8 to 10 per cent of the volume of road oil handled, this ratio varying with the rate of sending out loads. The retort burner operates at full heat only during the actual loading of a tank. Also the fuel efficiency depends, of course, upon whether the oil is handled directly out of the car or heated only for unloading and then re-heated for distribution.

The weight of the outfit complete, exclusive of fuel and water, is 7¾ tons. Although it has to be handled with care, it withstands the jar of moving very successfully. When the plant is being moved the two smokestacks and the long sections of pipe for making connections to the car are carried betwen boiler and retort. When set up for service the chassis is jacked up and set on solid underpinning to avoid vibration.

Model Chimney Ordinance Specifies Flue-Lining for All Chimneys

All chimneys, irrespective of what material (brick, concrete, stone or hollow tile) must be lined with fire clay flue-lining or with fire brick, according to a model ordinance for chimney construction just drafted and issued by the Natioal Board of Fire Underwriters' committee on construction of buildings. The ordinance refers to chimneys of ordinary dwelling houses or the like and does not cover power plant chimneys or others in which high temperatures are maintained. Safe design and construction methods are described quite fully.

Brick or concrete chimney walls must be at least 4 in. thick, and concrete chimneys cast in place or concrete blocks must be reinforced in both directions. Stone chimneys must be 4 in. thicker, and rubble walls not less than 12 in. thick. Hollow tiles may be used for chimney walls where the chimney is attached to or forms a part of an exterior hollow tile wall of a building not over three stories high, in which case the chimney wall must be 8 in. thick or more. Flue-lining is specified to be not less than ⅝ in. thick, to have no collars, to be set in cement-lime mortar 4:1 by weight (as used for the chimney wall masonry) and to be carried up continuously to 4 in. above the capping; the projection allows for a 2 in. sloping wash of rich cement-mortar and a 2 in. projection of the lining. When two flues are set in the same space within the chimney brickwork the in-joints must be offset at least 7 in.

Chimneys are to be built at least 3 ft. above flat roofs and 2 ft. above the ridges of peak roofs, and must be properly capped with terra cotta, stone, cast-iron or the like. Minimum flue areas are fixed as 75 sq.in. for furnaces or fireplaces, 49 sq.in. for stoves or ranges, and 10 sq.in. for small gas stoves or heaters. Where a flue enters the chimney in a cellar or basement, a clean-out must be provided below the smoke intake.

It is stated in support of this ordinance that the average annual loss due to defective chimneys in the United States, determined from three-year figures, was over $12,000,000, and taking account of unreported losses it is estimated that the total per year is over $16,000,000. All such fires are considered "strictly preventable." Ira H. Woolson, consulting engineer to the National Board of Fire Underwriters, drafted the ordinance, for a committee of the board headed by E. T. Cairns.

Old Wood Stave Pipe Successfully Rewound On the Job

By M. R. Kirkpatrick
Superintendent, Ochoco Dam, Prineville, Oregon

THE wood-stave pipe now in use on the Ochoco hydraulic-fill dam near Prineville, Ore., was purchased a dozen years ago and since that time has been in use on 11 extensive sluicing jobs and has been many times moved, stored or shipped by rail. That it was worth shipping to the Ochoco work at all is much to its credit. After a short time in the hot, dry climate of Prineville, the winding became so loose from shrinkage of the staves that great care in handling was necessary to prevent the pipe from falling to pieces, and its use in a pipe-line without some repair was impossible. Submersion in water was tried in the hope that the wood staves would swell to their original size and so make the wire wrapping taut. This plan failed even when a pipe was left in the water until it became water logged. The next scheme tried was that of driving wooden wedges under each turn of wire until the wrapping became taut enough to hold the staves in place. Thus succeeded in making the pipes water tight, but the wedges made sharp kinks which caused the wire to break easily. Moreover, they interfered with rolling the pipe and gave it a very shabby appearance. It was then determined to attempt rewinding. After some experiment a method was devoloped which has been applied to several thousand feet of 14- and 18-in. pipe with such success that the old pipe has apparently served its purpose as well as new. Heads up to 350 ft. have been used.

A rewinding machine was built up on a bedplate consisting of two 8 x 8-in. timbers 18 ft. long, held rigidly 4 ft. apart by 4 x 6-in. headers and ½-in. iron rods. Two standards or bearings were built up on this bedplate to a height of 3 ft. One of the standards was fixed rigidly to the bedplate and the other was made to slide along to accommodate different lengths of pipe. A socket suitable for a 2-in. iron pipe was cut in the top of each of these bearings. A pair of 6-in. tapered end plugs was made for each diameter of wood pipe to be rewound. Each plug had four radial turning arms 2 ft. long bolted to it. The center of the plugs was bored so that the 2-in. iron pipe could be easily thrust through.

Before being put in the rewinding machine each section of pipe had its staves drawn up together by means of a split ring of ½-in. iron with lug and nut for tightening. The ring was placed around the chime (the chime is the 4-in. section on each end of a wood stave pipe which carries no wiring and is chamfered so it can be driven tightly into a wooden coupling). After cinching the pipe with the split rings, one at each end, the two plugs were driven solidly into place with an 8-lb. maul. The section was then rolled upon skids to place in the rewinding machine, and the 2-in. pipe thrust through the end plugs and rested in the sockets of the two standards. The pipe section could then be rotated easily by means of the end plug handles.

In unwinding, one end of the wire wrapping was pried loose and attached to a reel. Two men, one on the crank on each side of this reel, wound the wire upon it, while a third man guided the wire to place on the reel by moving back and forth a wooden crotch made of two pieces of 1 x 6-ft. timber, 5 ft. long, fastened together like the letter X, the bottom of which rested upon the ground. A man stood at the handles of one of the end plugs to prevent the pipe from rotating too fast and another man worked along the pipe as the wire unwound, ready with hammer and chisel to take out the staples as they were reached.

REWINDING A LENGTH OF WOOD STAVE PIPE

Best results were not obtained until this reel was moved to a distance of about 75 ft. from the rewinding machine. The reel drum was about 2 ft. in diameter and 1 ft. long, with flanges 4 ft. in diameter. As the wire was unwound, additional ½-in. pipe rings were placed every 4 ft.

When ready to begin rewinding, the end of the wire last removed from the pipe was restapled on the same end from which it was taken and two men at the handles of each end plug rotated the pipe so that the wire would rewind upon it. The old groove in which the wire originally fitted was plainly visible and one man guided the wire into this groove, or as nearly so as feasible, while another constantly hammered the wire to make a snug fit. With very little experience a job closely resembling a machine-wound pipe was produced.

Proper tension on the wire was obtained by placing one end of an 8 x 8-in timber, 16 ft. long, on top of the rewinding reel, the other end of the timber resting on the ground. By sliding the ground end of this timber to or from the reel, the desired tension was secured. It was found possible to replace weakened or broken staves before rewinding, although ordinarily this was not required. When the chimes had been damaged, a new chime was cut on the pipe, space being left for this repair when the pipe was rewound.

With this equipment and the crews mentioned 115 ft. of 14-in. pipe or 75 ft. of 18-in. pipe could be rewound

in a day. The cost for the 14-in. pipe was 24c per foot and for the 18-in. pipe 39c per foot. The diameter of the 18-in. pipe after rewinding was about 17 in.

The Ochoco dam is being built by the sluicing department of the Puget Sound Bridge & Dredging Co., formerly Lewis, Wiley & Morse, Inc., of Seattle.

Water-Waste Survey Shows Defects at Evansville, Ind.

Tests Disclose Broken Pipes, Running Fixtures, Secret Connections and Large Meter Recording Half Its Flow

RESULTS of a water waste survey by the pitometer system, which included the detection of an industrial meter so geared as to be 45 per cent slow, were given at the annual meeting of the Indiana Sanitary and Water Supply Association by Charles Streithof, superintendent of the water department at Evansville, Ind. A 24-hr. record of flow in the two 30-in. mains supplying the distribution system showed 10,245,600 gal. by the pump counters and 10,102,000 gal. by the pitometer measurement, the slippage of the pumps being less than 1½ per cent.

As a preliminary to the main survey two districts having different characteristics were selected. District No. 1, covering 110 blocks, was mainly residential but contained twelve manufacturing plants and two packing houses. The average daily consumption was 1,018,000 gal., and the minimum night rate was 750,000 gal., or 73.6 per cent. Of 350,000 gal. per day in the 12-in. main on Morgan Ave. it was found that 129,000 gal. were metered for industrial use and 36,000 gal. metered by a 6-in. meter of the Evansville Packing Co., while 185,000 gal. passed this meter without being recorded. Although a 4-in. meter at the same plant had not registered since October, 1918, the pitometer tests showed that water was being supplied through this main, while when this was shut off the company had to ask to have it turned on again.

With the larger meter registering incorrectly the loss of water and consequent loss of revenue might have continued indefinite through no fault of the meter reader. After a series of tests this meter was examined by two representatives of the meter company who found that the gear ratio was wrong and the meter was 45 per cent slow. Assuming the low figure of 175,000 gals. per day at 5c. per 1,000 gal. the annual loss to the department has been about $3,200. Investigation showed that when this meter was purchased about three years ago it was fitted with a register of cubic feet. This was changed to a register of gallons and a mistake was made in the gears supplied by the maker for this change.

District No. 2 was in the heart of the city, where the mains and surface piping are about fifty years old. This district of 42 blocks contains hotels, theaters, churches, hospitals, clubs, city hall, police and fire stations, a large part of the business section and many residences, only a few of which are metered. The average daily consumption was 1,043,000 gal. and the minimum night rate 700,000 gal. or 67 per cent. Leaks were discovered where a 1-in. connection discharged into an abandoned vault and three 1-in. services were broken off at the mains.

For the survey of the entire distribution system the city was divided into 15 districts, each divided into two or more sub-districts, depending upon the extent of the territory. In all districts where gaging points were established for sub-division work a permanent vault was built, with an iron manhole cover, so that future tests may be made without tearing up the paving. Traverses were made at all gaging points on mains larger than 6 in. in diameter. In a district which is 100 per cent metered and entirely residential the average daily consumption was 150,000 gal. and the minimum night rate 115,000 gal., or 75 per cent. This district was composed of 56 city blocks, all thickly settled.

The test showed that 35,000 gal. were running to waste at a public school building, where the following fixtures were found to be running continuously, night and day: 30 toilets, 14 urinals, 4 drinking fountains and 7 wash stands. Water was being wasted in all public buildings, particularly those supplied with water at a minimum rate or getting water free. There was 69 house service connections with bad leaks or broken service connections discharging into sewers. One drain line valve was found partly open and three fire hydrants with drain valves disconnected and water discharging into sewers. Several unauthorized connections were also discovered.

Since the completion of the survey the average daily pumpage shows a reduction of 669,000 gal. Although the system is 50 per cent metered, including all large services, it is considered that this survey was well worth its cost. Practically all the valves in the distribution system were operated, and in several instances it was found that pipe lines were not connected, of which the water department had no information. All fire services were tested, unknown to the owners. Several illegal connections were found. The underground leakage located during the survey amounts to over 500,000 gal. per day, which at a rate of 5c. per 1,000 gal. per day would indicate a saving of $25 per day. This amount does not include the under-registration of meters.

Tentative Height Zones for Washington

THE zoning Commission of the District of Columbia has tentatively adopted a plan restricting the height of buildings in four stated districts to 35, 55, 85, and 110 ft. The plan provides that in no case shall the height of buildings exceed the width of the street and that the height of buildings on the corner lots shall be governed by the width of the wider of the two streets, but shall not exceed a depth of 100 ft. measured along the building line of the narrower street. The proposed heights are to be the maximum allowed and no building shall be higher than is provided by an act of Congress June 1, 1912, nor than limited by Section 39a of the District building regulations for 1915. The proposed rules provide that in the 35-ft. height districts various public or semi-public buildings may, upon approval of the Commissioners of the District of Columbia, be carried to a height not over 55 ft. when kept back from the building line not less than 1 ft. for each foot of height in excess of 35 ft.

Highest Mountain in New York

According to the U. S. Geological Survey the highest mountain in the State of New York is Mount Marcy, a peak on the Adirondacks, which rises 5,344 ft. above sea level. The average or main elevation of the state, as estimated by the Geological Survey, is 900 ft.

Year's Traffic Census on French National Roads Begins

Three General Classifications for Vehicles and Two for Animals — Special Forms for Tabulation Prepared

A TRAFFIC census, to be carried on under the direction of the Minister of Public Works, is to be taken upon the French national highways beginning Aug. 3 and continuing for a year. The census will be in direct charge of chief engineers and division engineers of departments, with whom is left some choice as to the location of traffic count points.

In general, traffic count points established in preceding censuses, notably that of 1913, will again be used in the 1920-1921 census, though additional points will of necessity be chosen in certain locations where recent industrial and railroad expansion has been noted. The census, beginning on Tuesday, Aug. 3, will continue at intervals of thirteen days, ending Wednesday, July 21, 1921. Counts will begin at 5 a. m. from April 1 to September 30, and at 6 p.m. for the rest of the year. They will end at 9 p. m. Night counts will be made, the chief engineer fixing their frequency and points at which they will be made, taking into account local circumstances in such a fashion as to secure as nearly as possible exact representation of night travel.

Vehicles will be classed, as in preceding censuses, in three categories: First, vehicles loaded with produce and merchandise; second, public conveyances loaded or empty; and, third, private conveyances and empty conveyances of any nature, save those named in the second classification. Animals not attached to vehicles will be placed in two classifications: Unharnessed animals such as horses, cattle, mules and donkeys; and small cattle including sheep, calves, swine, and goats. Among the unharnessed animals distinction will be made between those which are mounted by riders, or laden, and those which are neither mounted nor laden. The five following classifications will be made of self-propelled vehicles: (1) Commercial automobiles, (trucks, vans, delivery trucks); (2) auto buses (automobiles used in public passenger transport); (3) private automobiles; (4) motorcycles; (5) velocipedes or other vehicles moved by the feet. No count will be made of pedestrians. Cars traveling upon rails will be made the object of a particular census for which later instructions will be given.

Fig. 1 is a reproduction of the census blanks which will be distributed among those taking the traffic censuses. The passage of each vehicle or of each unharnessed animal is noted by means of a pinhole pierced in the proper column in one of the little squares. Vehicles drawn by donkeys, and pushcarts, are noted in the column of empty vehicles, no matter what loads they carry. Cannon and artillery caissons will be counted as empty vehicles. When unharnessed animals appear in large groups, as in detachments of cavalry or in large herds, their numbers are set down in pencil in larger spaces pro vided for such purposes. Automobile trailers will be noted by as many pinholes as there are trailers. As soon as the count has been finished sheets are totaled and turned over to division engineers who make totals of all counts made in their divisions and who in turn send such totals to the chief engineer of the department in which they operate.

In order to determine the weight and intensity of the traffic, all traffic is referred to a "collier," or a draft horse harnessed to a vehicle. A vehicle loaded with produce or merchandise is counted as one collier; a public conveyance either filled or empty counts as one collier; private vehicles for passengers and empty vehicles of any description, save those noted in the second classification, are counted as ½ collier; unharnessed animals such as horses, cattle, mules, and donkeys count as ⅕ of a collier; and small beasts, such as calves, sheep, swine, and goats count as 1-30 of a collier. In order to reduce self-propelled vehicles to the common collier base it will be necessary to weigh enough vehicles of all types to arrive at a mean weight.

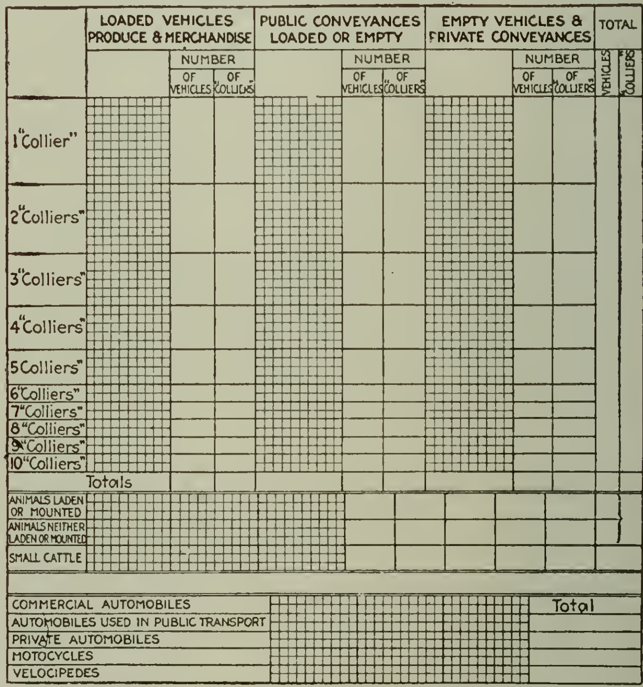


FIG. 1. CENSUS SHEETS FOR RECORDING TRAFFIC DATA

No reduction of automobiles to colliers is made until after an average weight of those vehicles is available from weighings taken all over the department. The letter P expresses that yet undetermined mean vehicle weight in the following reduction of automobiles to colliers: Commercial automobiles, 1.20 P colliers; autobuses, 2 P colliers; private automobiles, 5 colliers; motorcycles, ½ collier; velocipedes, 1-20 collier.

In order to arrive at a definite determination of the value of a collier, those taking censuses are requested to make as frequent weighings of passing vehicles as is possible. Where it is impossible to weigh passing vehicles information will be sought from drivers as to approximate weights.

From the individual traffic count sheets compilations are made which show the amount of tonnage, in kilograms and kilometers, moving over any national highway. Table 1 indicates the method used in determining this tonnage. Gross weight is composed of the dead weight of the vehicle and of the harness, together with the useful weight of the load whether it be persons or produce, merchandise or baggage. The useful tonnage noted in columns 19, 21, 33 and 35 comprises only produce, merchandise and baggage, passengers being omitted. Useful load of private conveyances, of donkey carts, of push carts, of beasts of burden, of private automobiles, of motorcycles and velocipedes is neglected.

In estimating the average weight noted in the odd columns from 13 to 27 due regard is given to the fact that not all vehicles traveling are loaded to capacity. The columns of even number are the product of the columns of odd number by the corresponding length of road.

The table is arranged by roads. For each road, the total weights of traffic are given and the products are found for each section of traffic count. A total is then made of these products, and this total, divided by the length of the road, gives the mean relative weight sustained by the road. At the end of the table there is made a general recapitulation by roads. By the same means employed in the determination of loads sustained by any particular road there is found the total load sustained by all the roads in either a division or a department. The results are only approximate as the lengths are expressed in kilometers with no decimals and the weights in kilograms without fractions.

All departmental reports are to be in the hands of the central administration not later than the first of November, 1921.

As a general rule those making the traffic counts will be men employed upon road work, or *cantonniers*. For each traffic count taken during the day the man taking the count will be allowed a half day's salary, or one-fiftieth of his monthly salary. For each count taken at night a pay equal to the salary of a day and a half will be given. If a road worker is called to make counts outside of his district his traffic count pay as noted will be increased by one-fifth, and in case counts are made on Sundays or holidays the pay already noted will be increased with the day's salary.

TABLE I. CHART FOR COMPILING "COLLIERS" AND TONNAGE FROM DATA SUPPLIED BY INDIVIDUAL CENSUS SHEETS

Designation of Roads and Road Sections	Road Lengths (Kilometers)	Average Weight of Animals Harnessed to						Mean Weight of Unharnessed Animals		Mean Weight of Small Cattle		Gross Weight by "Colliers" of						Useful Mean Tonnage By "Colliers" of				Gross Mean Weight of										Mean Useful Tonnage of			
		Agricultural Vehicles		Public Conveyances		Private Conveyances						Agricultural Vehicles		Public Conveyances		Private Conveyances		Agricultural Vehicles		Public Conveyances		Commercial Automobiles		Autobuses		Private Automobiles		Motorcycles		Velocipedes		Commercial Automobiles		Autobuses	
		Weight	Product	Weight	Product	Weight	Product	Weight	Product	Weight	Product	Weight	Product	Weight	Product	Weight	Product	Weight	Product	Weight	Product	Weight	Product	Weight	Product	Weight	Product	Weight	Product	Weight	Product	Weight	Product	Weight	Product
Column	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36

Shortage in Housing Construction

Building permits issued in twenty-one cities of various sizes widely distributed over the United States show that, in value, housing construction formed 36 per cent of all building in 1913; 21 per cent in 1918; and 27 per cent in 1919, says a recent report emanating from the United States Forest Service. The amount of housing construction in 1913 was exceeded in 1918 in only two of the twenty-one cities, continues the report, and in 1919, in only six, in spite of the "Build a Home" campaign. The falling off in house construction appears to have been most marked since late in 1919 when the greatest upward movement of lumber prices began.

Railway Gage Problem in Australia

RENEWED discussion is taking place in regard to the problem of unifying the railway gages of Australia, according to a report by Consul Edward J. Norton, Sydney, New South Wales, recently published in *Commerce Reports*. Every year the problem is becoming of more pressing importance on account of the increasing extra cost, delay, and inconvenience in transferring of passengers and freight at places where breaks of gage occur.

The following tables indicate the growth in track mileage since 1913 and the existing gages of the Commonwealth railway system, as well as amounts of rolling stock:

MILEAGE OF RAILROAD OF DIFFERENT GAGE IN AUSTRALIA

State	— Track Open — 1913–14 Miles	1917–18 Miles	Existing Gages Ft.	In.
New South Wales	4,251	5,030	4	8½
Victoria	3,886	4,222	5	3
Queensland	5,213	6,679	3	6
South Australia	2,357	3,356	5	3
Western Australia	3,910	4,904	3	6
Tasmania	766	781	3	6
Northern Territory	146	199	3	6

CARS AND LOCOMOTIVES OF DIFFERENT GAGE

Gage	Locomotives	Passenger Cars	Freight Cars
4 feet 8½ inches	1,282	1,659	22,859
5 feet 3 inches	1,038	1,978	24,120
3 feet 6 inches	1,395	1,577	31,600
2 feet 6 inches	17	34	254
2 feet	11	13	211

In 1897 when a conference between the railway commissioners of New South Wales, Victoria, and South Australia made estimates for a conversion to a standard gage, the costs were reported as follows: To a 5-ft. 3 in. gage, $20,730,000; to a 4-ft. 8½-in. gage, $11,500,000. In 1912 another conference of railway engineers representing the six states was held at which the estimates were: To a 5-ft. 3-in. gage, $251,400,000; to a 4-ft. 8½-in. gage, $180,860,000. During the interval from 1897 to 1912 trackage had nearly doubled and construction costs had increased 50 to 150 per cent.

As an indication of the extra transportation costs involved, the junction charges on interstate traffic between New South Wales and Victoria range from 1s. 6d. to 2s. 6d. (from 37 to 61 cents) per ton. On the journey of 3,476 miles from Brisbane to Perth the through passenger is obliged to transfer six times because of the break of gage between connecting lines.

In a report submitted to the Federal Parliament in 1911 the consulting engineer recommended the adoption of a uniform gage of 4 ft. 8½ in. for the railway systems of the commonwealth. The last conference on the subject of a universal gage for the Commonwealth railways was held at Melmourne in August, 1918.

Cracks in New Brick Pavement

By C. C. Wiley
Assistant Professor Highway Engineering, University of Illinois

IN THE spring of 1918, following an unusually severe winter, several peculiar cracks appeared in some of the newest brick pavements in the city of Champaign, Ill. A year later a few more appeared and others are now being watched for. The cracks all occurred in pavements of the newer type, none of which were more than about 5 yr. old. These pavements were exceptionally well built, with well-prepared subgrade, 6-in. concrete base, a 1½-in. sand cushion, and 4-in. brick with asphalt filler. Combined concrete curb and gutter was used. The concrete base was 1:4:8 mix in the older sections and 1:3:5 in the newer. The subsoil is principally yellow clay and loam which compacts well and drains readily. There are, however, occasional pockets of heavy clay which drain slowly, and of sandy clay which heave considerably with frost.

CLOSEUP OF CRACK, SHOWING FILLING STARTED

The cracks showed on the surface by an opening up of the joints between the brick giving the appearance of a crack in the pavement which was easily traceable with the eye and by a subsidence of the brick due to a shifting of the sand cushion. No displacement of the curb was noticeable to the naked eye. With a single exception the cracks began at the junction between a new and an older and poorer type of pavement, and extended practically parallel to the curb and from 3 to 6 ft. distant from the edge of the brick section for a distance of 50 to 100 ft. The one exception began at a small bridge over which the pavement and curb was continuous but was otherwise typical.

On removing the brick and sand cushion the concrete base was found to be cracked cleanly. The opening varied from ½ to ¾ of an inch in width at the junction with the old pavement and gradually tapered out to the point of disappearance. The displacement was entirely lateral as neither section was raised above the other.

Repairs were made by cleaning the cracks thoroughly and then filling them with hot asphalt. The sand cushion was then replaced, the brick relaid and the joints repoured with asphalt. None of these repairs have given any difficulty, are practically invisible, and apparently the cracks have not widened or extended. The accompanying photograph shows one of these cracks while repairs were being made.

It is the general opinion that the cracking was due to frost and that the position of the cracks bears some relation to the location of the drain tile. It seems reasonable to assume that frost was the primary cause but there is no apparent relation between the positions of the tile and the cracks. One crack occurred with a line of tile on each side of the pavement, one with no tile at all, while the remainder are equally divided between the same side and the opposite side to a single line of tile. It therefore appears more probable that the contributing factors were the pockets of different materials previously referred to. This goes to show again the importance of having *uniformity* in the subgrade as against great compactness.

Motor Trucks on Eastern Farms

Some illuminating data have been secured in a recent survey of motor trucks used on farms in the eastern states, made by the United States Department of Agriculture. The survey covers reports from 753 farmer motor truck operators. The farms which these men operate are of all sizes and types and the motor trucks of varying sizes from ½ to 5 tons. The rated capacity of very few of the trucks is greater than 2 tons, however, says the office of Farm Management and Farm Economics, who directed the survey, and nearly half of them are of the 1-ton size. Among the important facts revealed by the investigation are the following:

Only 18 per cent of these farms are less than 5 mi. from markets and nearly one-fourth of them are 20 mi. or more. One-ton trucks are preferred by more men than prefer any other size.

As compared with horses and wagons, the trucks save from one-half to one-thrid of the time required for hauling materials to and from farms.

Farmers have return loads for their trucks about one-fourth of the time.

About one-fourth of the farmers have changed their markets since purchasing trucks, the average distance to the old market being 7 mi. and the average distance to the new one 20 mi.

On the average trucks travel 3,820 mi. per year and are used 173 days per year. The average cost of operation of the ½-ton trucks is about 8c. per mile; of the ¾-ton trucks about 13c.; of the 1-ton trucks about 12c.; of the 1¼-ton and 1½-ton trucks about 19c., and of the 2-ton trucks about 20c.

The average cost of hauling crops, including the value of the driver's time at 50c. an hour, is about 50c. per ton-mile with the ½-ton trucks; 34c. with the ¾-ton trucks; 26c. with the 1-ton trucks; 24c. with the 1¼- and 1½-ton trucks, and 18c. with the 2-ton trucks.

Milwaukee Testing Station Results on Filtration of Water

Hydraulic Jump Makes Excellent Coagulant Mixer—Ozone Treatment Cost Out of Reason—Slat Underdrains Effective

UTILIZATION of the hydraulic jump to obtain a cheap and effective mixing of coagulating chemicals with the water to be treated is the most striking possibility obtained from the year's experimental work by J. W. Ellms, consulting engineer, Cleveland, O., on the water purification problem at Milwaukee, Wis. That apparatus for sterilization by ozone is not yet developed to the point where it can compete with chlorine is another conclusion backed by plenty of data. High rates of filtration are believed to be feasible, at least the recommended plant will have passages large enough to accommodate a flow of 15 per cent in excess of the normal. A wooden grid strainer system compared favorably with a pipe-manifold strainer system.

Four mixing devices were experimented with: (1) An "around-the-end" series of 22 mixing channels, 60 ft. long, 13 in. deep and 5½ in. wide; (2) a compact "fish ladder" tank, 7 ft. high and 1 x 3 ft. in plan with 17 around-the-end baffles; (3) a "fall," consisting of a 4 x 4-ft. box, 3 ft. deep, near the top of which was placed a 10 x 10-in. receiving tray. The water spilled over the sides of the tray to an apron set at an angle of 45 deg. on which were 1-in. riffle strips. From the apron the water fell on a pile of stones; (4) a "flume" or trough, 28 ft. long, 2 ft. wide and 1 ft. deep, contained 13 riffles, 2 ft. apart and 6 in. high. It was set on a slope to give a 4-ft. drop. Mr. Ellms describes the results of experiments with the mixers as follows:

The poorest mixing action was obtained with the "fall"; some improvement was effected after changes were made in the manner of introducing the chemical solution, but on the whole its action was unsatisfactory. Somewhat better results were obtained with the "fish ladder," but as this device is in reality an "around-the-end" baffled mixing chamber placed vertically, it offered no particular advantage except in taking up but little space.

It was observed when using the mixing chamber that prompt coagulation, which is, of course, an indication of the completeness of the mixing, took place in the first five or six channels, but that the size of the floc had decreased as the water passed through the lower channels. In some cases the flocculation did not make its appearance until seven or eight channels had been passed, reaching its best condition in the tenth and twelfth channels. The long travel, however, appeared unnecessary and even harmful in breaking up the floc.

In order to see whether reduction in the size of the flocculated particles was due merely to the velocity acquired in the straight channels, or was caused by the agitation of the water as it reversed its direction of flow at the ends of the channels, the latter were blocked about 18.9 ft. from the end and new openings cut through the baffle walls. The same number of reversals of the direction of flow was obtained, but the length of travel in each channel was cut down from 60 ft. to 18.9 ft. The results were as satisfactory as those previously obtained, but no more so, although nearly 70 per cent of the chamber has been cut out of service.

The water in flowing down the "flume" formed a series of cascades. An excellent mixing action was produced at a comparatively low velocity of flow. The loss of head, however, was too great. By cutting the flume into two parts and attaching the box known as the "fall," the loss of head was cut down about 25 per cent. The results obtained were good and were secured with a low rate of flow. The device takes up little room as compared with a mixing chamber. Mr. Ellms says:

In the last device an entirely new principle was utilized. By removing the weirs from the "flume," extending it slightly into the receiving box ("fall"), and placing a low weir at the end, there was produced by the rapid flow of the water down the flume a "hydraulic jump." By the impact of the water flowing down the "flume" into the pool back of the weir, a turbulent condition of the water was produced, which effectively mixed the chemical solutions and the water. The chemical solutions were applied at the head of the "flume." The water acquired a velocity of 9 ft. a second in flowing down the "flume," but this velocity was practically all dissipated in complex eddies, at the "jump." Considerable air is trapped in the "jump," and its escape contributes materially to the turbulent condition of the water and consequently improves the mixing action.

The results with this device have been very satisfactory, and the reason for it requires explanation. When a precipitate is the product of a chemical reaction, it first appears in a very finely divided condition. In the case of a colloidal precipitate such as ferric hydroxide or aluminum hydroxide (the two compounds utilized in water purification), the aggregation of these particles into larger masses is necessary, not only to entrap the fine sediment and minute bacteria in the water, but also to prevent them from passing through the sand bed of the filters. It is obvious that violent and continuous agitation of the water will hinder rather than assist in the clotting together of these particles, and hence, to aid this coagulation, a quiescent condition is necessary.

The "hydraulic jump" mixing device provides an extremely rapid and thorough mechanical mixing of the chemical solution and the water to be treated, thereby bringing the reacting substances together and hastening the reaction. Immediately following the "jump" the water flows quietly to a settling basin in which the physical action of coagulation can take place with the least possible amount of agitation, and thereby reduces to a minimum the breaking up of the floc during its formation.

Experiments were made with floats on the actual rate of flow through a four-pass 40,000-gal. settling basin. When run at a rate giving a theoretical displacement period of 7.5 hours they indicated a detention period varying from 4.9 hours to 4.1 hours, corresponding to a linear velocity of 0.46 ft. and 0.56 ft. per minute. At double the theoretical rate the actual velocities varied from 1.24 ft. to 1.1 ft. per minute. This doubling of the actual velocity over the theoretical was rather surprising in view of the shallow depth of tank, 8 to 9 ft. The sliding of the top water over that at the bottom of the tank is in some ways considered undesirable, since it means larger basins. It shows, says the report, that the slowly moving or quiet body of water near the bottom furnishes a zone in which deposition may take place more quickly. The performances of the tank, even with turbidities between 15 and 20 p.p.m., showed a reduction of 67 per cent for a theoretical displacement of 7.5 hours and 45 per cent for 3.75 hours. These results were obtained with alum. With lime and iron the settled water turbidity was always higher than that of the lake water.

Unsatisfactory results were obtained from an attempt to produce an artificial turbidity to improve coagulation. By the addition of an aluminous clay the turbidity was raised from 3 to 21 p.p.m. A larger floc was produced but the filter sands were overloaded with clay, which the washing did not remove. Effluents were slightly turbid at the beginning of a run. Since the turbidity of

21 p.p.m. was brought down to 7 p.p.m. in the water applied to the filters, the investigators concluded that there was not too great a volume of sediment passing to the filters.

Wooden Grid Strainer System

Two filters, 5 x 5 ft. 8½ in. in area, equivalent to 0.001 acre, had a depth of 9 ft. A U-shaped gutter extending through the center of the tank had its edge 2.5 ft. above the 35-in. sand layer which rested on a 16 to 18-in. gravel layer.

The wooden grid strainer system in one filter consisted of 1 x 6-in. boards set on edge 1 in. apart, giving a 50 per cent opening. The underside of the grid was placed 6.5 in. above the bottom of the filter box. The perforated pipe system in the second filter was provided with openings of 0.3 per cent area of the bed. Pipe laterals of 1½-in. pipe with ¼-in. perforations placed 2½ in. c. to c. and staggered were used. Of these filters the report states:

The rate at which the filters were washed was from 16 to 19 in. per minute, with a rate of 20 or 21 in. per minute when the wash water valve was first opened. It was somewhat unfortunate that it was not possible to wash at higher rates for experimental purposes. While flotation of the sand was always affected and the sand bed properly cleaned each time, it may have required somewhat more wash water to do the work than would have been needed with a higher pressure. The distance between the sand and the edge of the wash trough was 30 in., and was probably higher than was needed for the washing rate available.

The pipe manifold strainer system gave satisfactory results, and is a safe and conservative design. Nothing developed in its use experimentally that indicated that it could not be employed locally in the design of a municipal plant.

The wooden grid strainer system also gave good results. Toward the end of the work an examination was made of the filtered water well immediately under the grid in order to see whether sand had worked its way down through the gravel bed. None was found. Examination from above showed the gravel bed to be in good shape also.

In spite of the absence of trouble with this form of strainer, it is believed that had there been available a wash water pressure capable of producing an upward velocity of 2 to 2.5 ft. per minute, the bed might have been "blown up" and ruined. What has not been established is the necessary depth of the gravel layer below the sand to prevent a hole being blown through the gavel, thereby disrupting the bed. If high velocities through the gravel can be properly controlled by a sufficient depth and by proper grading of the gravel, it is believed that the grid will furnish a comparatively cheap, simple and effective type of strainer. Further experiments for the purpose of establishing the truth or falsity of the points noted are necessary before it could be safely adopted for use in a large plant.

"Breaking" Lengthens Runs

Diatoms are never present in less numbers than 100 to 125 organisms per c.c. Operating periods of the filters were accordingly short, the shortest less than an hour. "Breaking" was tried with the results described as follows:

"Breaking" consisted in closing the effluent valve of the filter and opening the wash water valve for about half a minute. The rising wash water breaks the surface of the sand bed, throwing the deposited matter into suspension or displacing it so that a fresh surface of sand is exposed down through which water may filter. After the wash water valve is closed, the effluent valve is again opened and filtration resumed.

The "breaking" of a filter usually may be done twice to advantage. Periods of service are lengthened from 200 to 300 per cent. The wash water percentages are proportionately diminished since no wash water is really lost by the breaking process, although such as is used must be refiltered and repumped. A gain of 10 to 15 hours in the length of the run and a reduction of 2.5 to 3 per cent in the wash water may be effected by "breaking."

In order to determine the effect on the quality of the filtered water of "breaking" the sand beds, a series of special samples were obtained. The average results were:

	Bacteria, per c.c.	B. Coli Index per c.c.
Applied water	250	0.86
Filtered water.		
Just before first "break"	64	0.04
Fifteen minutes after first "break"	100	0.78
Just before second "break"	164	0.17
Fifteen minutes after second "break"	77	0.98
Just before regular 4-minute wash	82	0.12
Fifteen minutes after regular wash	210	2.03

Ozone Experiment

The following statements regarding the ozone apparatus and the results which it gave have been taken from the report:

The ozone apparatus consisted of three water towers connected together by pipes, an ozone generator, air compressor, equalizing air pressure tank, and switchboard with the various electrical switches, watt, volt and ampere meters. In addition, a water meter, an air meter and thermometers for registering the temperature of the air entering and leaving the ozone generator were used. Raw or filtered water could be passed through the ozone plant. Each tower was 8 ft. high and 1 ft. in diameter. The towers were placed in steps so the water could flow by gravity from the highest to the lowest tower through connecting pipes. The water entered each tower 4 in. below the top, and discharged at the bottom of the tower into the riser pipe of the next lower tower. The tops of the tower were vented to the outside atmosphere to allow for the escape of excess or ozonized air.

The ozonized air pipes entered in each case at the bottom of the tower. The rising air containing the ozone passed through the descending water in a continuous stream of small bubbles. The ozonized air pipe was trapped by being carried above the level of the water in the towers in order to prevent water backing over into the ozone generator.

The ozone generator was contained in a cylindrical metal tank, capable of withstanding the air pressure required to overcome the head of water in the towers, or about 4 lb. per square inch. It had three compartments. The first received the entering air and acted as a sort of equalizing reservoir. From the first compartment the air passed through orifices, designed to impart a uniform flow into the middle compartments.

In the middle compartment were the frames for holding the electrodes, which consisted of aluminum foil, 9 x 15 in. in size. Between them were micanite dielectrics, 12 x 18 in. in size. The spacing apart of the electrodes was from $\frac{3}{16}$ in. to ¼ in. The ozonized air produced by the electrical discharge between the electrodes passed from the middle compartment to the third compartment through distributing orifices, and thence through a pipe line to the three water towers.

In making the ozone, a single phase alternating electric current of 220 volts and 60 cycles was passed through an oil-cooled transformer, capable of providing a secondary voltage as high as 20,000. One side of the secondary coil of the transformer, the container and one side of the ozone generating circuit were grounded to insure safety against the highly dangerous voltages required in case of short circuits or leakages of current.

At the request of the manufacturers of this apparatus, The Ozone Co. of America, Milwaukee, they were permitted to install a mechanical mixing device to replace the towers first used. This emulsifier consisted of a 10-in. cast-iron pipe about 5 ft. long, laid horizontally. Through the center of the pipe passed a shaft carrying oval-shaped mixing paddles made of wire netting. The paddles were set at an

angle of about 30 deg. to the axis of the shaft. Adjoining paddles inclined toward each other on one side, and away from each other on the opposite side of the axis of the shaft. The water entered at one end of the emulsifier and passed out at the opposite end. Provision for applying ozonized air was made at a number of points along the bottom. The shaft was rotated at a rate of about 154 r.p.m. The sweeping action of the paddles distributed the ozonized air throughout the water with considerable uniformity. The capacity of this device was about 10 gal. per minute as compared with about 6 gal. per minute when the towers were used.

Each tower held approximately 40 gal. of water. The average volume of water flowing while using the towers was 6.5 gal. per minute. At this rate it would require about 6 min. for the water to pass through one tower. The average volume of air applied was 5.48 cu.ft. per minute. As the water received three successive treatments with ozone it was exposed to the ozonized air at the rates noted above for a total period of 18 to 20 min. Assuming a 20-min. contact with air entering at the rate of 5.48 cu.ft. per min., there were used 109.6 cu.ft., or practically 3.1 cu.m. The average weight of ozone in each cubic meter of air for the period that the towers were used was 0.52 gram. This is equivalent to 0.04 per cent of the weight of the air.

Bactericidal Action Good

It is evident from even a short study of the results that good bactericidal action has been obtained in both raw and filtered water. The exceptions to the rule are usually easily accounted for. They generally arise from using too low voltages on the ozonizer, applying too small a volume of air, or purposely working the apparatus improperly in order to learn the effect of some particular set of conditions. Ozone, like chlorine, however, is not always able to care for the sudden appearance of excessive numbers of bacteria, a condition that is frequently met with in the Milwaukee water supply. It only adds emphasis to the need for a first line of defense, such as is afforded by a filtration plant. The average quantity of ozone applied to the water in parts per million was 2.17. Before reconstructing the ozonizers the average amount used in treating the water was 2.97 p.p.m., whereas after rebuilding, the average was but 1.56 p.p.m.

Assuming the ozonizer was one of several units required to treat a million gallons of water in 24 hours, then the energy needed to produce results equivalent to those obtained in the experimental apparatus would average 600 kw.-hr. Before reconstructing the ozonier, the average number of kilowatt-hours per million gallons estimated on the above assumption would be 802, while after rebuilding the apparatus it fell to 431. Good results might be expected with an energy output per million gallons of about 200 kw.-hr., and the application of from 1.0 to 1.5 p.p.m. of ozone, if the number of bacteria did not exceed about 1,000 per c.c. With higher bacterial content more ozone would be needed, and in consequence a greater output of electrical energy. These figures might be modified somewhat if more efficient methods of applying the ozone were developed.

Additional Costs

It should also be borne in mind that the above estimates of power relate only to the production of the ozone. To the cost of power to produce the ozone must be added the cost of power for pumping in order to overcome the friction head due to the flow of water through any form of treating apparatus, for any mechanical stirring device, if such were used, and for the compression and forcing of the air through the ozone apparatus and water. If drying of the air by refrigeration should be found necessary, then this cost too must be added to those cited.

The Milwaukee experiments were carried out by Ernest F. Badger under the direction of J. W. Ellms, consulting engineer, Cleveland, reporting to H. P. Bohmann, superintendent of water-works and water purification.

Detail Design of Riveted Joints of Bridge Trusses

Riveting Determined by Study of Paths of Forces Concentrated at Joint by the Members Connected—Two Examples

By Major W. M. Wilson
Professor of Structural Engineering, University of Illinois, Urbana

The design of structural details is not as well standardized as the design of the main members of a structure. In fact, many structural engineers are reluctant to use the term "design" in connection with details, showing that they do not consider it necessary to analyze the stresses or trace the paths of the forces the same as they do in the design of the main members. Although it is not always possible to analyze the stresses in a connection satisfactorily, it is the

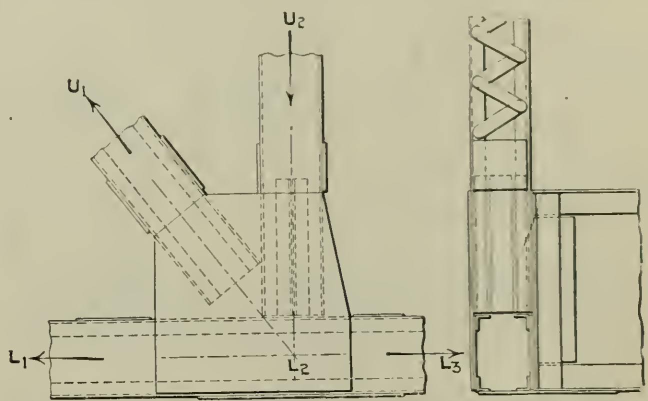


FIG. 1. GUSSET-PLATE CONNECTION AT BOTTOM-CHORD JOINT OF RIVETED TRUSS

opinion of the writer that a more careful study of joints will lead to better details.

Many designers in determining the number of rivets required at the panel points of the bottom chord of a through riveted truss use a method that fails to consider the action of the parts connected, and therefore leads to faulty results. Such a joint will be discussed here.

Fig. 1 represents the second panel point of the bottom chord of a truss. The forces acting upon this connection are the floorbeam shear, acting downward; the compression in the post U_2L_2, acting downward; the tension in the diagonal U_1L_2, acting upward to the left; the tension in L_1L_2, acting to the left; and the tension in L_2L_3, acting to the right. These forces must pass through the gusset plates.

To determine the rivets required in the different parts of the joint, trace the paths of the forces, beginning with the end shear on the floor-beam. The end shear is transmitted from the floorbeam to the inside gusset plate. Half of this shear is delivered by the inside gusset plate directly to the diagonal U_1L_2 and the other half is delivered by the gusset plate to the inside flange of U_2L_2. This latter part is then transmitted through the diaphragm in the lower end of the post to the outside gusset plate, and from the outside gusset plate to the diagonal U_1L_2. The stress from the post, a downward force, is delivered one-half to the inside gusset plate and one-half to the outside gusset plate.

Having now in mind the paths of the forces, we will next consider the stresses upon the rivets. The rivets through the outstanding legs of the floor-beam connec-

tion angles are in single shear, and they develop the entire end shear in the floor beam. Contrary to a common opinion among many structural engineers, the writer contends that all of the rivets connecting the floor-beam to the gusset plate, including the rivets below the vertical post, help to develop the end shear of the floor-beam. The reason for this contention is that, even though these latter rivets do not pass through the vertical post, they do pass through the inside gusset plate; and, hence, are capable of transmitting force from the floor-beam to the gusset plate. The fact that half of the end shear of the floor-beam is transmitted directly from the inside gusset plate to the diagonal, makes it unnecessary for all the stress delivered to the gusset plate by the floor-beam to be delivered to the vertical post.

Consider next the rivets connecting the inside gusset

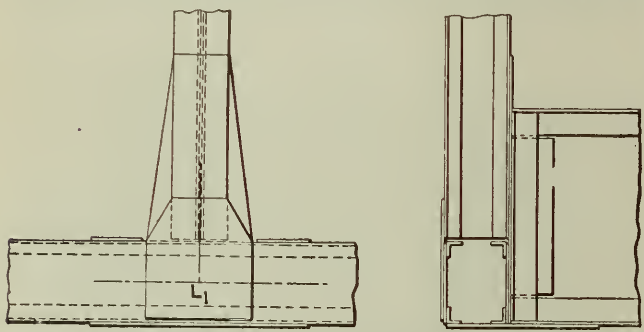


FIG. 2. CONNECTION OF FLOORBEAM TO HIP VERTICAL BY SIMPLE GUSSET PLATE

plate to the vertical post. The vertical forces acting on this gusset plate are as follows: On the inside is the shear from the floor-beam, acting downward. On the outside is half of the stress in the post, acting downward, and the shear in the diaphragm, acting upward. The shear in the diaphragm is one-half of the floor-beam shear. In addition to these, the vertical component of the stress delivered by the inside gusset plate to the diagonal, acts upward. The sum of these vertical forces must be zero. The shear between the gusset plate and the vertical post is the numerical difference between one-half the shear in the floor-beam and one-half the stress in the post. This resultant force must be developed by the rivets which pass through the gusset plate and through the vertical post.

Consider next the rivets connecting the outside gusset plate and the vertical post. One-half of the floor-beam shear has been transmitted through the diaphragm at the lower end of the post to the outside gusset plate. This acts as a downward force upon the plate. Half of the stress in the vertical post is also delivered to the outside gusset plate. This also acts as a downward force.

The total shear, therefore, between the outside gusset plate and the vertical post is the numerical sum of one-half the floor-beam shear and one-half the stress in the vertical post. This quantity is the sum of simultaneous stresses and its maximum value cannot be determined by adding one-half the maximum post stress and one-half the maximum floor-beam shear. But, inasmuch as the vertical component of the stress in U_1L_2 must always balance the stress in the vertical post and the floor-beam shear, the maximum shear between the vertical post and the outside gusset plate is one-half of the vertical component of the maximum stress in U_1L_2. The fact that half of the stress U_1L_2 comes from each gusset plate is a check upon this statement.

Inasmuch as the shear between the post and the outside gusset plate is the numerical sum of two forces, whereas the shear between the vertical post and the inside gusset plate is the numerical difference between the same forces, the shear between the post and the outside gusset plate is always greater than the shear between the post and the inside gusset plate.

As a result of the above discussion, the writer recommends the following method of determining the number of rivets required for the joint L_2:

(1) The rivets through the outstanding leg of the connection angles of the floor-beam shall develop the end shear in the floor-beam. These rivets shall include the rivets below the vertical post.

(2) The rivets connecting the vertical post with the outside gusset plate shall develop one-half the vertical component of the stress in U_1L_2. These rivets do not include the rivets below the vertical post.

(3) The rivets connecting the diaphragm to the inside and also to the outside flange of the post shall develop one half the end shear in the floor-beam.

Fig. 2 shows a typical detail for the connection of the floor-beam at L_1 of a riveted truss. With this connection, the end shear of the floor-beam is delivered from the floor-beam connection angle to the inside gusset plate and from the inside gusset plate to the hip vertical. Half of this shear is taken by the inside flange of the hip vertical; the other half is delivered by the diaphragm or the web of the hip vertical to the outside flange.

The writer, therefore, recommends the following method for determining the number of rivets in the connection at L_1:

(1) The rivets through the outstanding leg of the floorbeam connection angle shall develop the end shear in the floorbeam. These rivets may include the rivets below the hip vertical.

(2) The rivets connecting the gusset plate to the hip vertical shall develop the end shear on the floorbeam. If there is not an excess of rivets through the outstanding leg of the floorbeam connection angles, it will be necessary to extend the inside gusset plate above the floorbeam far enough to put as many rivets above the floorbeam as there are below the hip vertical.

(3) If the hip vertical does not contain a web plate, a diaphragm must be used at the bottom. The rivets connecting the diaphragm to the inside flange and also to the outside flange of the hip vertical must develop one-half of the shear in the floorbeam.

(4) The outside gusset plate need contain only enough rivets to support the bottom chord as they do not develop any of the stress in the hip vertical.

Utilizing the fact that the rivets below the vertical post help develop the floorbeam shear, reduces the cost of the joint. Moreover, a careful study of the paths of the forces establishes the fact that these rivets do help develop the floorbeam shear.

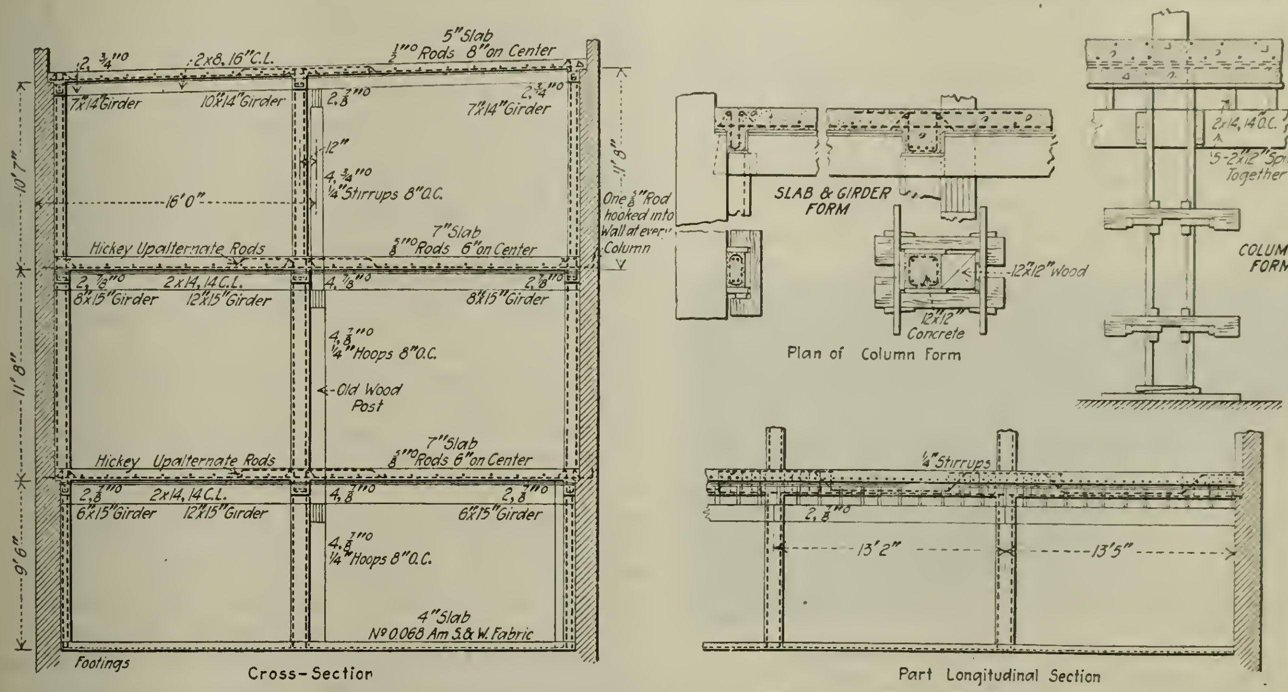
Progress on U. S. Topographic Map

On July 1, 1919, according to the U. S. Geological Survey, 42.6 per cent of the topographic map of the continental United States, exclusive of Alaska, had been completed. Approximately one-fifth of this area is in need of re-survey, leaving 35 per cent of the entire country covered by satisfactory maps.

Concrete Replaces Wood as Frame of Existing Warehouses

Old Floors and Columns Used as Falsework in the Transformation of Buildings into Fire-Resisting Type

OLD timber floor and column construction is being replaced in some warehouse buildings in Kansas City by reinforced-concrete floors and columns placed without materially disturbing the total contents of the building and at the same time utilizing the old floors and columns for the forms and centers for the new framework. The carrying capacity of the floors is increased and the building is given a very much higher degree of fire resistance. At the same time considerable money is saved in the utilization of the old structure for form work. These buildings have been rebuilt under the direction of E. Lee Heidenreich, consulting engineer, of Kansas City.



DETAILS OF SUBSTITUTION OF CONCRETE FLOORS AND COLUMNS FOR WOOD MEMBERS IN OLD BUILDING

A typical reconstruction job is shown in the accompanying drawing and photograph. This building is a three-story brick-wall structure with interior wooden framework and has an outside plan of 32 x 153 ft. Transverse 2 x 14-in. joists 14 in. on center, span a 32-ft. opening, with intermediate lines of stringers made up of spiked 2 x 14-in. plank resting on 12 x 12-in. square wood posts. The reconstructed floor consists of a 7-in. reinforced-concrete slab supported by a middle longitudinal 12 x 15-in. reinforced concrete stringer on 12 x 12-in. concrete columns and two marginal girders of varying dimensions, as shown on the drawings, supported on concrete columns at the brick walls. The roof, as shown, is of the same general design but of smaller dimensions.

The new concrete columns are offset just outside the old wooden posts so that one of the new concrete spans is 17 ft. out of wall to centre of column, and the other 15 ft. In construction one floor is laid at a time and the material on the floor moved to an adjacent floor, merely during the reconstruction operations. The wooden floor is used as the bottom form for the concrete floor and a "trench" cut through the 14-in. joists a depth of 8 in. makes the forms for each of the

REINFORCEMENT IN PLACE FOR NEW CONCRETE FLOORS USING OLD WOODEN FLOORS AS FALSEWORK

girders. Column forms consist of three vertical planks forming three sides of the concrete column and the old wood post forming the fourth side. These forms are held in place by wedged wooden ties fastened to the wood posts, as shown in the detail. The new floor is designed to carry a load of 125 lb. per square foot. The extensive load from the columns to the foundations is taken care of by underpinning and increasing the size of the piers.

Belgian Highways

BELGIUM is beginning to feel on her highways the strain of the motor truck. The roads on her national system are almost entirely of stone block laid on sand and sand jointed. On account of the heavier traffic, when these roads are renewed concrete foundations are generally used and the joints are grouted. The older type of road had a life of from 15 to 20 years.

During the German occupation only such roads were kept up as were needed for war purposes. The highway system, as a whole, therefore, is not in good repair. Financial conditions are such, too, that restoration cannot proceed at a very rapid rate. Even if the former type of construction were to be continued, the present cost would be about 50 francs (about $9.50 at normal exchange rates) per square meter, compared with a pre-war cost of 12 francs.

ROAD ROLLER ON BELGIAN HIGHWAY
Driven by Gasoline Engine on Shaft Inside Roller and Steered by Smaller Roller

Some tar-macadam has been used, but on the whole stone-block construction is preferred. Just now, because of shortage of block, considerable waterbound macadam is being laid as an emergency measure. Concrete has been laid only in experimental sections and conclusions regarding it have, apparently, not been drawn.

For stone block, porphyry is preferred, except on grades where a hard sandstone, called *grès*, is used. The latter is gritty and gives a better foothold than porphyry.

The national highway system, totaling 8,000 km., is built and maintained solely by the national government, even where the roads run through towns and cities. The provincial and communal roads are built and maintained solely at the expense of the respective political divisions. Maintenance costs on the national systems, the *grandes routes*, averaged, before the war, 1,000 francs per kilometer (about $316 per mile), but this was considered an inadequate expenditure; in other words, the maintenance standards were below those deemed desirable by the technical staff. The amount stated was all the Parliament would allow.

The paved width of the *grandes routes* has been a minimum of 5 m., except through towns. When rebuilt the minimum width is made 6 m.

Water-Power Control in England

IN A second report the Water Power Resources Committee, recently organized in Great Britain, has made certain recommendations toward the control of the water resources of the country and the jurisdiction over water power.

The committee recommends that either the Board of Trade or the Electricity Commissioner should be specifically charged with the duty of studying, supervising and promoting water-power developments, although it was stated before the committee that there was comparatively little water power in England and Wales remaining to be developed. The committee thinks that its preliminary investigations did not justify this view. There are several parts of Great Britain in which there are large sources of water power but very few inhabitants. It is unlikely that such sources, according to the committee, will be developed unless some state assistance is available, and the committee recommends that the department charged with the duty of developing water power should be provided with a fund for the purpose of starting enterprises in such areas.

The committee further recommends that there should be established by act of Parliament a controlling water commission having jurisdiction over England and Wales, who would have among its duties the compilation of records of water resources, the allocation of these resources, in the general interest of the community, the adjustment of conflicting interests, and the consideration of the development of rivers as a whole from point of view of all water interests.

A final report dealing more fully with water power and with the amendments required in the law as to pollution, underground water, and kindred subjects is expected soon.

Data on Permeability of Rubber to Gases

According to experiments recently made at the Bureau of Standards by J. D. Edwards and S. F. Pickering, the relative ease of passage of various gases through sheet rubber is expressed by the following table:

Kind of Gas	Relative Permeability, Hydrogen = 1
Nitrogen	0.16
Air	0.22
Argon	0.26
Oxygen	0.45
Helium	0.65
Hydrogen	1.00
Carbon dioxide	2.9
Ammonia	8.0
Methyl chloride	18.5
Ethyl chloride	200.0
Water vapor, approximately	50

The permeability varies directly with the partial pressure of the gas (under constant total pressure) and is inversely proportional to the thickness of the rubber (this was measured only for hydrogen). It varies rapidly with temperature; at 100 deg. C., the permeability to hydrogen was 22 times that at 0 deg. C. and to carbon dioxide 17 times the rate at 0 deg. Rubber that is old and brittle, or has been over-vulcanized, is low in permeability. At 25 deg. C. the permeability of vulcanized dental dam rubber was found to be about 0.00002 cu.cm. per min. per sq.cm. of surface. A report of the tests will soon be published.

Costs of Upkeep and Repairs on a Large Building

Records of Labor and Materials in Maintaining Printing Plant for Eight Years Give Annual Itemized Costs

By Walter R. Metz
Mechanical Engineer, Takoma Park, Md.

RECORDS of cost of upkeep of buildings and their component parts seem to be very scarce and it is probable that the average owner does not know which items cover the biggest parts of his expense or where the "leaks" might be. It is for this reason that the following figures are given and it is hoped that it will prompt some readers to give their experiences.

It might be stated that the costs as given cover a group of ten buildings all connected together but not all under one roof. The main building is seven stories high and the other buildings are from four to six stories high. All of the buildings were designed for heavy loads and heavy machinery and are used for a printing plant. The floors in the main building were designed for loads of 300 lb. per sq.ft. and in the other buildings 200 lb. per sq.ft.

Costs have been given for each year from 1912 to 1919 inclusive and indicates the gradually increased cost of both labor and materials.

Floors

All floors were leveled up with concrete and finished with hard maple blocks 2½ x 12 x ⅞ in., cut with interlocking grooves and projections on the sides and near the lower faces of the blocks. These blocks were dipped so as to coat the under side with hot bituminous mastic and applied to the concrete, which had been previously prepared by giving it a coat of bituminous varnish. The total area of the floors, in round numbers, is 250,600 sq.ft.

Year	Labor	Material	Total	Cost per Square
1919	$2,387.69	$267.48	$2,655.17	$1 06
1918	2,787.91	132.57	2,920.48	1 16
1917	2,454.53	202.30	2,656.83	1.06
1916	1,178.37	125.31	1,303.68	.52
1915	1,068.33	99 01	1,167.34	.46
1914	1,005.17	57.86	1,063.03	.42
1913	1,336.54	95.87	1,432.41	.57
1912	1,055.09	121.59	1,176.68	.47

Roof

The roof is of reinforced-concrete slabs supported by steel beams. It was finished with flat vitrified tiles, laid on a base of Neufchatel asphalt mastic. The mastic was applied in two coats with a layer of fine wire netting between to serve as a bond. Each tile was stuck fast to the mastic with a spoonful of bituminous cement. The inclination of the roof is about 1 to 7. This is rather steep for tiles on an asphalt base but the whole roof has stood up remarkably well. The total area of tile roofing is 50,700 sq.ft.

Year	Labor	Materials	Total	Cost per Square
1919	$726.91	$16.20	$743.11	$1.46
1918	2,038.80	459.96	2,478.76	4.88
1917	392.38	12.82	405.20	.79
1916	643.78	166.03	809.81	1.59
1915	102.13	4.95	107.08	.21
1914	657.96	89.33	747.29	1.47
1913	493.70	36.94	476.64	.94
1912	239.11	28.54	267.65	.52

Steam Heating.—The total volume of the main building is 7,600,000 cu.ft. The system of heating is the direct-indirect, the coils being placed in pockets under the windows with dampers for admitting fresh air and baffles for deflecting the air to the floor, whence it would have to rise through the coils. The total radiation is 70,000 sq.ft., consisting of 694 steam coils and 35 cast-iron radiators. The ratio of heating surface to the volume of the building is 108.

In addition to this there is approximately 30,000 sq.ft. of radiation in coils in the other buildings, making the total radiation approximately 100,000 sq.ft.

Year	Labor	Material	Total	Cost per 100 Sq.Ft. of Radiation
1919	$3,928.23	$601.46	$4,529.69	$4.53
1918	2,631.21	2,000.38	4,631.59	4.63
1917	3,823.02	523.04	4,346.06	4.34
1916	3,183.45	694.11	3,877.56	3.87
1915	2,635.52	222.35	2,857.87	2.85
1914	2,643.43	399.83	3,043.26	3.04
1913	2,870.56	480.71	3,351.27	3.35
1912	2,436.34	343.97	2,780.31	2.78

Plaster

Plaster on ceilings was applied to a concrete surface and three coats of plaster were applied. The first and second coats were heavily gaged with portland cement, the idea being to secure a hard plaster. Around beams the plaster was applied to wire mesh. The plaster was rather thick and it is believed it would have lasted better if it had been applied thinner, say about ¾ in. thick. The plaster on practically every beam either fell or had to be removed after about eight or ten years' use, but that on the ceilings is still in good shape although about 18 years old. The total area of plastered surface is approximately 360,000 sq.ft.

Year	Labor	Material	Total	Cost per Square
1919	$993.63	$21.83	$1,015.46	$0.28
1918	62 61	......	62 61	.017
1917	9,026 52	956 49	9,983 01	2.77
1916	2,659 62	409.81	3,069 43	.85
1915	681 68	51 66	733 34	.20
1914	466.66	3.59	470 25	.13
1913	858 77	38.44	897 21	.24
1912	578.42	96 47	674 89	.18

Doors

There are 223 doors of all sizes and types in the buildings, single-acting hinged office doors, double-acting, plain sliding, and automatic sliding fire doors. These doors receive very hard usage and need constant attention. Practically all of the double-acting doors have wire glass in the upper panels.

Year	Labor	Material	Total	Cost per Door
1919	$564.58	$109 18	$673.76	$3.02
1918	883.44	182.91	1,066.35	4.78
1917	598.88	185 03	783.91	3.51
1916	910.38	224 22	1,134.60	5.08
1915	691 04	148.46	839.50	3.76
1914	855.72	143 85	1,099 57	4.93
1913	440 42	130 28	570.70	2.56
1912	435 80	142 81	578.61	2.59

Windows

There are 2,290 windows in the buildings, most of them of the double-hung sliding type with a few of the hinged type. Glass sizes vary from 12 x 18 in. to 36 x 50 in.

Year	Labor	Material	Total	Cost per Window
1919	$593.67	$220.26	$713 93	$0.31
1918	794 70	294 87	1,089 57	.47
1917	486.97	161 72	648 69	.28
1916	729.51	191.99	921 50	.40
1915	421.47	76 46	497 93	.21
1914	758.72	168.70	927 42	.40
1913	474.50	108 95	583 45	.25
1912	564.12	174 40	738 52	.32

Plumbing:—Fixtures in the building consist of 240 water closets, 338 washbasins, 90 urinals, 21 slop sinks, 120 drinking fountains, 80 fire hose and racks. The repairs includes, of course, repairs to the necessary piping as well as to repairs to fixtures. It is difficult to find any unit basis so total amounts only are given.

Year	Labor	Material	Total
1919	$5,304.63	$406.08	$5,810.71
1918	5,309.31	352.87	5,662.18
1917	4,530.09	556.05	5,086.14
1916	3,291.66	464.90	3,756.56
1915	2,974.87	237.93	3,212.80
1914	2,941.40	238.95	3,180.35
1913	2,738.26	395.26	3,133.52
1912	2,250.82	160.36	2,411.18

Presaturated Sand Facilitates Concrete Mixing

Outlet Works at Taylorsville Dam Last of Major Concreting Operations for Miami Valley Flood Control Works

CONSTANCY of mortar volume and increased speed and smoothness of mixing, are being secured by wetting the sand to saturation in proportioning concrete for the Taylorsville dam of the Miami valley flood protection works. Water is added to the sand until it contains all that it will retain by capillarity. This procedure combined with excavation from different parts of the pit as a finer or a coarser mixture is wanted is standardizing very successfully a washer product where the pit materials run irregular.

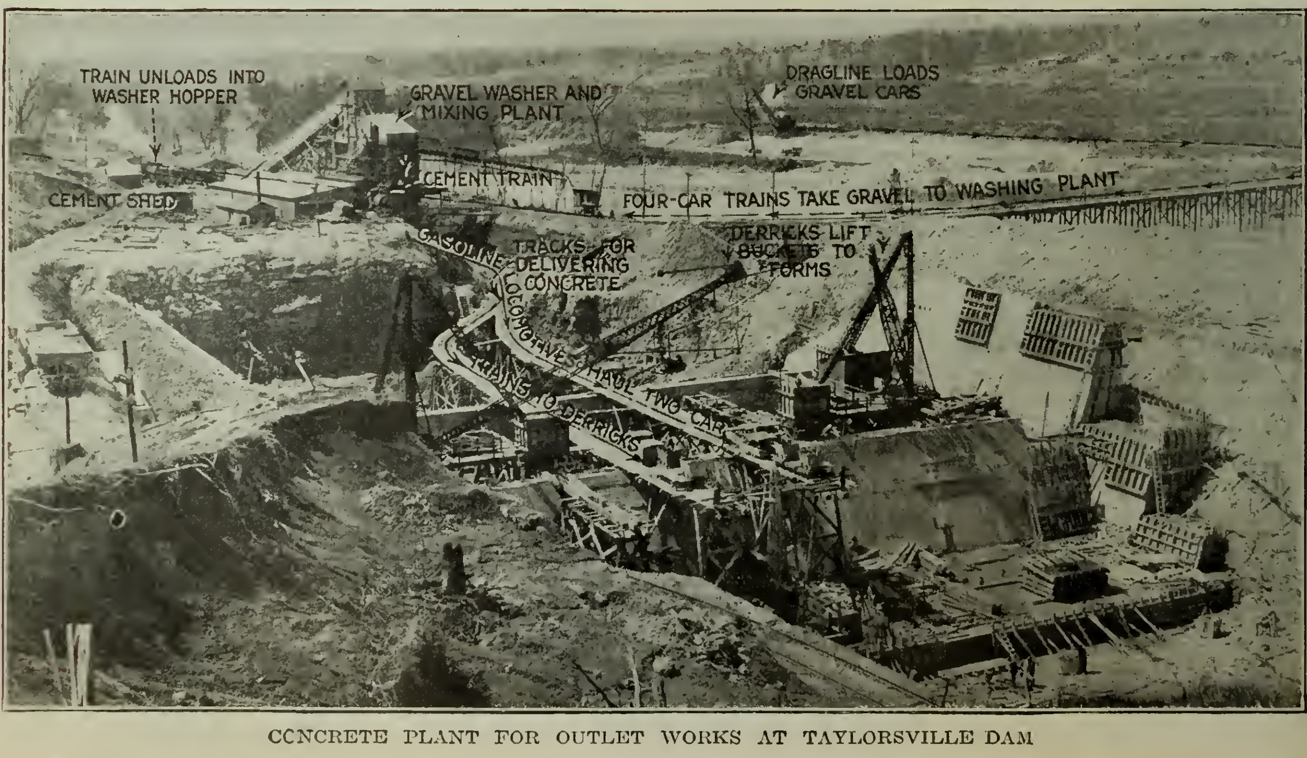
Of the five outlet structures, that at Taylorsville is the only one where major concreting operations are not completed. The structure requires about 55,000 cu.yd. of concrete mainly in massive walls and floor slabs. In general the outfit and procedure for making and distributing concrete are those described in *Engineering News-Record*, Oct. 2, 1919, p. 640, and are plainly indicated by the illustration. With this outfit records of 500 cu.yd per day of concrete in place have been made.

Concrete proportioning on the Miami work is done on the principle of density of the combined aggregate. Tests of the local gravel at Taylorsville demonstrated that the most dense gravel mixture was obtained by combining equal parts of coarse (1½- to 3-in.) gravel and of small (1¼- to 1½-in.) gravel. Further tests to determine the volume of sand which would, with the gravel mixture, give the most dense combined mixture, disclosed the facts: (1) That sand as drawn from the washed sand bin contained varying amounts of moisture; (2) that varying amounts of moisture in the sand gave varying volumes of mortar per measure of sand, and (3) that sand saturated with water gave a constant volume of mortar and also, with the gravel mixture, the most dense combined mixture. Considering a 1-cu.yd. mixer batch, 16-cu.ft. of coarse gravel and 16-cu.ft. of small gravel and 13-cu.ft. of saturated sand gave a 30½-cu.ft. batch. This was the minimum volume which could be secured by any combination and was adopted as the standard working mixture.

To saturate the sand, water is run into the measuring chute, a prescribed quantity determined by experience being admitted. The final adjustment of water in the concrete is made by jetting water into the mixer until the desired consistency, judged by the eye, is secured.

The use of the saturated sand has practical advantages besides that of keeping the mortar volume constant. The charge flows more easily into the mixer and the materials mingle more readily. The mixing process is more rapid. The newly charged material has less tendency to ride up the rising side of the mixer and to spill out. Since danger of loss by spilling is lessened the size of the batch can be increased. For example, in placing 3,000 cu.yd., measured in the forms, the 1-cu.yd. mixer averaged 1.2 cu.yd. per batch.

The Taylorsville dam forms one of the flood water detention reservoirs being constructed by the Miami Conservancy District, Arthur E. Morgan, chief engineer; Charles H. Paul, assistant chief engineer, and C. H. Locher, construction manager. O. N. Floyd is division engineer in charge of the dam construction.



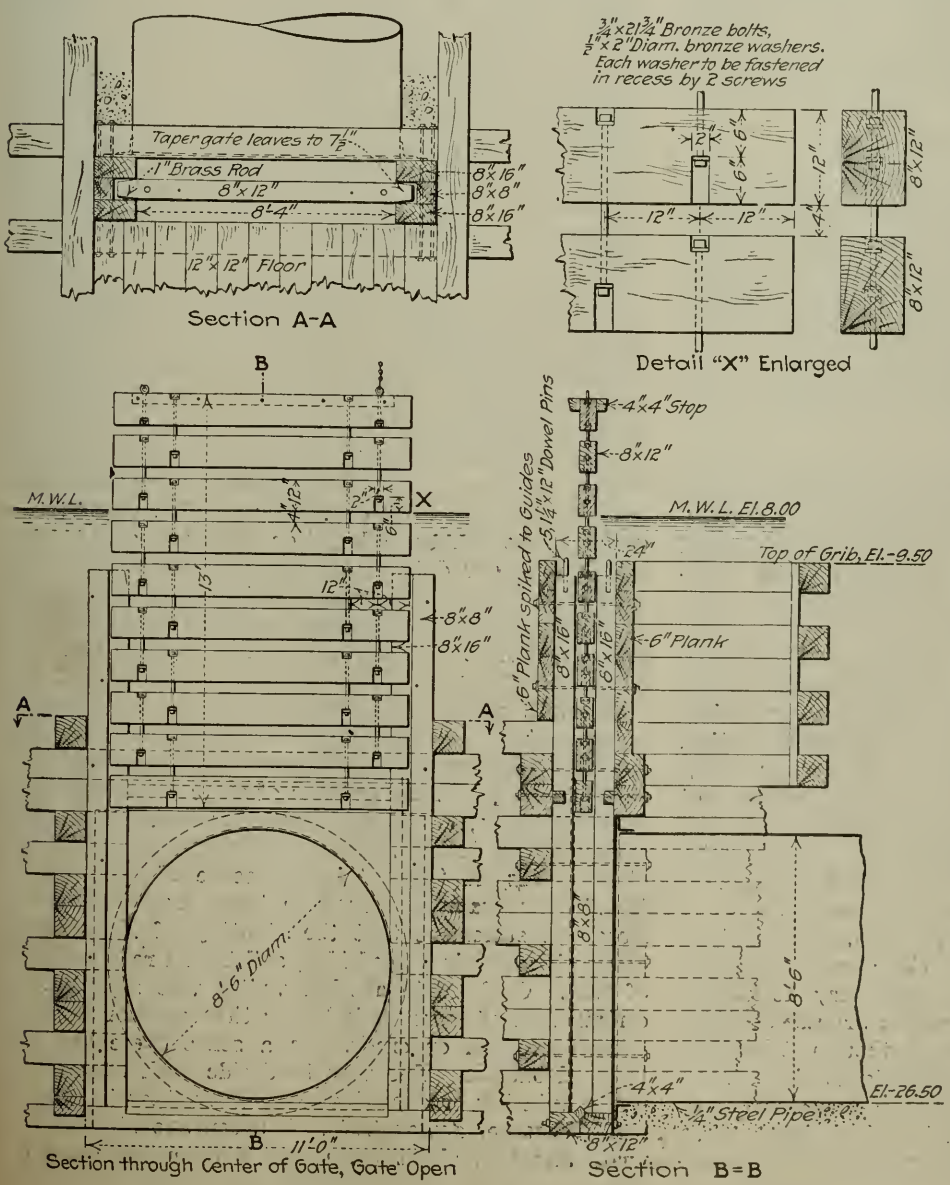
CONCRETE PLANT FOR OUTLET WORKS AT TAYLORSVILLE DAM

Sewer Gate With Articulated Units To Facilitate Moving

Stop Logs Held Together With Bolts in Counterbored Holes—Shutter Openings Reduce Pressure When Gate Is Raised

IN ORDER to avoid, or at least to reduce, the binding commonly met in raising a gate against water pressure, the outfall sewer gate for the Bird Island Pier Improvement at Buffalo has been built as an articulated structure.

The gate is made up of 8 x 12-in. timbers laid horizontally to cover the opening, but joined together by bronze bolts in counterbored holes so that when the top timber is lifted the logs will separate successively to the limit of the counterbores thus leaving openings between each log through which the retained water in the sewer can pass. Pressure on the gate is thus relieved and the binding on the guides reduced. Details are shown in the accompanying drawing. The gate was designed for the Department of Public Works in the office of George H. Norton, City Engineer of Buffalo.



DETAILS OF SEWER-GATE WITH WORKABLE STOP LOG UNITS

Chicago to Try Asphaltic Cushion for Street Pavements

TO introduce resilience in street paving, the Board of Local Improvements, of Chicago, has decided to lay sections of creosoted wood block, granite block and brick pavements on a cushion composed of 92 parts of graded lake sand an 8 parts of asphaltic cement having a penetration of about 70. In the opinion of J. G. Gabelman, chief engineer of streets for the Board, the rigid type of pavement with cement-sand cushion will not stand up under the present heavy truck traffic. He considers that the asphaltic-sand cushion will be sufficiently resilient to cushion impact and reduce wear on the surface of the pavement.

This latter cushion, according to John B. Hittell, formerly chief engineer of streets for the Board and now district engineer for the Asphalt Association, will not be as expensive as the 1 to 4 cement mortar cushion and although slightly more expensive than the 2-in. sand cushion previously used under granite blocks, it is believed the resulting benefits will more than compensate for the difference in cost. Mr. Hittell's estimate of the situation follows:

Chicago has many miles of brick, granite and wood-block pavements laid on sand cushions. A large percentage of these pavements are in streets occupied by street car tracks, and as they are not impervious to water, the shifting of the sand bed, due to combined action of traffic, seepage of water and vibration of car tracks has caused the surface of the pavements to be distorted generally by a settlement of that portion adjacent to the rails and a raising of the part along the quarter or gutter. The displacement has not been uniform and has materially reduced the life of the pavements.

To overcome this objection, especially in brick and wood block pavements, the specifications were changed to provide a cushion 1 in. in thickness composed of 1 part of portland cement to 4 parts of torpedo sand or limestone slag screenings. The cement and sand were thoroughly mixed dry and immediately spread upon the concrete foundation, shaping to contour being secured by use of a templet. Immediately before laying the blocks the cushion was wet by means of a rosehead sprinkler with water merely sufficient to dampen the cushion and wet the cement. The result expected from the use of this mortar cushion has not been attained, especially in the case of brick pavements which are deprived of all resiliency and which create considerable noise under traffic. To remedy these difficulties the trial of the asphaltic cushion was decided upon.

The Proof's the Thing!

By Howard Viets
Department of Rhetoric and Public Speaking, University of Minnesota

THE professor of mathematics, who had dropped into my office for a pipe of tobacco, leaned back in his chair, and, as he puffed, ran his eye over the text-books in English that lined the back of my desk. While I was concluding a 'phone call he reached for a text on Argumentation and slowly turned the pages. As I hung up the receiver and turned to him he mumbled from the midst of a cloud of smoke, "I'll wager the boys take to argument. Seems to me a mighty good thing if it will help them to think straight."

"You've said something now," I replied laughing. "Every year since we began to include Argument in our English course I have felt more and more convinced of the wisdom of our decision. It has more than made good."

"Might not be a bad idea to prescribe some for the faculty," my friend rejoined with a quizzical glance at me.

I chuckled as I struck a match, for I felt the tingle that comes with a spirited discussion of a genuinely interesting subject. "You speak about thinking straight," I began. "The very first step in the study of argument is an attempt to straighten out kinks in thinking."

Exposition and Argument

For one thing, most students have no clear conception of the difference between exposition and argument. Somehow, either from text-books or in high school, they become obsessed with the air-tight-compartment view of English—the notion, I mean, that all writing can be sharply set off, segregated, as either Narration, Description, Exposition, or Argument. To them, a certain piece of writing is purely one or another of these "types." It's what you might call the Ivory Soap theory.

Of course such a view is both wrong and pernicious. Consequently it becomes necessary to point out the very close relationship between exposition and argument, to show how any one who has acquired the knack of explaining has in his control the apparatus for arguing; that training in expository writing provides what may be called "mastery of materials," and that a study of argument is really a study of "special uses of materials." Actual specimens of effective argument will show that an arguer employs a great deal of exposition, often with some description or even bits of narrative. The students pretty soon see that an able writer recognizes no air-tight-compartment theory of writing, but reaches over into each of the "compartments," so-called, whenever he finds need of opportunity. He thus increases the number of tools to work with. Whatever may be trumps, he doesn't neglect the bowers.

But when this theory of isolation is unmasked there remains another misconception to clear away. Students have, almost without exception, very hazy notions of the sort of subject that lends itself to argument. They will tackle any subject that looks as though it had two sides. They will argue that the Spaniards blew up the Maine just as readily as they will the proposition that the honor system be established in this college. They apparently have little if any conception of the difference between what are called *questions of fact* and *questions of opinion* or *expediency*. In other words they don't know the distinction between "demonstration" and "proof." They don't realize that there are two ways of "proving" something—two senses in which the word "proof" may be used. It is this sort of hazy thinking that tolerates propositions like these: Resolved: that Engineering pays better than Law, or that Washington was a greater man than Lincoln, or that the horse has been more useful to mankind than the cow. Their study of Geometry, however, enables me to set them right here. I can show them that when they "prove" that the shortest distance between two points is a straight line they are using "prove" in a sense equivalent to "demonstrate" and not equivalent to "prove" as employed in logic. If Einstein's theories continue to gain ground I suppose I shall be forced to find a different theorem for illustration.

Ascertainment of Truth

All this leads quite naturally to a very fundamental matter; namely, that genuine argument is really a balancing, a weighing of pros and cons as though in scale pans—in a word, it is a matter of judgment. A really debatable question will provide arguments on both sides. One scale plan will never be entirely empty. I usually remind them at this point of the expressions used in law: In civil cases one side proves its case "by a fair preponderance of the evidence," and in criminal cases, "beyond a reasonable doubt." They then see how childish it is to write, or say, "I have now conclusively proved," or "Our opponents have failed to show a scrap of evidence" and so on. The role that judgment plays in argument needs, I believe, to be constantly emphasized.

This point is well brought out by John Stuart Mill in one of his addresses, in which he says, "The most incessant occupation of the human intellect throughout life is the ascertainment of truth. We are always needing to know what is actually true about something or other. We all require the ability to judge between the conflicting opinions which are offered to us as vital truths; to choose what doctrines we will receive in the matter of religion, for example; to judge whether we ought to be Tories, Whigs, or Radicals, or to what length it is our duty to go with each." Then a little further on he says, "In what consists the principal and most characteristic difference between one human intellect and another? In their ability to judge correctly of evidence."

It would not be right, however, to give the students to understand that questions of opinion or judgment are the only questions that concern them as engineers-in-the-making. In the practice of their profession they will, of course, constantly meet conundrums that are susceptible of definite, absolute solution—susceptible, in other words, of "proof" in the sense of "demonstration." For example, I read to them from the *News-Record* a statement that the planting of shade trees along highways is a good idea, and then I read a denial of that. Or I quote another writer who says that a certain mix of concrete is better than another because it will not roll or crack. In a sense these are not really debatable. The way to decide such matters is not to spill ink or expend oratory but rather to experiment, observe, *demonstrate.* I encourage students to write and talk about them, but I warn them not to fancy that they are debating, or, strictly speaking,

even "arguing." They may be "proving" something, but they are proving only in the sense of demonstrating.

Real Proof

After all, this is but preliminary. When they outgrow the air-tight-compartment theory of writing, when they are able to discern what questions are really debatable and what are demonstrable, when they appreciate that true argument is never one-sided, but rather a matter of judgment, the real nut remains to be cracked. This is the matter of evidence, of reasoning—in a word, PROOF. The proof's the thing! As prospective engineers, one of the best things they can possibly acquire from a study of argument is an adequate understanding of what constitutes proof—what real evidence is, what sound, solid reasoning is. And of course in the process of acquiring that understanding they will learn to detect flimsy, incompetent, irrelevant, untrustworthy evidence and its side-partner, fallacious reasoning.

They sadly need this acquirement. There is something really comical in the assurance with which they announce, "I have, therefore, conclusively proved" this or that, when as a matter of fact they have perhaps adduced only a little actual proof, and that, too, often vulnerable. I find that the whole field of proof, in its broadest sense, has to be slowly unraveled for them.

I begin with a text, like any other preacher, and constantly recur to it. This text is—*not winning, but the truth.* How to get at the truth is the nub of our entire study of PROOF.

Mill says in the same address from which I just quoted: "There are but two roads by which truth can be discovered—observation and reasoning. We all observe and we all reason." So we set out with this in mind: That proof—that is, the ascertainment of truth—is made up of facts (got from observation) plus reasoning. Our first precept is: Get your facts right. Learn to observe accurately, to read accurately, to copy accurately, to hear accurately. Without trustworthy facts there can be no sound proof.

As soon as the students appreciate the indispensableness of facts they can proceed to a study of reasoning, the other complementary angle, as it were, of Evidence. It is then easy to show how all evidence can be classified as direct or indirect—as "testimonial" and "circumstantial." The direct or testimonial consists of facts—documents, letters, reports, actual observations, or the "ipso dixit" of recognized experts. The indirect or circumstantial consists always of reasoning.

Of course, it is too much to expect mature, cogent reasoning from most undergraduates, but it is quite feasible to acquaint them with the commonest ways by which men reason and the commonest fallacies into which they are liable to fall. Any educated man surely ought to know what it means to argue in a circle, for example, or to beg the question, or to argue from the part to the whole and so on. Whether a man becomes an engineer or a merchant he will need to know more or less about abstract reasoning. I think it is true, however, apropos of this, that the young engineer will, in point of fact, use the direct form of evidence more than the indirect, facts more than logic.

Almost inevitably some one at about this point in our study of proof raises the question of the relative value of direct and indirect evidence. If no one does, I raise it myself. It is a pertinent inquiry. Off hand, ninety-nine persons out of a hundred will promptly pronounce in favor of direct evidence. Especially is this so in the case of those who have the scientific point of view. Facts, expert testimony, document—you can see the appeal to the scientist. A lawyer, however, will tell you that such a one-sided view is wrong, that as a matter of fact direct evidence is not inherently more trustworthy than indirect, that actually each form has its weaknesses. The outstanding weakness of direct evidence lies in the fallibility of our senses. Tests by psychologists, for example, have shown that rarely do two persons see the same thing in just the same way, or remember things precisely. Our ears often deceive us, so do our eyes and our noses. We make mistakes in copying figures, mistakes in using words that look alike and so on and so forth. The margin of error is surprisingly wide. Lawyers will tell you that the problem of law involved in a given case is nothing compared to the problem of the facts. Establish the facts and the law becomes plain.

You can see now why I make sure that this question is raised. The very act of pointing out the possible weakness of direct evidence emphasizes the need for careful scrutiny of it whenever it is relied upon. It also emphasizes my slogan: The proof's the thing!

I can not see any danger of overdoing that assertion, either. I am reminded of the young lawyer who eagerly handed over five dollars to a wise old attorney on the promise of getting some advice which would be of great value to him during his entire career. This oracular advice was: "Whenever you appear in a case be sure you have plenty of evidence." I'm not inclined to believe that the joke was on the youngster. The platitude he got for his five-spot is one of those commonplaces that can well bear repeating.

Persuasion and Proof

One thing that makes me feel as strongly as I do, that after all the proof's the thing, is the rather common neglect of sound, solid proof—facts and reasoning—for some of the more showy phases of argument, such as style, rhetoric, persuasion. Especially persuasion. So many young writers and debaters want to be persuasive. As though a man, if he be persuasive, eloquent, fiery, could carry the day regardless of sound evidence!

One of the hardest things to do, I find, is to put persuasion in its proper place. The trouble is that not one person in ten knows what persuasion really is. Most people, and especially college boys associate persuasion with eloquence, fire, noise, "pep"—whatever stirs and excites the emotions. One of the aims of a good course in argument should be to set this matter right.

Genuine persuasiveness — lasting persuasiveness — comes from sources too seldom recognized by unthinking people. It can not be slapped on like a coat of paint, nor can it be "created" by "special methods." One can not say "Here I will be persuasive, there I will be convincing." Persuasiveness is just as much at home in a talk or a paper on some engineering topic as in a Fourth of July oration. It is as often quiet as noisy. It comes in a speech or paper as a sort of concomitant of age and experience, of reputation, position, confidence of manner, naturalness of manner, a spirit of fairness. It blends with convincingness. One of the best ways to be persuasive is to forget that you want to be and instead bend all your efforts toward a clear, fair, sound presentation of facts. After all—the proof's the thing!

Plastic Fill Method Cuts Cost of Earth Dike

Water Jets Convert Loosely Deposited Earth Into Stiff Mud Which Flows and Settles Into a Solid Fill

PLASTIC fill was substituted for rolled fill at a reduction in cost in building a cross dam or dike required in constructing the hydraulic fill dam at Taylorsville for the Miami Conservancy District. Into earth which had been deposited by a dragline excavator, water was injected until it became a very stiff dough, sufficiently plastic to flow sluggishly under pressure. By flow and settlement the plastic material was then shaped into an embankment which was impermeable and as firm and solid as could be produced by spreading, wetting, and rolling the earth in thin layers. The plastic fill cost about 50c. a cubic yard compared with about $1 a cubic yard for rolled fill.

At Taylorsville, construction of that part of the main dam lying west of the river was begun first, so that the hydraulic filling might proceed while the river occupied its old channel until the outlet structure on the east bank was completed. For this purpose it was neces-

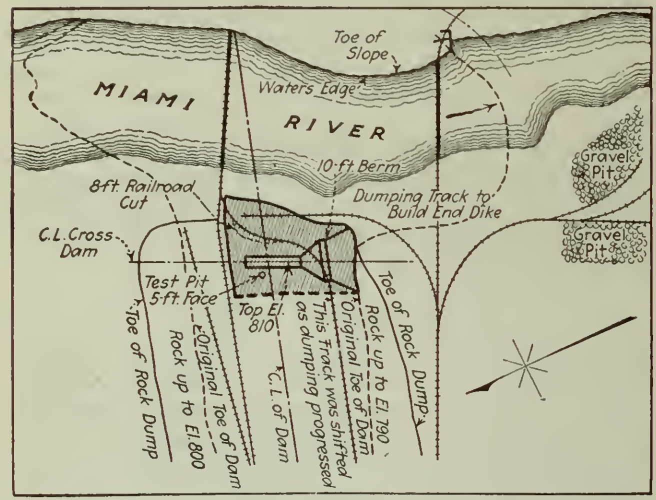


FIG. 1. PLAN OF CROSS DAM AND TRACK LAYOUT

sary to contsruct a cross dam along the west bank of the stream, as indicated by the sketch plan, to enclose the end of the core pool of the hydraulic fill. The volume of the cross embankment was about 45,000 cu.yd., and it was planned to form the fill by spreading and rolling. When about 10,000 cu.yd. had been placed it was decided, on the suggestion of G. L. Albert, superintendent of hydraulic fill, to substitute the plastic-fill method, with which Mr. Albert had had successful results on other embankment construction.

For rolled-fill construction, the material was excavated by a small steam shovel from a borrow pit on the east bank of the river, loaded into 12 cu.yd. cars, transtransported across the river on the downstream trestle, and unloaded by a dragline into a hopper, whence it was hauled in dump wagons to be spread on the fill and rolled. In changing to plastic fill the hopper, dump wagon and roller outfit was removed. In its place there were installed a small pump, pipe, and hose line and two ¾-in. gas pipe nozzles 10. ft. and 5 ft. long. Later the pump was eliminated and water was taken from the monitor pipe line for the hydraulic fill operation.

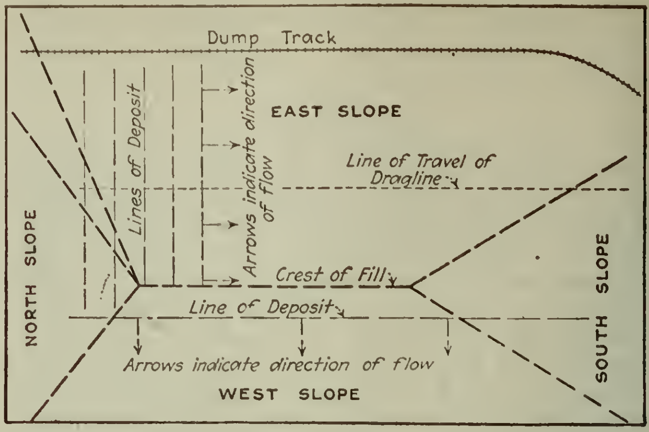


FIG. 2. DIAGRAM OF PLASTIC FILL OPERATIONS

With the dump car track located as shown along the east edge of the cross-dam, the dragline was unable to reach, with its load, to the west edge. Therefore two methods in detail of making the plastic fill were required, one for the fill west of the crest of the dam and another for the remainder of the fill. For both sides the procedure was the same in that dry material was dumped on the ground alongside the dumping track and thence picked up by the dragline and placed in position for the injection process.

When building up the west slope, the dragline laid a windrow of dry material parallel to, but well inside, the west toe of the cross dam. The depth of this pile was about 10 ft. On a line about 2 ft. west of the ridge of the windrow and about 3 ft. apart vertical holes were sunk to the bottom by means of the "jet pipe" and water thus introduced by percolation throughout the depth of the material. As the earth became plastic it would flow and since the water purposely was introduced under the west slope of the windrow the flow was toward the west. By dropping continually fresh material on the windrow, and thus loading the top, and by continuing the injection as circumstances demanded the flow was kept continuous until it reached the slope limits of the cross dam. The greatest distance which the earth was required to move in this manner was 40 ft.

For the remainder of the fill the dragline traveled east and west on the approximate center line of the cross dike, building the material up in a 10-ft. layer by successive north-and-south lines of deposit across the fill. The jetting was done practically as each bucketful was deposited so that the growing edge of the layer was kept plastic and flowing toward the machine. The diagram, Fig. 2, indicates the principle of procedure but does not show the actual methods, which were more or less irregular.

The flow of the plastic fill was slow, not in excess of 3 to 4 ft. a day, and completely under control. At any time the motion could be accelerated by adding to the top load or by injecting more water. It gradually stopped if no load or water was added and it could be checked more quickly by piling dry earth in front of the forward moving edge of the material. When the flowing material had finally settled it was exceptionally dense and stable. The walls of a test pit 5 ft. deep stood vertical. When a cut was made for a service railway an 8-ft. bank stood for a long time at a slope of 1 on ½.

From the experience at Taylorsville and later at the

Englewood dam it is evident that the success of plastic fill will depend upon the character of the earth used. At Taylorsville dam, the material was a glacial till or a mixture of rock ground fine by glacial action and containing a large percentage of clay, the combination being a mixture which would permit the water to escape. The last characteristic, of permitting the water to leak away after it has performed by flow and settlement its task of solidification, is particularly important in an earth to be placed by the plastic fill method. Too fine and retentive a clay, which hangs onto its entrained water, would, it appeared, give trouble if used for plastic fill. This was in fact discovered at Englewood dam, where rolled fill proved to be best.

Taylorsville dam is one of the flood-protection works being constructed by the Miami Conservancy District, Arthur E. Morgan, chief engineer, Charles H. Paul, assistant chief engineer, and C. H. Locher, construction manager. O. N. Floyd is division engineer in charge of the Taylorsville dam operations; H. R. Daubenspeck was in immediate charge of the plastic-fill operations above described.

Function of Technical Schools and Universities

In view of the discussion of engineering education in this country since our entry into the great war, the following editorial from *The Electrician*, London, has special interest:

At the present moment, when scientific and technical education is being much discussed, and plans for their extension are in preparation, it is worth while to consider seriously what the functions of the various institutions, colleges and universities should be, and especially how their activities should dovetail into one another. We perceive a tendency for institutions that are essentially technical schools or colleges to assume almost the functions of a university; and simultaneously we find the older universities, in their zeal for applied science, taking up work that might, perhaps, be more fitly left to technical colleges. There is also a certain inclination towards amalgamation for mere "bigness," which we are not sure is always desirable in an educational institution.

These remarks are suggested by the fact that in Germany the functions of technical schools are now being much discussed. There the so-called "technical school" has, perhaps, reached its greatest development, Charlottenburg being, of course, famous for its size and equipment. We see that Professor Riedler, late professor of engineering at this institution, is dissatisfied with the present methods, and even goes so far as to indicate that a decay set in with the present century, that too much stress is laid on pure technique and encyclopædic knowledge and too little importance attached to general scientific methods and principles. We are inclined to think that this somewhat arid and soulless form of work had become characteristic of many German technical schools before the war. It is, perhaps, a natural consequence of the commercialization of science in a narrow sense, and the modern tendency to "judge by results." We hope that the momentary stress laid on the material results of applied science, necessary as it may be to arouse the interest of the business man, will not go too far in this country. The pure spirit of scientific research, and the uncramped imaginative effort that gives, in the long run, the greatest benefit to humanity, does not thrive in a commercial atmosphere. We hope that this greatest work will be pursued at our leading universities, and that they will not be compelled to adjust their methods to the "payment by results" tendency. Even at those institutions which are admittedly mainly technical, and even industrial, there should be room for the humanizing element in education, and not too much emphasis should be placed on the purely material side of science.

Iowa Methods of Widening and Maintaining Earth Roads

Operations Planned to Build Up Permanent Foundation for Paved Road—Bulk of Work Performed by Tractor-Hauled Graders and Drags

By A. F. Fischer
County Engineer, Johnson County, Iowa

Tractor-operated graders and drags are creating the foundation for a paved road system in Iowa at a cost not exceeding that of ordinary earth road maintenance. Neither the drag nor the grader methods are unusual except that each operation is definitely planned to contribute a part toward the upbuilding of a piece of road to receive a permanent surface, as well as to keep that piece of road in the best condition for its present traffic. Broadly speaking, earth road upkeep is made a paved road construction process.

By the method indicated foundation construction is a succession of small operations of simple character. That the sequence of these operations is planned and that each is directed to a definite construction purpose are the facts which give value to a step-by-step recital. Let it be kept in mind, then, that the steps enumerated are units of a construction process which has prepared literally thousands of miles of earth road for hard surfacing at the cost of ordinary earth road maintenance.

As formulated in practice the general plan of earth road improvement in Iowa is: (1) To design a road section which can be machine constructed; (2) to plan a machine outfit and its operation to construct the designed section, and (3) to establish maintenance methods which will continuously preserve and further build up the road.

In the designed cross-section, shown by the accompanying diagram, there is no surface, even the back slopes of the ditches, which cannot be formed by the blade of a grader.

Equipment is standardized as follows: A team outfit works ahead widening narrow cuts and filling in bridge approaches, low places and mudholes. It consists of from eight to twelve teams and an equipment of wheeled, fresno and slip scrapers and small tools. A tractor-operated grader outfit follows the team gang. It consists of two 12-ft. blade graders hauled tandem by a 40-hp. tractor.

For maintenance a combination of patrol outfits, drags and graders is employed, all operations being technically directed as to time, place and procedure.

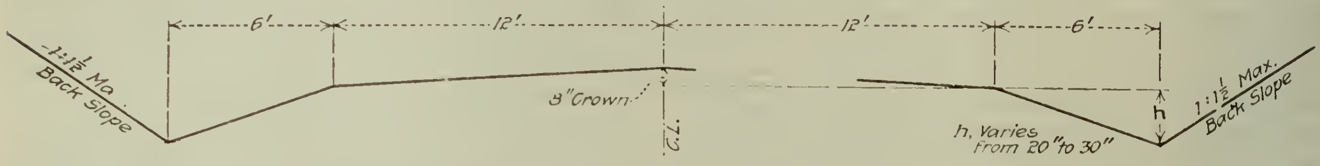
Tractor Grader Methods

Except at the last, in finishing the crown, the grader operations are duplicated on the two sides of the road. As conditions determine, resort is had to judgment in varying the sequence and the number of grader cuts, but substantially a definite schedule of operations is followed.

Removal of the sod on the outside of the roadway next to the ditch is the purpose of the first cut. The forward grader marks the ditch line but makes no cut, while the rear grader shaves off the sod in a layer about 2 in. thick and 6 ft. wide from the ditch line toward the middle of the road. The thin cut has two objects: (1) It makes it less difficult to hold the grader steady, and (2) it furnishes a thin sod which will not pile up in the succeeding spreading operations. One trip of the grad-

ers completes the sod cutting from the shoulder to the ditch line.

The next operation is to cut the front slope of the ditch to about a foot in depth. Two or three trips of the graders are required for this operation. On each trip the forward grader acts as a cutter and the rear grader as a spreader. In the first trip the forward grader shaves the sod from the front slope of the ditch and carries it onto the shoulder, while the rear grader takes the sod previously cut from the shoulder and distributes it in depressions or lays it in a flat strip next to the center line of the crown. In succeeding cuts the forward grader deepens the ditch while the rear grader spreads the sod. The purpose is to spread the sod and



STANDARD ROAD SECTION FOR BLADE GRADER CONSTRUCTION

iron it down with the tractor before any loose dirt from the ditch is spread.

When the ditch has been deepened to approximately a foot on the front slope, both graders are brought out of the ditch to distribute the dirt from the ditch cuts. This dirt is spread evenly over the previously placed sod layer. One trip is made with both graders spreading.

Ditch Deepened

The next operation is to cut the back slope and deepen the ditch. On the first trip the forward girder shaves off the sod in a thin layer for the full width of the slope while the rear grader completes the final spreading trip on the crown. Care is taken to remove all sod from the back slope in this one cut. On the second trip the forward grader is in the ditch, shifting onto the shoulder the sod cut from the back slope, and the rear grader starts taking this sod to the quarter point on the crown. On the third trip the forward grader is on the back slope deepening the cut while the back grader is finally distributing the back slope sod on the quarter point on the crown. The operations described are repeated until the ditch is at the required depth. Each time the front grader runs in the ditch to move away the dirt from the back slope, it also deepens the ditch cut from 4 to 6 in. Usually it requires two trips of the forward grader in the ditch to one trip on the back slope to acquire the planned cross-section. There are intervals in the ditching operation when both graders are taken out of the ditch to spread the excavated material.

Slope Finishing Cut

After the ditch has reached the required depth and the back slope has been properly formed, a final cut on the front slope is made from the shoulder to the bottom of the ditch. This is purely a slope-finishing cut. It does not deepen the ditch but leaves the shoulder in nearly perfect alignment, with a uniform front slope.

Upon completion of the ditch, both graders are used for smoothing the roadway to the planned cross-section. Finally, when the graders have completed a stretch of road, all ditches inaccessible to the graders and all waterways are opened by hand.

Blade graders, road drags and patrolmen's outfits maintain the graded road. The road system is divided into patrol sections varying in length from 8 to 15 mi., and a boss patrolman has charge of each section. Sometimes the patrolman is given helpers. The patrolman and his helpers are usually hired by the month and furnish their own teams, the county furnishing the tools. Where two men work together, they are given twice as much mileage as that given a signal patrolman. The inclination is to favor the "pair" system because it gives four horses instead of two for light grader work; also when desired, the men can be sent to different locations at the same time. Four-horse graders are preferred to two-horse graders. Good work can be done by either machine, but the four-horse machine, being heavier, does better work, all other factors being equal.

Contracts are entered into with various individuals, usually farmers living along the road, to do such dragging as cannot be done by the patrolmen. Horse-drawn drags have been used, but the horse is being replaced by the tractor. When using a tractor for power, two drags are hitched abreast or one of the newer forms of patented drags or "maintainers" is used. In order to drag the entire traveled roadway properly, two and sometimes three full round trips are necessary. A stretch of 3 mi. is about all one man can drag, and do the dragging when it should be done, if horsepower is used. If tractor power is used, as many as 12 mi. of road can be properly dragged by one man.

Check Kept on Draggers

The dragmen are at all times under the general supervision of the patrolmen, and they drag the roads in accordance with instructions given them from time to time. Reports of each dragging are sent directly to the engineer's office, where a chart is kept showing the dates of rains, time of dragging, the amount of road dragged by each man. A check is thus kept on the draggers and on the general condition of the dragging which they do.

As soon as the roads permit in the springtime, the tractor-drawn blade graders are sent over the entire mileage. They do not attempt to do any ditching or road building on these initial trips, but merely make a round or two in order to smooth up the traveled roadway by butting off the humps, filling the holes and shaping up the crown. It is best to do this grader work as early as possible because it gives the draggers a good roadway to work on. The same operation with the graders is repeated two or three times during the season, or as often as is necessary to keep the crown in good shape.

In the maintenance of an earth road, dragging at the right time is the big factor in keeping the traveled roadway smooth. Continual dragging tends to "case harden" the roads so that it will take a considerable wet period to damage them seriously during the summer time.

Pontoon Drawbridge and Temporary Girder Swingspan

Bobtail Swingspan Built of Old Girders and Operated by Cable Gear — Replaced by Timber Pontoon Span

A FLOATING draw span installed in 1919 as part of the new Missouri River bridge of the Chicago, Milwaukee & St. Paul Ry., at Chamberlain, S. D., consists of a single barge or scow carrying a track floor which can be raised and lowered in accordance with changes in the water level of the river. It is similar to other pontoon drawspans used by the same railway for several years (see *Engineering-News* of April 30, 1908, p. 474). This type of pontoon bridge differs from those used in Europe and for military service in that a single large boat lies across the current and forms a floating span, while in the other type a number of small boats anchored parallel with the current form floating piers to support spans laid between them.

In the Chamberlain bridge, the new pontoon is a timber flat-bottom barge 262 ft. long, 40 ft. wide on the deck and 5½ to 6½ ft. deep, as shown in Fig. 1. Its frames are spaced 24 in. c. to c. The planking on the upstream side is protected against ice and drift by $\frac{3}{16}$-in. steel plates held in place by ½-in. carriage bolts spaced 4 in. in both directions.

Two rows of uprights extend along the barge at about 18-ft. spacing. Each is composed of four posts so arranged as to form an opensided member, these posts being seated on stringers laid along the bottom ribs of the frames and secured by through bolts and distance pieces. The uprights extend about 20 ft. above the deck and each is supported laterally by a pair of brace posts seated on a longitudinal timber in the side of the hull. Floor beams for the track system have their ends extending between the posts, which serve as guides. These floor beams are pairs of steel channels, having at each end web filler pieces which give a side bearing against the posts and a bottom cushion which rests on blocking placed longitudinally between the posts. This blocking consists of 8 x 16-in. pieces, 5 ft. long, laid longitudinally between the posts of the upright.

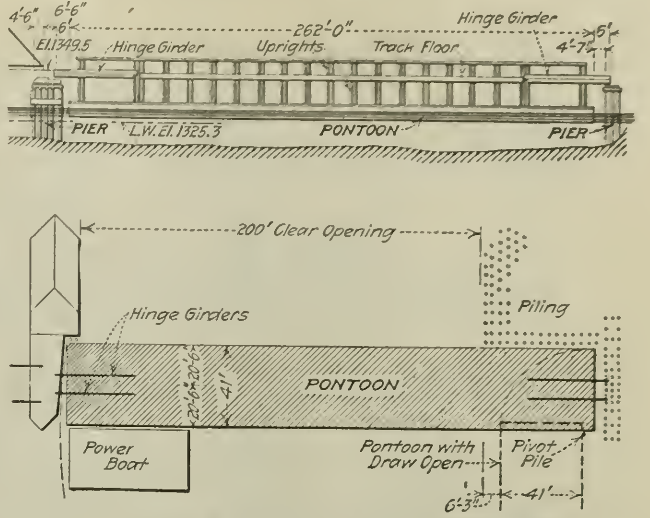


FIG. 2. ARRANGEMENT OF PONTOON AND OPERATING BOAT

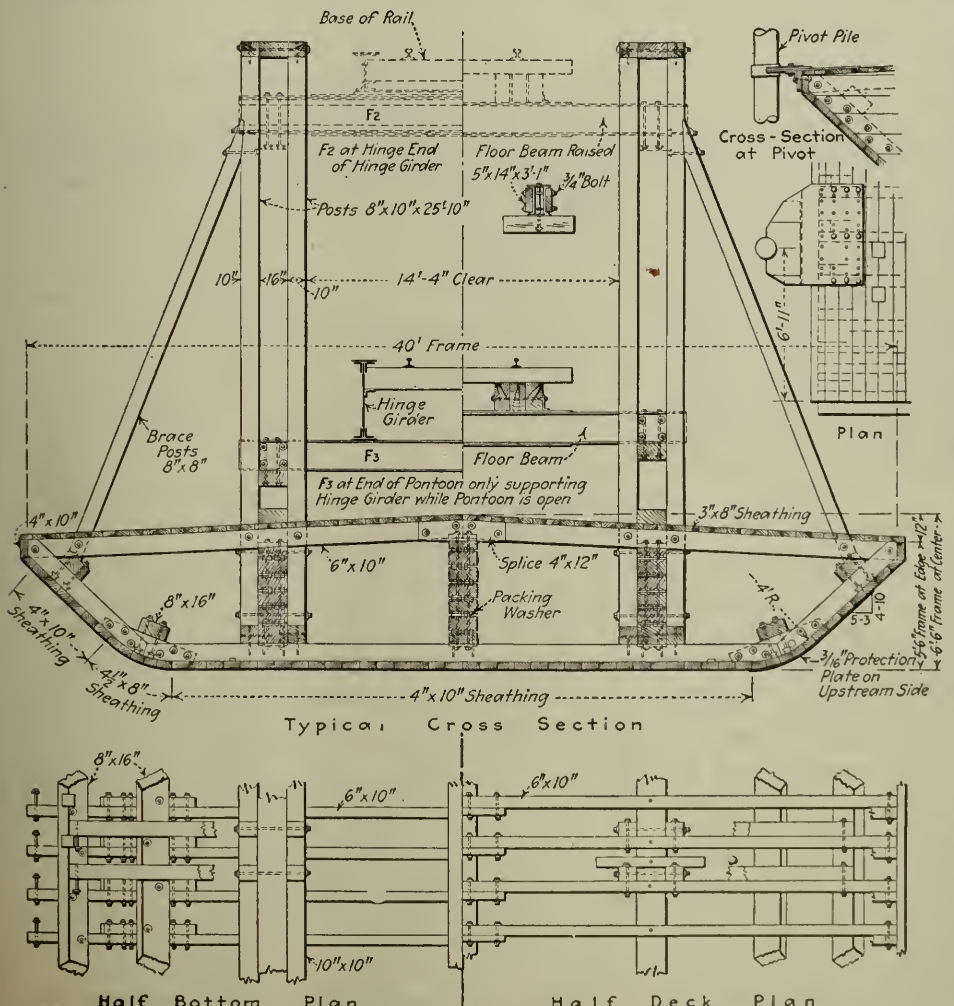


FIG. 1. PONTOON DRAWBRIDGE WITH ADJUSTABLE TRACK DECK

To adjust the track level, the floor beams are raised or lowered by jacks while the blocking is built up or removed correspondingly. The vertical range in elevation is about 16 ft. Upon the floor beams are packed stringers to support the track ties. At each end of the track floor is a hinged girder or apron extending from the pier to the floor beam, these aprons providing for minor differences in elevation between the track on the pontoon and that on the fixed approaches. When the pontoon is moved, the outer end of each apron is raised clear of the pier and supported on a beam between the end and pair of uprights. These aprons have pairs of plate girders, with shelf angles on the webs to support the ends of the ties.

In swinging, the pontoon

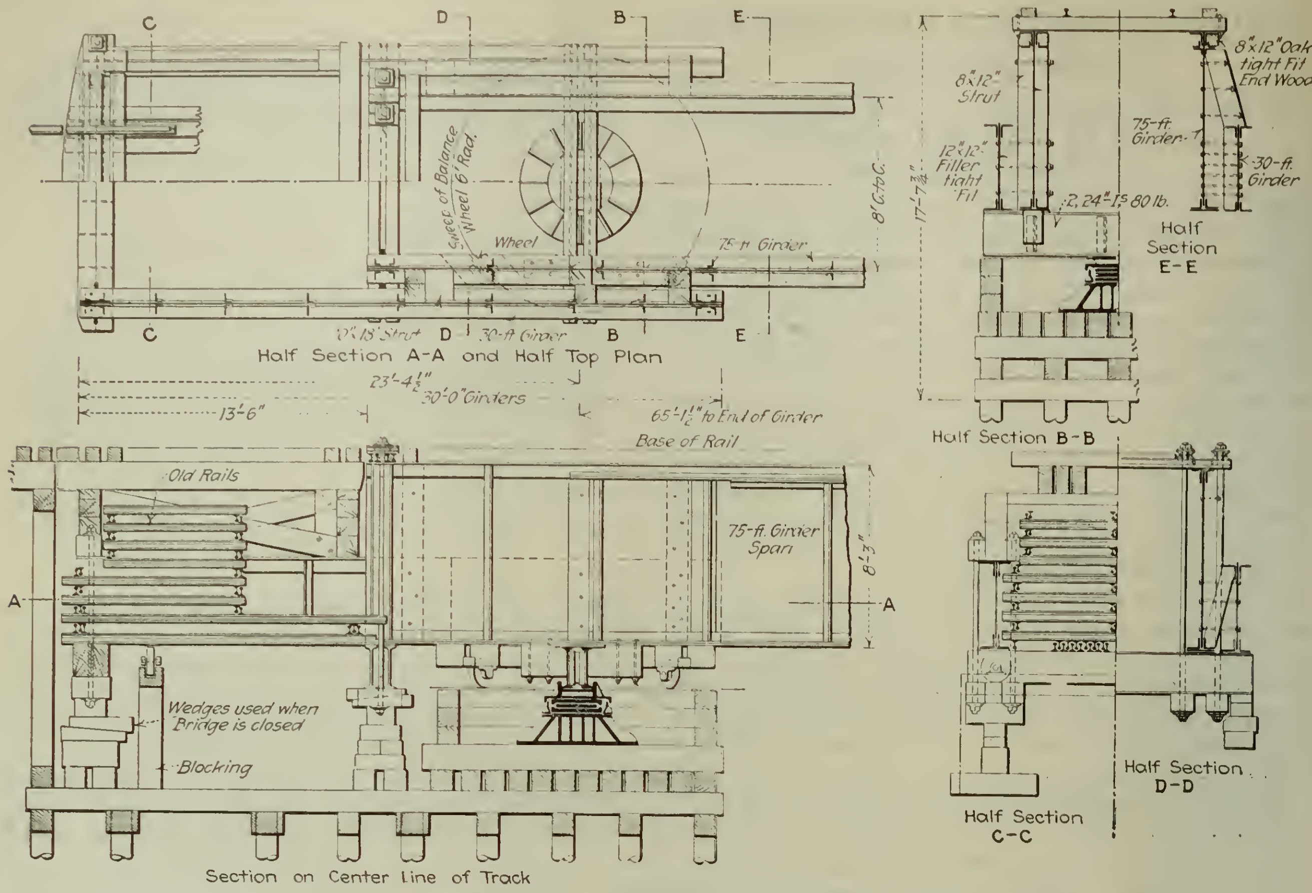


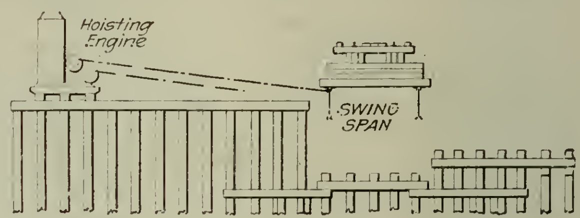
FIG. 3. TEMPORARY SWINGSPAN BUILT OF OLD GIRDERS

revolves about a pivot pile near the end of the downstream side, this pile engaging a semicircular notch in a steel-plate projecting from the deck of the pontoon. When closed, the free end is locked to a pair of anchor piles on the upstream side. For operating the pontoon there is a power boat or small scow lashed to the downstream side of the free end and carrying a hoisting engine. This arrangement is shown in Fig. 2. Over the drum of the engine passes a chain which lies on the bed of the river and is anchored at each end of the draw opening. Horizontal and vertical rollers guide this chain up the side of the scow and pontoon and it is carried across their decks on grooved rollers.

Temporary Girder Swing Span

A 366-ft. pontoon was used originally for the draw at the Chamberlain bridge, but in 1918 this had become so leaky that it could not be kept in service. Pending reconstruction of the bridge and the provision of the new but smaller pontoon described above, a temporary swing span was provided. This was a bobtail plate-girder span built of old material available (Fig. 3.)

Two 75-ft. plate girders formed the main arm and rested upon a bolster at 65-ft. from the free end. Outside of these and projecting 13½ ft. beyond their rear ends were two shallow 30-in. girders carrying a counterweight of old rails piled as shown. This short counterweighted arm was supported by rollers when moving, but with the bridge closed wedges were driven to give the arm a rigid support on the blocking. For the free end of the span the weight was 82,500 lb. for the girders and 17,500 lb. for the track floor, or 100,000 lb. acting at a radius of 31 ft. For the bobtail arm, the weight was 43,900 lb. for girder and floor, with 139,100 lb. of counterweight, making a total of 183,000 lb. acting at a radius of 17 ft.



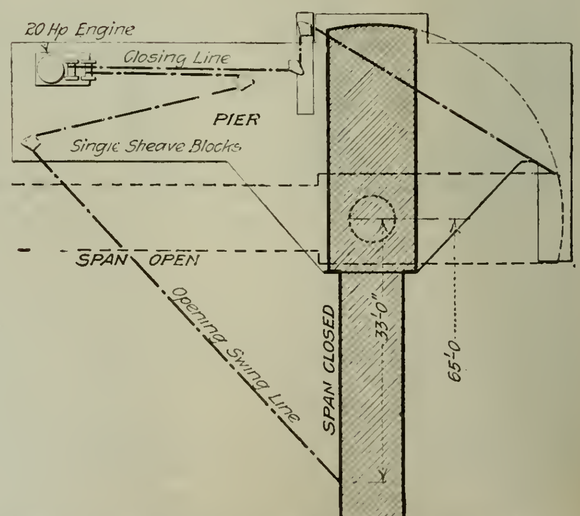


FIG. 4. LAYOUT OF OPERATING MECHANISM OF TEMPORARY SWING SPAN

A bolster or bearing girder composed of a pair of I-beams carried the span and transmitted the load to the upper disk of the center bearing, while four rollers or balance wheels under the girders traveled on a track of 6 ft. radius. At the rest pier, the girders were seated on a pair of rails laid along the bridge seat, the ends of these rails projecting beyond the pier and being curved downward so as to guide and raise the free end of the bridge as it came to the closing position. The end lock was a 3 x 12-in. stick 8 ft. long, laid on the center line between two similar sticks 5 ft. long bolted to the ties on the bridge and the approach.

To Operate Swing Span

To operate this swing span, a 20-hp. double-drum hoisting engine with boiler was installed at one end of the pivot pier, having cables arranged as shown in Fig. 4. The opening line was led from one drum through single-sheave guide blocks and attached to the middle of the main arm of the span, while the closing line was led through similar blocks and attached to the tail end. As the free end of the span reached its closed position, a spring buffer at the side engaged a stop consisting of a pair of heavy timbers bolted to the trestle approach and projecting into the draw opening.

This temporary drawspan and the new pontoon draw were parts of the work of rebuilding the bridge, which work was done by the railway company's forces in 1918-1919 under the general direction of Charles F. Loweth, chief engineer of the Chicago, Milwaukee & St. Paul Railway.

Effect of Electric Locomotives on Track and Wear of Rails

THAT electric locomotives compare favorably with steam locomotives in their effect upon the track is the experience of the Chicago, Milwaukee & St. Paul Ry., according to the report presented by the committee on electricity at the annual meeting of the American Railway Engineering Association.

In the opinion of roadmasters and superintendents on the electrified zone there is no greater slipping of the locomotive wheels on the rail and consequently no greater damage to the top of the rail under electric operation than there is under steam operation. It has not been found that there is any greater tendency for the rails to creep on account of regenerative braking on descending grades than there was under the braking action of steam locomotives. No case has been found in which electric locomotives moving at a high rate of speed have tended to displace the rail on the ties or the ties in the ballast.

Roadmasters agree that electric locomotives are easier on the track than steam locomotives because of the less rigid construction. It is stated that the flange wear on curves under electric operation is actually less than under steam operation, for the reason that the electric locomotives are less rigid in their wheel arrangement.

On curves the outer rails are elevated for speeds of 30 m.p.h. on mountain grades and 45 m.p.h. for valley territories. On the Rocky Mountain and Missoula divisions the mountain grade superelevation is ½-in. per degree of curvature with a maximum of 3 in. On other curves the superelevation is 1 inch per degree with a maximum of 3½ inches.

Notes from Foreign Fields

BRITISH ROADS FOR HEAVY TRAFFIC

BY
E. J. Mehren
EDITOR, ENGINEERING NEWS-RECORD

IN A previous letter (see *Engineering News-Record*, June 24, p. 1267) I raised questions whether waterbound macadam in England stands up under motor-truck traffic and, if so, why.

These questions I am in a position now to answer. in a single statement:

Waterbound macadam here, as in the United States, *does not stand up under motor-truck traffic.*

The maintenance costs are excessive, and as rapidly as possible waterbound macadam on heavily-traveled routes is being replaced with some form of tar or asphaltic construction. In fact, a very large mileage of the main roads has already been so reconstructed, and had been even before the war.

To the American observer the universal adoption here of the bituminous road occasions surprise. We are accustomed to thinking of concrete and brick as being, with bituminous pavements, the standard types of construction for heavy traffic. Never once have I heard the concrete road proposed as a solution of the British road problem, but when I have brought up the subject a lively interest has been shown. The concrete road, however, is distinctly out of the reckoning here. Brick is even less in mind.

Moreover—and this must have special emphasis—the bituminous pavements *are not laid on a concrete base*, but on the old macadam.

The reasons for these practices are not difficult to find. First, however, regarding the non-use of a concrete base. Compared with our own, the road system of England is quite mature. In addition, long tenure of office has resulted in standardizing practice in highway construction. A county surveyor does not rush out of office the very year he begins experimentation. He stays on and benefits by his failures and successes. As a result a sound body of practice has been built up, and by constantly sharing experiences—rather easy to do in a country as small as Britain—practices have tended to standardize.

This shows itself, for example, in the extremely important matter of drainage. So much do they consider adequate drainage a necessary condition of good roads that no one has mentioned the subject to me. I have always had to bring it up, and then have been met by the rejoinder, "Of course, you can't do anything unless your roadbed is kept dry." And dry they do keep it—not by any mysterious means, but by ditches and longitudinal tile, with herringbone drains when conditions demand them. For two genrations, under intelligent supervision, the wet spots have been systematically eliminated, so that the drainage job, as a construction feature, may now be said to be done. The ditches, drains and culverts are well looked after, so that they continue to function properly.

It follows, therefore, that a solid roadbed having been secured and the metalling having been consolidated by years of traffic, the old waterbound macadam pavement is a very excellent base for the tar-macadam or asphaltic top. British expectations regarding this construction have been fully realized and the thousands of miles of it in use show that for conditions here a concrete base is not required.

Of course, one can foresee traffic conditions that will lead to more expensive construction. In Lancashire, for example, the county surveyor, Mr. W. H. Schofield, has long since found it economical to lay granite-block pavement, both with and without concrete base, on the roads between the great industrial cities in the south of the county, in the Liverpool-Manchester area. These roads carry as much as 10,000 long tons of motor-truck traffic per day.

So much for the none-use of the concrete base.

Slight Interest in Concrete Roads

As for the relatively slight interest in the concrete road, there are a number of reasons. They may be summarized as follows:

1. Experimental sections laid here have not been successful. The reasons for failure I have not been able satisfactorily to learn.

2. British engineers insist upon proceeding cautiously. Their traditions and their outstanding success in road work fully justify them in knowing whither they are going before they start on large outlays.

3. There is quite general doubt as to the satisfactory qualities of concrete as a wearing surface. This may be due, in part, to the failures of the experimental sections, but probably more largely to a partiality, fully warranted by their experiences, for the bituminous surface.

4. Tar macadam was cheap before the war, costing from 3s. 6d. to 4s. per square yard (from about 85 to 96 cents per square yard), including the scarifying, reshaping and rolling of the old macadam base. With the excellent foundation afforded by the old macadam there was no reason for laying a more expensive pavement—and more expensive concrete would have been.

5. For six years any new thinking in engineering work has been stopped. Interest was shown in concrete roads in 1914 and there might have been a change in sentiment had there been, since then, six years of road study and experimentation instead of war and its aftermath. In our own country the great strides in the popularity of concrete have been made in these six years.

6. There is doubt whether, in the long run, concrete will prove to be cheaper than other pavements. British engineers listen attentively when I tell them that our maintenance costs for the pavement itself are less than $100 per mile per year for an 18-ft. width. That figure impresses them, but they advert to the relatively short period of our experience—say, 7 to 8 years—and ask what it will be after 15 years, when we may have had to put on a bituminous topping.

7. Finally, there is an objection that we in the States would never dream to be serious—the shutting off of traffic while the concrete cures. Here again we must understand British conditions. Detouring is, of course, possible, but the parallel system of roads, so common with us, is unknown here. The length of detours, compared with the length of road closed, would be much greater than with us. Apparently, too, the British public is more likely than ours to protest against inconveniences. When I first heard this objection I found it difficult to accept it as serious, but confirmation of the original statement by various road authorities convinces me that it is an important factor in eliminating the concrete road.

These are the principal reasons, as I find them, why concrete is not used here. It is admitted, though, that with the great rise in price of tar and pitch (the price of Portland cement has not risen in equal proportion) much more thought will be given to the use of concrete. Our success with it is known here, and commends for concrete respect and consideration it might otherwise not get.

Bituminous Construction

As to bituminous construction, there are a number of types in use. Tar and pitch are used to a very much greater extent than asphalt, though here again a change appears impending, due to price considerations. Asphalt has always been the dearer product, but tar and pitch are now so expensive that asphalt cannot compete on a price basis. (I take asphalt here in the sense used in the United States. When the British engineer uses the term "asphalte," without qualification, he means rock asphalt—a material used here only for city paving.)

Tar-macadam is, from my observation, the favorite type, using blast-furnace slag as an aggregate where obtainable. Granites and andesites are also used for aggregate, though the general experience here is that they do not give as good results as slag. The latter has little or no free sulphur in it, and carries from 30 to 40 per cent of lime. Practice varies as to thickness—from 3 to 4½ in.—but universally it is laid in two courses, a 2 or 2½-in. stone for the bottom course and 1½-in. stone for the top. The stone is coated hot at the quarry or at a central plant, then shipped to the job and laid cold. After the two courses are down the surface is sealed with tar (about ⅙ or ⅕ gal. per yard) and the top covered with ⅜-in. granite chips. These roads as a rule are given a tar-spraying annually, at a pre-war cost of about 2½d. (about 5 cents) per yard. This would give an annual spraying cost, for an 18-ft. road, of about $500 per mile, and for the first 8 to 10 years this is the only maintenance cost.

The penetration type is also used. It is here called "pitch grouting." I had the pleasure of going over the truly remarkable highway system of Midlothian County, Scotland, where the county surveyor, Mr. W. H. Ellacott, has used the penetration method extensively and successfully. It is done much after the methods we use in the United States, the grouting material being pitch (the residuum from coal-tar distillation) fluxed with creosote oil. At Liverpool, the city engineer, Mr. John A. Brodie, has also used the penetration method successfully. He showed me many miles of it carrying, as it does in Mr. Ellacott's county, heavy traffic. Some of it has been down 20 years, with very little maintenance. One street had been laid 14 years with *not a single spraying*. It was still in fine condition. Mr. Ellacott sprays even his grouted roads every year, though often only the center needs the annual treatment.

In his pitch grout Mr. Brodie uses 50 per cent fine sand, with which some lime is mixed to increase the percentage of fine material.

Always where roads are sprayed a surfacing of granite chips is used, thus putting on annually a new wear-

ing surface of, say, ½ to ¾ in., beside sealing the surface.

While these types are the ones generally in use, a two-course bituminous pavement with an asphaltic wearing surface is coming into favor and is the concrete road's direct competitor for heavy traffic. This type consists of a pitch-penetration or a tar-macadam lower course laid to a consolidated thickness of 3 in. (using 2-in. stone). On this course is laid a 1½-in. asphalt wearing surface, similar in composition to our wearing surfaces for sheet-asphalt pavements. The cost of this type of work (which like all bituminous paving on country roads is laid on the old macadam pavement as a base) is now about 17s. per square ward, while concrete, 6 in. thick, would cost from 18s. 6d. to £1 per square yard. The reason that this two-course work is coming into favor is that for 2 or 3 years it requires no maintenance whatever, while the maintenance cost is very small for the first 8 or 9 years. It was freely predicted to me that this type will come into very rapid favor. This view was endorsed by Mr. J. S. Killick, chief engineer of the Roads Department of the Ministry of Transport, who regarded it as the coming popular type for main roads except those of extremely heavy traffic.

This subject, I find, is taking more space for its treatment than I had anticipated and since I still have two especially important points to bring out regarding road practice in Great Britain I will defer their treatment to the next letter, rather than, by putting them last, to allow it to appear that they are relatively unimportant.

Liverpool, June 2.

'URTHER HIGHWAY OBSERVATIONS IN GREAT BRITAIN

MY LAST letter closed with the statement that I had two observations of some importance to make regarding highway practice of Great Britain. One relates to the construction of any road over clay and the other to the need for abutments for bituminous road crusts. Both subjects are viewed here with remarkable unanimity and, I believe, in a way new to us in the United States.

It is the universal practice here to cover the clay subgrades with 3 to 4 in. (after rolling) of cinders or ashes. It is the generally prescribed remedy for preventing clay working up into the stone. Gravel is used if ashes or cinders are not available, but the agreement is general that gravel is not as good as either of the other materials. The common description of the effect of the cinders is that they "smother" the clay. I drove over a road near Blackpool constructed over very wet ground, and the county surveyor informed me that he felt it wise at this place to use 12 in. of cinders.

Any kind of ash or cinders apparently will do—from stove-ashes to steam cinders and destructor clinker. It seems worth while to place special emphasis on this practice, for the boiling up of clay into plain macadam and surface-treated macadam tops is a common difficulty with us. In some of our states a layer of gravel is used on top of clay but the universal view here that cinders are better should induce experimentation with them in the States.

Be it noted, too, that the cinders are put down even when a Telford base or "pitching," as they call it here, is used. The cinders cover the clay and the Telford goes on top of the cinders.

The second point that I wish to emphasize is that there is general agreement here that bituminous surfaces—laid, of course, on a macadam base—require abutments on both sides to prevent the surface pushing outward. Mr. A. Dryland, the county engineer of Middlesex, stated that he had found tar crusts pushed 18 in. under the sod shoulder. The type of abutment used is a curb, sometimes of sod, but preferably of stone. I have seen miles of stone curbing along the more heavily-traveled country roads, the purpose being twofold—to furnish the abutment, or shoulder here referred to and to prevent the cutting into the sod shoulder which would otherwise occur. Incidentally, the drivers run their wheels against the curbs on down grades and use them as brakes.

It should be remembered, as I pointed out in an earlier letter, that shoulders as we know them—extensions of the road surface, but of a cheaper material—are not used here. The word "shoulder" here means a raised margin, or curb, at the edge of the metalled way.

Obviously the sod shoulder does not furnish as much support as is desirable, yet it is of some value, particularly when backed by a gravel footpath.

So far as I know we have not given this matter of abutments as much consideration as they have here. British engineers consider it an essential feature of good bituminous construction.

Footpaths

Reference has been made several times in this correspondence to the practice of providing footpaths on country roads. These paths are generally of gravel, but it is beginning to be the practice to tar-treat them. There are many miles of such tar-treated footpaths in two of the counties whose roads I inspected, Midlothian and Lancashire. In Midlothian ¼ to ½-in. stone is used, and sprayers 3 ft. wide have been developed to cheapen the work. Spraying in alternate years is sufficient to keep the paths in good condition.

This construction and maintenance of footpaths is but one of the many evidences of a development far beyond our own. We are coming, of course, to greater refinements—and among those refinements maintained footpaths will be the earliest. It is highly uncomfortable and even dangerous now to walk on the highways near the big cities. Before long some one will "break the ice" by building footpaths; their acceptance after that is likely to be rapid.

Liverpool, June 2.

Zoning Commission at Philadelphia

In accordance with a provision of the new city charter, the Mayor of Philadelphia recently created a zoning commission of 18 members. Seven of the members are heads of municipal departments and bureaus, nine represent various organizations in the city, and two members are unattached. Among the department or bureau heads are George S. Webster, chief of the Bureau of Surveys; John A. Vogelson, chief of the Bureau of Health, and John P. B. Sinkler, city architect. etThe Philadelphia Engineers Club is represented by Walter F. Ballinger, and the Amercan Institute of Architects by Edgar V. Seeler, Philadelphia chapter. The Master Builders' Exchange and the Central Labor Union each has a representative on the commission.

Table Simplifies Use of Templates In Track Plotting

By J. G. Walsh
Chief Field Engineer, T. C. I. & R.R. Co., Ensley, Ala.

The accompanying table was prepared to simplify the use of drafting curves, or templates, in plotting track layouts. Templates in common use for such work are practically all designed to be used on maps of 1 in. to 100 ft. scale.

My experience has been that in the use of other scales, such as 20 ft., 30 ft. or 40 ft. to the inch, reduction of the curve by calculation, though very simple, entails a certain loss of time as well as probability of errors in calculation, which I have found amounts to about 15 per cent of loss in a day's work.

In using this table the draftsman desiring to plot an 8 deg. scale will find his curve indicated in the column headed "1 in. = 30 ft." opposite "8°" column headed "D. C." (Degree of Curve), and it will be found to be a 2°24′ curve of radius, 2387.5 ft. Therefore if his templates have been marked according to the curve degrees he will select the one nearest to 2°24′. This would be the one marked 2°30′ as they generally are marked by even quarters of a degree. If his templates or curves are marked by a certain number of given inches to the radius he will select the template or curve marked 24. The number 24 indicates that it is cut on a 24-in. radius, which on a scale of 100-ft. to the inch would be a 2400-ft. radius, being the nearest distance to the 2387.5-ft. radius given in the table. This is close enough for all practical purposes in plotting track work.

Templates or curves marked to indicate the number of inches to the radius are not used very extensively by engineers in plotting track-work; the explanation of the use of the table in connection with the templates marked this way is for the benefit of draftsmen who have a varied class of work, perhaps including pipe work, as is the case in our engineering department. In my department we use the curves marked with degrees; in the drafting room they use the radius of the templates marked in inches.

Driest Season at Panama

Gatun Lake in the Panama Canal was at its lowest recorded minimum level during the past season. That season, beginning about the middle of December, 1919, and ending on May 13, 1920, was the driest since the American occupation of the Canal Zone. The average precipitation recorded at twelve stations on the isthmus was 3.93 in. as against 5.37 in. in the season of 1911-12, the previous dry record. The scanty rainfall resulted in lowering the surface of Gatun Lake to 81.76 ft. above sea level, the lowest on record. This occurred on May 28, after rains had begun but before the runoff drainage basin had increased. The storage depletion of the lake represented in the drop of 5.24 ft. from the 87-ft. level at which the dry season began amounted to 20.46 million cu.ft. On March 3 the water consumption of the hydro-electric station was reduced and about 50 per cent of the load carried by the steam generating plant at Miraflores until June 3. It is stated that a surface elevation of 79 ft. has been considered as giving ample depth for navigation through the completed canal. Had the proposed Alhajuela Lake of 15 billion cu.ft. capacity been built there would have been available this year for replenishing the Gatun Lake storage depletion a somewhat larger flow, but due to the very low rainfall the lake elevation would not have been so very much higher than it actually was.

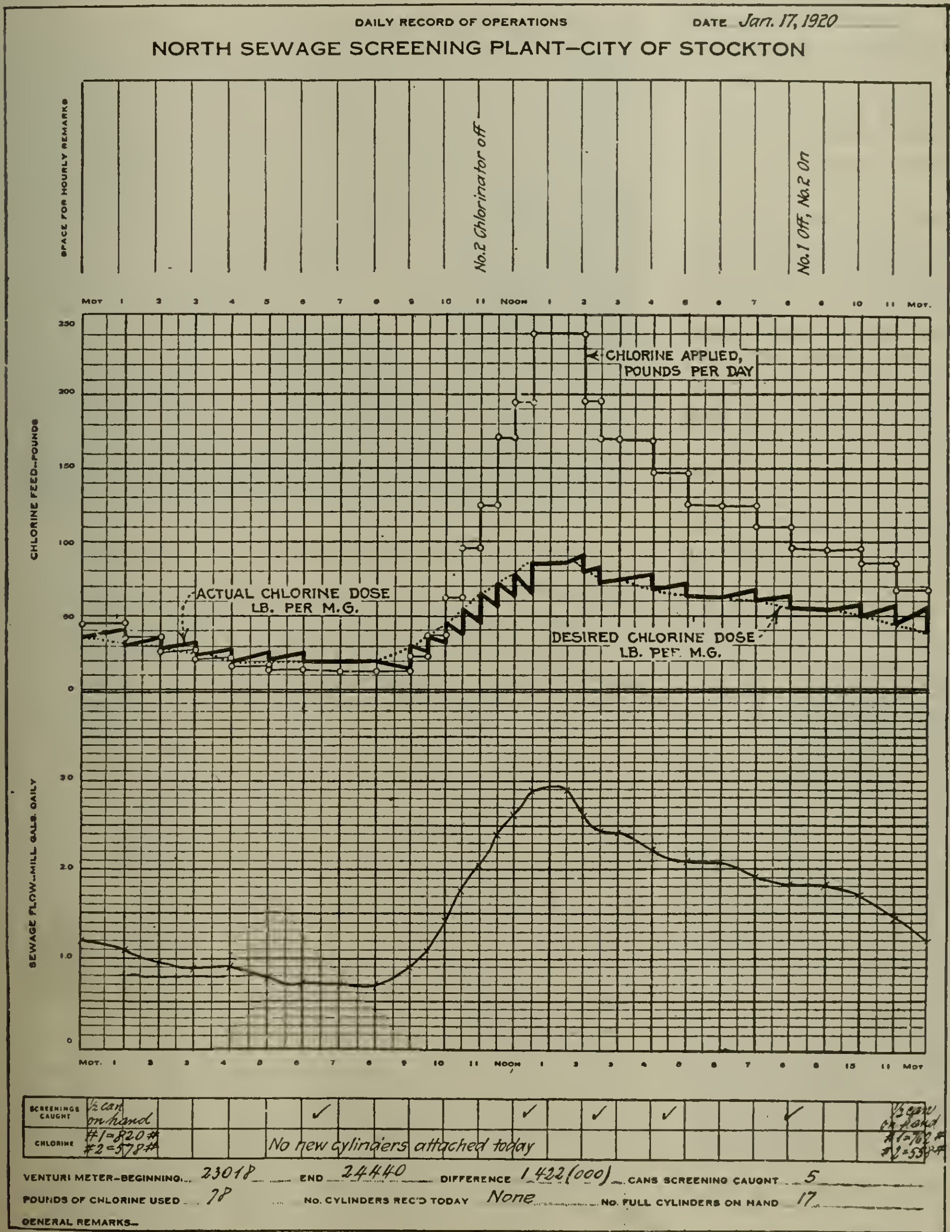
COMPARATIVE TABLE OF RADII AND DEGREE OF CURVE, FOR CURVES MARKED 1 IN. = 100 FT. SCALE

No. C.	1 In. = 100 Ft. D.C.	R.	1 In. = 60 Ft. D.C.		R.	1 In. = 50 Ft. D.C.		R.	1 In. = 40 Ft. D.C.		R.	1 In. = 30 Ft. D.C.		R.	1 In. = 20 Ft. D.C.		R.	1 In. = 10 Ft. D.C.		R.
Deg.	Deg.		Deg.	Min.	Ft.	Deg.	Min.	Ft.	Deg.	Min.	Ft.	Deg.	Min.	Ft.	Deg.	Min.	Ft.	Deg.	Min.	Ft.
1	1	5,729.6	0	36	9,549.3	0	30	11,459.2	0	24	14,323.6	0	18	19,098.6	0	12	28,647.8	0	06	57,295.8
2	2	2,864.9	1	12	4,774.7	1	0	5,729 6	0	48	7,162.0	0	36	9,549.3	0	24	14,323.6	0	12	28,647.8
3	3	1,910.0	1	48	3,183.2	1	30	3,819.8	1	12	4,774.7	0	54	6,366.3	0	36	9,549.3	0	18	19,098.6
4	4	1,432.6	2	24	2,387.5	2	0	2,864 9	1	36	3,581.1	1	12	4,774.7	0	48	7,162.0	0	24	14,323.6
5	5	1,146.3	3	0	1,910.1	2	30	2,292.0	2	0	2,864.9	1	30	3,819.8	1	0	5,729.6	0	30	11,459.2
6	6	955.4	3	36	1,591.8	3	0	1,910.1	2	24	2,387.5	1	48	3,183.2	1	12	4,774.7	0	36	9,549.3
7	7	819.0	4	12	1,364.5	3	30	1,637.3	2	48	2,046.5	2	06	2,728.5	1	24	4,092.7	0	42	8,185.2
8	8	716.7	4	48	1,194.0	4	0	1,432.7	3	12	1,790.7	2	24	2,387.5	1	36	3,581.1	0	48	7,162.0
9	9	637.3	5	24	1,061.4	4	30	1,273.6	3	36	1,591.8	2	42	2,122.3	1	48	3,183.2	0	54	6,366.3
10	10	573.6	6	0	955.4	5	0	1,146.3	4	0	1,432.6	3	0	1,910.1	2	0	2,864.9	1	0	5,729.6
11	11	521.6	6	36	868.6	5	30	1,042.1	4	24	1,302.5	3	18	1,736.5	2	12	2,604.5	1	06	5,208.8
12	12	478.3	7	12	796.3	6	0	955.4	4	48	1,194.0	3	36	1,591.8	2	24	2,387.5	1	12	4,774.7
13	13	441.6	7	48	735.1	6	30	881.9	5	12	1,102.2	3	54	1,469.4	2	36	2,203.9	1	18	4,407.5
14	14	410.3	8	24	682.7	7	0	819.0	5	36	1,023.6	4	12	1,364.5	2	48	2,046.5	1	24	4,092.7
15	15	383.1	9	0	637.3	7	30	764.7	6	0	955.4	4	30	1,273.6	3	0	1,910.1	1	30	3,819 8
16	16	359.3	9	36	597.5	8	0	716.8	6	24	895.7	4	48	1,194.0	3	12	1,790.7	1	36	3,581.1
17	17	338.3	10	12	562.4	8	30	674.7	6	48	843.1	5	06	1,123.8	3	24	1,685.4	1	42	3,370.5
18	18	319.6	10	48	531.3	9	0	637.3	7	12	796.3	5	24	1,061.4	3	36	1,591.8	1	48	3,183.7
19	19	302.9	11	24	503.4	9	30	603.8	7	36	754.4	5	42	1,005.6	3	48	1,508.1	1	54	3,015.7
20	20	287.9	12	0	478.3	10	0	573.7	8	0	716.7	6	0	955.4	4	0	1,432.7	2	0	2,864.9
21	21	274.4	12	36	455.6	10	30	546.4	8	24	682.7	6	18	909.5	4	12	1,364.5	2	06	2,728.5
22	22	262.0	13	12	435.0	11	0	521.7	8	48	651.7	6	36	868.6	4	24	1,302.5	2	12	2,604.5
23	23	250.8	13	48	416.2	11	30	499.1	9	12	623.5	6	54	830.8	4	36	1,246.0	2	18	2,491.3
24	24	240.5	14	24	398.9	12	0	478.3	9	36	597.5	7	12	796.3	4	48	1,194.0	2	24	2,387.5
25	25	231.0	15	0	383.1	12	30	459.3	10	0	573.6	7	30	764.5	5	0	1,146.3	2	30	2,292.0
26	26	222.3	15	36	368.4	13	0	441.7	10	24	551 7	7	48	735.1	5	12	1,102.2	2	36	2,203.9
27	27	214.2	16	12	354.9	13	30	425.4	10	48	531.3	8	06	707.9	5	24	1,061.4	2	42	2,122.3
28	28	206.7	16	48	342.3	14	0	410.3	11	12	512.4	8	24	682.7	5	36	1,023.6	2	48	2,045.5
29	29	199.7	17	24	330.6	14	30	396.2	11	36	494.8	8	42	659.2	5	48	988.3	2	54	1,975.9
30	30	193.2	18	0	319.6	15	0	383.1	12	0	478.3	9	0	637.3	6	0	955.4	3	0	1,910.1
31	31	187.1	18	36	309.4	15	30	370.8	12	24	463.0	9	18	616.8	6	12	924.6	3	06	1,848.5
32	32	181.4	19	12	299.8	16	0	359.3	12	48	448.6	9	36	597.5	6	24	895.7	3	12	1,790.7
33	33	176.1	19	48	290.8	16	30	348.5	13	12	435.0	9	54	579.5	6	36	868.6	3	18	1,735.5
34	34	171.1	20	24	283.3	17	0	338.3	13	36	422.3	10	12	552.4	6	48	843.1	3	24	1,685.4
35	35	166.4	21	0	274.4	17	30	328.7	14	0	410.3	10	30	545.4	7	0	819.0	3	30	1,637.3
36	36	161.9	21	36	266.0	18	0	319.6	14	24	398.9	10	48	531 3	7	12	796.3	3	36	1,591.8
37	37	157.6	22	12	258.1	18	30	311.1	14	48	388.2	11	06	517.0	7	24	774.8	3	42	1,548.8
38	38	153.7	22	48	252.9	19	0	302.9	15	12	378.1	11	24	503.4	7	36	754.4	3	48	1,508 1
39	39	149.8	23	24	246.6	19	30	295.2	15	36	368.4	11	42	490.6	7	48	735.1	3	54	1,469 4
40	40	146.2	24	0	240.5	20	0	287.9	16	0	359.3	12	0	478.3	8	0	716.8	4	0	1,432 7

Graphical Records of Sewage Flow and Chlorine Dosage

TO get a daily report which can be quickly reviewed and a closer approach to the true conditions than is afforded by the usual method of recording operations at a Riensch-Wurl sewage screening plant, the City of Stockton, Cal., is using a graphical record chart on which sewage flow, chlorine dosage and other data are recorded.

In devising a chart that would accomplish this purpose, C. G. Gillespie, then director of the Bureau of Sanitary Engineering of the State Board of Health, said: "Readings in such a plant can seldom be made on schedule, nor can the series of readings to be taken together at one time always be so made. Yet for the sake of economizing on space on his record sheet, the operator will seldom enter the time of readings more closely than to the nearest hour. All sorts of fluctuations, however, may have occurred between the time the reading was taken and the time it is recorded as having been taken."



At the Stockton plant sewage flows to the works by gravity and after screening is chlorinated as it enters a sump from which it is pumped into the San Joaquin River. The sewage flow is measured by noting the rate of rise of the sewage in the sump, usually ranging about 1 ft. a minute, and taking the corresponding flow from a chart which shows the relation between rate of rise in the sump and daily rate of flow. The chlorine is applied through two Wallace & Tiernan manually controlled chlorinators, to each of which are attached several cylinders setting on scales.

To gage the chlorine feed the sewage flow is measured hourly or oftener, depending on the fluctuation, and the chlorine feed changed accordingly. The purpose is to use a dose which will afford a safe degree of disinfection as determined by the State Board of Health. To accomplish this the dose must be varied with the strength of the sewage and the rate of sewage flow.

The chart is composed of two main sections, one for recording the sewage flow and the other the chlorine data. Miscellaneous information is also noted at less frequent intervals. Sewage flows are charted as a dot and a smooth line backward to the previous dot. The inclination of this line enables the operator to predict fairly well the flow he should be prepared to dose in the next half hour or so. The entire line gives a regimen of sewage flow for that day.

On the upper half of the chart three lines are charted after much the same idea. First, the "desired" chlorine dose is entered. The figure for this is given by the State Board of Health, and taken as a function of the sewage flow. The chlorine feed as measured at the chlorinators is then read and charted. From this the "actual" dose is calculated and charted. If it departs materially from the "desired" dose line the chlorine feed is changed by hand, this fact being indicated by a step in the chlorine feed line. The time of the change is likewise shown to within the nearest five minutes. One copy of the chart is sent to the State Board of Health daily.

City Planning Commission at Davenport, Ia.

A city planning commission was recently created by ordinance at Davenport, Ia. It consists of 12 citizens and the Mayor and City Attorney serving as ex officio. The commission will act in an advisory capacity and will take up zoning.

Impulse Turbines Utilize Wide Range of Head and Flow

Small Plant at Fontana, California, Loses Only 3 Per Cent Efficiency When Flow Falls Off 83 Per Cent

At FONTANA, Cal., the scope of an irrigation project was recently extended to include the development of water power when it was found that a favorable contract could be made with the local power company. The conditions imposed on the plant by the irrigation requirements vary the effective head 30 per cent and the flow 83 per cent. With the hydraulic impulse turbines which were designed to meet these conditions it has been found possible to operate at minimum flow with a loss of only 3 per cent in the efficiency attained at maximum flow. This has made it profitable to utilize the power even under the disadvantage of the wide variation.

Only a limited area in the mountains was available as a source of water supply, and as a protection against dry years the supply had to be carefully conserved in a storage reservoir. The topography of the country required a pipe line nearly 6 mi. in length. In this distance a total gross head of 725 ft. was developed.

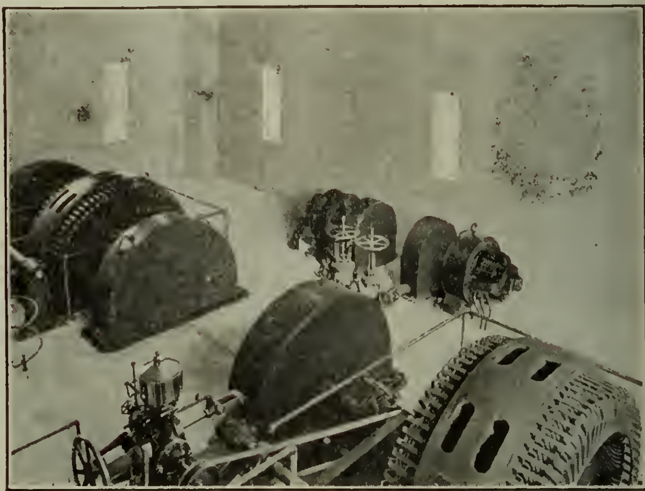
The agreement with the power company was on the basis of a flat rate per kilowatt-hour to hold for any amount of power delivered. These terms made it desirable to develop all the power possible, but against this had to be balanced the necessity for water conservation. In other words, irrigation had to be given precedence and the problem became one of getting the maximum power from the varying flow as determined by irrigation needs. The quantity and head

WEIRS AT FONTANA PLANT TO MEASURE TAIL WATER

ranged from a maximum of 58 sec.-ft. developing a 505-ft. effective head, to 10 sec.-ft. developing a 657-ft. head. The amount of change in effective head is due to the large variation of friction head in the long line of small diameter.

Under these conditions efficiency and flexibility were believed to go hand in hand and the equipment decided upon was two 1,350-hp. Pelton double overhung impulse turbines equipped with electrically-operated needle nozzles and governor-operated jet deflectors. Two units with two runners each were chosen in order to maintain efficiency on partial loads. With this arrangement the friction and windage losses are small and are considerably less than would be the case if an equal amount of water were used in a single duplex-nozzle unit of double the capacity and with larger and heavier generator and larger wearing surfaces.

Both units are supplied equally when the maximum quantity of water is flowing. As the flow decreases each unit supply is decreased to the point where the efficiency of the individual units tends to drop. Then one unit is shut down entirely and the one remaining is opened to take all the flow. As the flow continues



TWO MAIN UNITS AND TWO EXCITER SETS

to decrease the needle openings of the two nozzles of the operating unit are gradually closed equally until the efficiency of the unit again tends to drop. At this point one jet is entirely shut off and all the water diverted through the remaining nozzle. The efficiency

KILOWATT-HOURS GENERATED AT FONTANA, MONTH BY MONTH

Month	1917	1918	1919
January	......	752,000	804,000
February	......	652,000	632,000
March	......	1,282,000	738,000
April	......	1,451,000	833,000
May	......	1,266,000	754,000
June	......	955,000	581,000
July	......	1,144,000	494,000
August	......	1,241,000	472,000
September	......	1,066,000	449,000
October	......	1,122,000	602,000
November	......	901,000	533,000
December	188,000	844,000	555000

at this lowest point is only 3 per cent below the maximum efficiency developed under the most favorable conditions. As the flow increases the reverse order in the opening of the nozzles is followed.

As the quantity of water flowing is the important factor rather than the load requirements, the operation of the turbine unit is controlled by the quantity of flow and the governing and control equipment was designed accordingly, every effort being made to obtain close regulation. A long distance water level indicator is installed at the plant to show the level of the water in the forebay. The operator in the plant is guided by the indicated water level and manually controls the needle nozzle openings, though the needles themselves are electrically operated.

The hydraulic equipment for the Fontana plant was designed by the Pelton Water Wheel Co., San Francisco.

Letters to the Editor

Technical Engineers Neglected in Labor Board's Wage Award

Sir—The rail award given out July 20 by the United States Railway Labor Board contained no increase for the technical employees of the engineering departments of the railroads. In fact these engineering departments did not appear to exist. The newspapers informed the public that all departments of the railroads received some increase and in the list of all departments there was to be found no reference to any engineering departments.

Why was this? Of all the 57, or more, technical societies and associations in this country was there none which attempted to plead the cause of the engineers before the Board? If there were any, then what reasons were given for discriminating against the engineers? Is it improper for the engineers of this country to demand an explanation from the societies as to why they neglected this opportunity to effect recognition and to gain a salary increase for the whole body of technical employees of the railroads?

Danville, Ill. WALTER J. SYKES.

Engineer's Duties on Cost-Plus Work

Sir—In H. M. Bryant's query on p. 40 of your issue of July 1 in regard to the duties and authority of the engineer on cost-plus-percentage construction work, he describes difficulties and perplexities which need not exist and which certainly can be avoided by the simple precaution on the part of the owner of selecting the builder with the same care supposed to be exercised in the selection of his engineer. A man is known by the work he does and there is no reason why the owner should be more fortunate in the selection of the engineer than in the organization to do his building.

Why can we not be fair to the successful and reputable contractor and credit his success to honesty, energy, ability and his desire to give his client a first class job in order that he may find another one when that is completed? The aim of this sort of man is not simply to "get by" the engineer; good, fair or poor work will do that, depending on who the engineer happens to be, but why not have confidence in one as well as the other?

When Mr. Bryant goes to the tailor for a new suit of clothes he does not employ an inspector to sit by while it is being made, but if he does not get the worth of his money he goes elsewhere the next time and advises his friends to do the same. This method soon puts the dishonest tailor out of business or leaves him only such customers as desire his class of work.

The country is full of expert builders, specialists in their lines, who are up-to-date business men with large sums of money invested in their plants and organizations. These men know better than the general public that their business depends on the class of work they do so why should one be viewed with suspicion and a careful watch set upon him the instant he moves on a job? Ordinary business policy demands that proper records and check be kept on all expenditures and the man who is paying the bills should most certainly be properly represented and his interests safeguarded, but if the owner or his engineer is assumed to be more capable of directing operations than the contractor why employ him at all?

Business men who have construction work to do should not overlook the obvious fact that it costs money to get and hold together a first class plant and organization with which to do his work and the better it is the more it costs. When one of these same business men consults a lawyer or physician he does not look for the one who will advise him for the least money but goes to the one whom he knows to be reputable and generally gets the kind of service he wants; he can apply the same method to the selection of his builder with results equally as satisfactory.

Addison, Ky. H. G. McCORMICK.

"Crossover Practice" and Standard Fees In the Legal Profession

Sir—In the article "Crossover Practice" in your issue of June 24 offers the following paragraph:

"In the legal profession admission to the bar admits to general practice and reaches into any specialty in which a lawyer may wish to enter. A real estate lawyer may defend a murderer and a criminal lawyer may try an involved insurance case. A corporation lawyer may serve in riparian disputes. A specialist in insurance may try an admiralty case."

These statements are entirely correct, but only if the word *may* is in each case accented. It is a rare thing that a man specializing in any branch of civil practice is engaged in criminal cases. The "corporation lawyer" (an attorney in the employ of a corporation) is of course liable to be called on to try a riparian case if his employers are interested in such matters, but admiralty practice is meddled with but little by the general practitioner. Of course he *may* appear in any matter whatever if requested to do so, but I do not think that attorneys are less confined to specialties than engineers.

Another article contains the statement that "in the legal profession there has been no action for standardizing fees," and takes a needless slap at the legal fraternity in the statement that a standard schedule of fees would probably be opposed by many lawyers because it would serve in many case to protect the client against exorbitant charges. It would seem that if the writer had made any research worth mentioning he would have found that, far from it being a fact that there has been no action for standardizing fees, such action has in most localities preceded similar action by any other profession. I know of no county in this neighborhood where there is not a fee table established, and in a very wide stretch of country now the so-called "uniform fee bill" has been adopted so far as commissions on collections are concerned. Thus a client at a distance can readily ascertain what commission will be deducted from any collection. Again, in every county that I am acquainted with there is a regular schedule of fees for drawing legal instruments and for all routine matters before the various courts, all such fees being of course the minimum charge. In the preparation and trial of important cases any fixed rate is of course out of the question.

The following is quoted from the preamble to the latest fee bill of the Knox County bar: "We hereby establish the following schedule of fees and rates of compensation as the lowest which we can reasonably and honorably receive, but these rules are not intended to restrict members of the Bar from receiving larger fees in cases of difficulty or magnitude." This is I believe in spirit as well as letter substantially the same as the sum of all fee bills of all professions. O. H. TRIPP.

Rockland, Me.

Prohibition, China, and the Railroads

Sir—In a letter in your issue of June 17, Mr. F. C. Finkle of Los Angeles makes this surprising statement: "They (the Chinese) come from a country where prohibition was first adopted, 459 B.C., and has been enforced so long that the Chinese Empire has lost its power and the people have degenerated through the use of drugs and narcotics taken as substitutes," etc.

If my recollection of history is good, there were other great empires in the world, in 459 B.C. and the centuries immediately succeeding, where the use of alcohol was not prohibited. Have Persia, Greece and Rome stood the test of time so much better than China? I should like to hear Mr. Finkle discuss this point.

Regarding the Railroad Problem:

Has anyone recently considered putting the railroads as nearly as possible on the basis of the public highways? We do not expect the highways to be self-supporting, why should we expect more of the railways which are really only another kind of a highway? Making proper allowance for interest and renewals, was the country's railway system,

taken as a whole ever self-supporting anyway? I should like to see this question discussed by a competent authority.

Why not let the government take over the rails and roadways and maintain them as it does the highways? For operation divide the national system into convenient units and lease each to the highest bidder for a reasonable term of years. The proceeds from the lease, supplemented by taxation as necessary, would maintain the roadways. Doubtless many trunk lines would lease for more than the maintenance cost, the surplus going to help make up deficits elsewhere. In this way most of the benefits of private operation could be retained, while the evils of a direct subsidy would be avoided. At the same time the corporations would be relieved of much expense which evidently cannot be met under present conditions.

Southbridge, Mass. H. F. AMMIDOWN,
Surveyor and Genealogist.

Shrinkage of Earthwork

Sir—I have read with interest and profit your article on "Shrinkage of Loosely Filled Earthwork in Embankments" in *Engineering News-Record* of June 24. On p. 1257 appears the following statement: "A rule issued by the engineering section of the Division of Valuation in 1918 specifies a shrinkage allowance of 10 per cent." For your information, I write that the rule referred to provides that in no case shall 10 per cent be exceeded, but a less allowance shall be made in case of recent construction and where 10 per cent is clearly too high.

My understanding is that shrinkage is taken to mean the difference between the volume of existing seasoned embankment and of original excavation, including not only the shrinkage proper but also such variable factors as loss in transportation and losses which may occur from erosion and other causes during the construction period.

EDWIN F. WENDT,
Member, Engineering Board, Interstate
Washington, D.C. Commerce Commission.

On the Efficiency of Union Labor

Sir—There has been much discussion in the past few months of the relative efficiency of labor at the present times as compared with the period preceding the war. We have the statement of Louis Horowitz, president of the Thompson-Starrett Co., New York, to the effect that while a competent brick mason can lay 2,000 brick per day, and was actually laying from 1,200 to 1,500 in 1916, he is laying only from 600 to 700 at the present time. Offset against this is the opinion of many managers that labor is doing its share, and that there is too much of a tendency to criticize labor for conditions beyond its control.

In this connection a very interesting study has been made of the operation of unloading ships of the Morgan Line at New Orleans after their trip from New York. There are three combined passenger and freight steamers on this line—*Creole, Comus* and *Momus*. These ships are practically alike, having been built in 1906. A comparison of the number of tons of cargo handled from these ships on five consecutive voyages of each ship in 1914 has been made with a similar record of the past winter. The results are rather startling.

It is shown, for instance, that in 1914 on five trips there were unloaded from the *Comus* 7,872 tons of cargo with the expenditure of 20,218 man-hours on the wharves. During five runs in 1919-20 the tonnage unloaded was 7,748 or nearly two per cent less than in the previous period. But the man-hours required for the work amounted to 28,638, or an increase of 42 per cent. For the three ships with a total of 15 voyages in each of the two periods it was found that the total tonnage unloaded increased from 26,831 in 1914 to 27,092 in 1919-20—a gain of not quite 1 per cent. But the man-hours required for the work in 1914 were only 70,196, as compared with 99,063 in 1919-20. This is an increase of 41 per cent in man-hours, to cover an increase of 1 per cent in tonnage.

Hours of labor having been slightly reduced, the question of fatigue from a long day's work has been practically abolished. It has been suggested that the influence of prohibition is largely responsible for the above result, this being on the theory that a longshoreman will work about two hours at top speed if he has some alcoholic stimulant under his belt, and then requires further stimulant before the next two hours of work. It seems to the writer that this view is an ex-parte one, of a type particuarly prevalent at the present time, and that it is entitled to very scant consideration. However that may be, we have the definite facts as set forth above, the figures having been prepared by E. E. Lamberton, in charge of operations at New Orleans, for the Southern Pacific Steamship Co., which owns and operates the Morgan Line.

The figures as given show in each case fifteen consecutive unloadings of the same three vessels at the same wharf, carrying the same kind of cargo, which was handled under identical conditions by practically the same men. The number of pounds handled per man-hour has decreased from 793 in 1914 to 547 in the present period, and the number of man-hours expended per ton of cargo unloaded has, in the same period, increased from 2.616 to 3.657 man-hours, or 39.8 per cent.

An interesting side-light on the same situation shows that pilfering on the wharves has undergone a tremendous expansion. In 1914, in connection with the fifteen voyages covered in the figures, there were thirty-four claims paid, aggregating less than $100. In 1919-20, under the same set of conditions, there were 655 claims paid, aggregating more than $20,000. SIDNEY G. KOON, M. E.

Boston.

Shall Chinese Labor Be Imported?

Sir—Present laws do not favor the importation of Chinese labor and no political party wants it or could afford to legislate in its favor. That being the case it simply will not happen and time might be more profitably spent in increasing the efficiency of our own people than in wishing for the Asiatics.

This country has periods of depression when labor is not fully employed. Organized effort was necessary to find places for the returning soldiers last year. Simultaneous undertaking of works of extraordinary magnitude when labor is short could and should be avoided. Extensive programs for road building and municipal improvements can be deferred until slack times. In that way the public work would be done at less cost to taxpayers, the tendency would be toward more uniform activity in all lines. It seems that we can better afford to try other expedients to keep things moving than to bring in any more race problems, for they are harder to solve than present labor problems. The sentiment seems pretty general that there are too many aliens now who live in America but will never be Americans. GEO. C. LOVE,

Newport News, Va. Civil Engineer and Surveyor.

Sir—Replying to the letter of John Ericson relative to the desirability of the importation of cheap coolie labor permit me to state that I am positively opposed to such a measure as one wholly unsound in economic principle and dangerous to the social fabric of our nation. The United States is the most favored nation of the world from the standpoint of natural resources. Its people are resourceful, intelligent, and progressive to a degree that is unsurpassed, and therefore capable of producing all that is necessary for their comfort or advantage. These facts alone controvert any argument of necessity for the importation of any labor whatsoever, whether skilled or unskilled, that the nation may prosper.

In thoughtless moments we are all wont to complain at the scarcity of labor and its high cost, forgetful of the fact that scarcity of labor and high wages mean improved living conditions for our laboring classes, better educational advantages for their children, more happiness for them, and the attraction to unskilled work of better educated, more skilled, and more capable men—a combination of brain and

brawn which spells progress instead of industrial stagnation.

It was said that "this nation cannot endure half slave and half free" and with equal force it may now be said that this nation cannot prosper and progress with its workers on two planes—one to which neither privilege of citizenship nor assimilation is denied, and one to which all privileges of citizenship and assimilation are denied. The nation is even now cursed with the problem of caring for one class of non-assimilable workers introduced by our forefathers in colonial days because there was a scarcity of labor, and this example alone should be sufficient to hush the argument for the importation of more.

There is now and there always will be (in spite of the most improved living conditions) a certain percentage of our people not richly endowed by nature with mental power, ambition, and capability. These gravitate naturally into the unskilled and rougher work, and into competition with them would be thrown any unskilled workers imported, thereby adding to the handicap imposed upon them by nature. This competition would bring poorer living conditions to this unfortunate class of our citizens, decreased advantages for their children, an increase in social unrest, and a reflection of discomfort all the way up through the labor world.

In conclusion let me point out that everyone of us, whether he be the humblest worker with pick and shovel or the whitest-collared, highest-salaried specialist, is a member of this labor world; that unduly high wages or fees cannot long endure for any one class of this labor world because the very attraction which high wages or fees afford introduces healthful competition from out the other classes and automatically brings an adjustment; and, that the bringing, by importation, of any class of inferior foreign labor into competition with a domestic class of labor means not only lowered living conditions for the latter, but for every other class of our domestic labor. The importation of the most skilled hands and inventive minds may well be encouraged because the productivity of our own labor and the sum total of the nation's happiness may thereby be increased. The importation of a class of labor lower than our domestic supply is degenerating, will increase our misery, and can have no sound basis in economic principle. EVERETT N. BRYAN.

Waterford, Calif.

Sir—In your issue of June 17 you print a letter from F. C. Finkle which discusses the admission of Chinese laborers, and we have noted that Mr. Ericson and "the best men in the country" are thoroughly criticized for their failure "to grasp the cause, much less the true remedy, for our serious labor shortage." While I do not care to enter into a discussion of the relative merits of the various views that have been advanced as to what should be done, I feel that I ought to object in writing to the attitude of Mr. Finkle on two general grounds: (a) Because of his unreasonable antagonism to prohibition, for which every right-minded man has been praying for these many years; and (b) because the classing of all Chinese with the degenerates is an insult to a friendly people that as true Americans we should very promptly resent as being entirely uncalled for, and as junkerism, if not downright propaganda of the brewers' association.

China looks to America as its one true friend and if Americans show even a spark of human decency and sympathy there is bound to develop a mutual co-operation that will go far to protect us against future encroachments of the Japanese, to say nothing of the opening up of satisfactory solutions for other great problems. The people of the Philippines are well aware of the importance of retaining the protection of the United States Government after they have become self-governing as a necessary guarantee of the perpetuation of their freedom and independence. Japan is a nation controlled by expediency, but China is honest and trained in the arts of peace and her backwardness is more the result of the deadening effect of her religious instruction than to any lack of brains and ability. Christian civilization, imperfect as it has been shown to be, has made America possible and it is the thing that can make China what it is hoped she will some day become—a friendly nation trained in honest intentions and peaceful pursuits. We cannot afford to antagonize a nearby (as distances go nowadays) nation, even unintentionally, which is possessed of such enormous latent power for good or evil. We should do our unmost to cultivate China's friendship by acts of kindness and expressions of goodwill and lofty sentiments.

It has lately been necessary for me to investigate the conditions that exist between America and China in connection with an opportunity offered me to serve the young men and the people there as an engineer and as an educator. Through personal correspondence I have been able to get a viewpoint that is intimate and human. As a result I am convinced that Chinamen look to America for guidance and help, but that America ought not expect large returns in a material way and should be satisfied with a knowledge of work well done in the great cause of humanity. Selfishness will undoubtedly destroy America's chance. Americans are wanted to guide the Chinese to the light but they must be willing to go forward slowly, beginning with things as they are and building step by step and soundly, giving the best that is in them. If they go to China's assistance for any lower motive than to be of complete service to China and her people it were better that they should perish before they do irreparable harm. Americans now are respected and may go anywhere that a Chinaman may go. Chinamen crave American aid in order that the bad influence of the Japanese may be offset. As there is no military question or suspicion between Americans and Chinese, mutual confidence is possible.

American educational institutions are very popular with the Chinese generally and they stand very high in comparison with either the government institutions or those supported by other nationalities. The important thing to be kept in mind in relation to this effort of Americans to help is that the real justification for American colleges in China taking up professional work such as engineering lies in their ability to give to their students the highest type of idealism and to emphasize all those factors that go to make up that complex thing we call character. The Chinese Government schools do not do this. Engineer graduates of the American institutions have this factor of character in addition to their purely technical training which ensures their rising to leadership in the profession in China and so be in a position to help to keep the ethics and practices of the engineering profession on as high a plane as in the West. It will be very serious for China if she has to rely entirely on the men educated under the demoralizing influences of the government schools to direct her great engineering works and to spend the millions of dollars that will be spent there in the years to come shortly. So there should be a greater spirit of helpfulness and co-operation shown, for if we need the help of Chinese labor, the Chinese need our help even more.

The first great convention of Chinamen ever held, to cement friendship between America and China and to establish better understanding between the two nations, has but lately met in San Francisco under the auspices of the Chinese National Welfare Society of the United States, which has a membership of 15,000. It is proper that we should approach the Chinese labor problem in the spirit of mutual respect and cordiality. Full and unqualified support should be given to this attitude by every loyal American, since only by encouraging mutual goodwill can we hope to protect ourselves against the "yellow peril" that is going to come whether we will or will not have it.

In conclusion let me say that I believe that the Chinese laborer will make a far better and more desirable citizen without his beer than the Polish, Slavonian, Italian, Swiss or Greek laborer who has quit our great and glorious country for a country where he can have his intoxicating beverage which destroys efficiency and weakens resistance to disease and makes the kind of citizens we call undesirable aliens—the kind we do not want.

EDWARD G. SHEIBLEY,
Consulting Engineer.

Los Angeles, Cal.

Hints for the Contractor

Checking Actual Unit Costs Against Estimates

By Chas. P. Rumpf
Fairmont, West Virginia

The cost data chart herewith illustrated is a departure from the customary curves, or coordinate system of plotting, and possesses the advantages of giving immediately an unusual amount of information in concise form. This style of chart is particularly applicable in checking an estimate of costs as the actual work progresses. Taking for example the item *concrete*, it will be seen that the following information is at once available: (1) The unit estimate per cubic yard; (2) the total estimate in dollars and in yardage; (3) the amount spent during each week; (4) the corresponding yardage placed in this period; (5) the actual unit cost per week; (6) the actual unit cost to date; (7) the state of completion as compared with the estimated quantity.

It is apparent that when the actual unit cost to date agrees with the estimated unit cost, the line joining amount spent and quantity placed will be horizontal, and, furthermore, that a departure from the estimated unit cost will be indicated by the line joining cost and quantity sloping towards the dollars or the quantity as the actual unit cost is less than or greater than the estimated unit cost. Another useful fact readily determined is the relative value of the various items as shown by their respective heights.

This form of chart is being issued weekly under the writer's direction by the architects Dreher, Churchman, Paul & Ford in connection with a building project in Fairmont, W. Va.

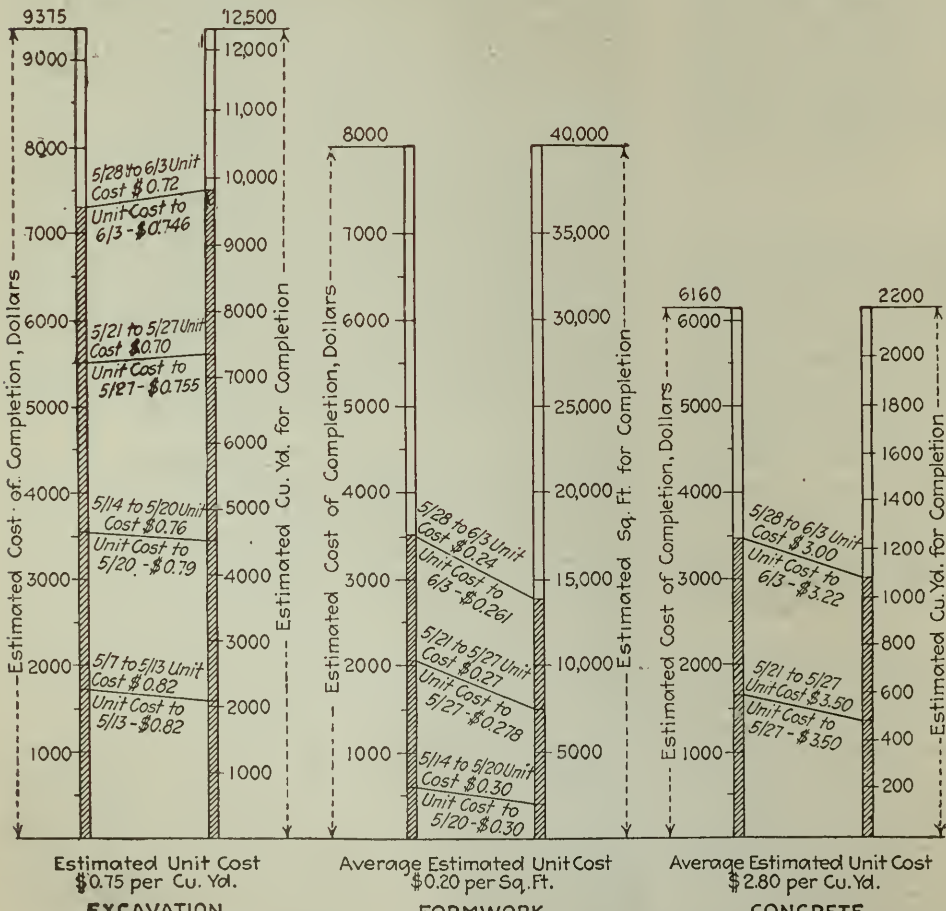


CHART ALLOWS GRAPHIC COMPARISON OF ESTIMATED AND ACTUAL UNIT LABOR COSTS

Wooden Runway Solves Trucking Troubles on Sandy Subgrade

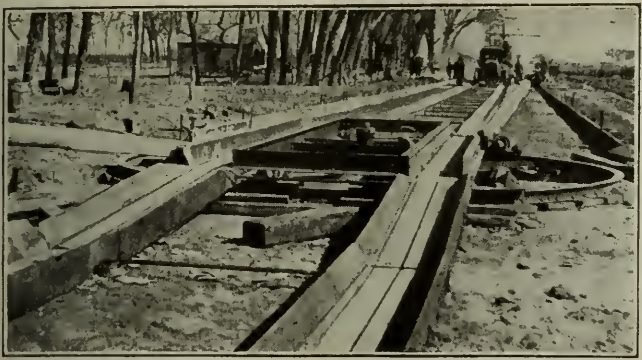
By Thos. E. Burton
Resident Engineer, Sedgwick Co., Kansas, Federal-Aid Roads

In laying the concrete base for the bituminous-filled brick road leading south from Wichita, Kansas, and known as Federal-Aid Project No. 24, Sec. A a method was developed which proved both practical and economical. This road is on a sandy soil, a fact causing great difficulty in the transportation of materials. The clay surfacing which had been put on by the county is removed in the grading and used where possible for the earth shoulders. Because of this the contractor found it advisable to carry his rough grading only a short distance in advance of his concreting. The method used in 1919 was to place the material on the subgrade and handle it in barrows to the mixer. This was found to be expensive procedure, especially because the finished grade was continually cut by the trucking.

To overcome the high cost of construction and increase the output simultaneously the Bickel Contracting Co., which is building this road, changed to the proportioned-batch system, hauling five two-sack batches to the truck. This meant the reconstruction of their storage bins. The truck is driven under the sand bin to the stone bin where the five batches of stone are dumped; it is then backed to the sand bin where the five batches and sand are loaded. Every fourth truck carries one batch of curb material which is different from the base material since the curb is integral. From the sand bin the trucks are driven to the cement sheds where two untied sacks are placed on each batch whenever there is considerable wind or when rain threatens, otherwise the cement is dumped direct into the batches. This loading operation takes an average of three minutes. When the trucks reach the work there is put into operation a steel turntable as illustrated which has

eight ball-bearing 8-in. rollers that run on an H-section circular track. This turntable is placed 300 ft. ahead of the mixer and between it and the mixer is laid a wooden steel-shod track upon which the trucks back to the mixer. The track is made in 9-ft. interlocking sections held apart by $\frac{3}{4}$ in. hooked rods spaced every 9 ft.

The turntable occupies the space of the two track sections and can be set ahead at any time and be replaced by track. When the concreting has reached the turntable the removed track sections are then laid in advance and by the use of two-wheel carts the turntable is moved down the track to the new location. At the beginning of the day's operation half way between the turntable and mixer three sections of form are taken out on one side and three sections of track are removed and replaced by planks, thus the returning empty trucks can turn out and drive down the shoulders and the incoming trucks are never more than 150 ft. from the mixer. After the mixer reaches this opening another is used which was left at the turntable. During the day forms are continually being set and upon them a subgrading machine is run just before the track and turntable are moved. The time required to move track and set turntable is forty minutes.



SECTION OF WOODEN STEEL-SHOD TRACK AND TURNTABLE USED ON FEDERAL-AID WORK IN KANSAS

Cost Cut 60 Per Cent

The contractor made sufficient track to operate his concreting unit seven hours; the other hour is used in preparing for the next seven hour's run. This method of operation has cut the cost per square yard of base laid to 60 per cent of the cost of the method used last year. With a few improvements that are being added from time to time the efficiency of this kind of operation apparently will equal that of any other method now in use. It is quite possible to increase the output by expanding the system in some direction, but, as it is, the correlation of the parts and their functioning on time is very good and it is a matter of making the increases according to the readily ascertainable percentages of their value to the whole.

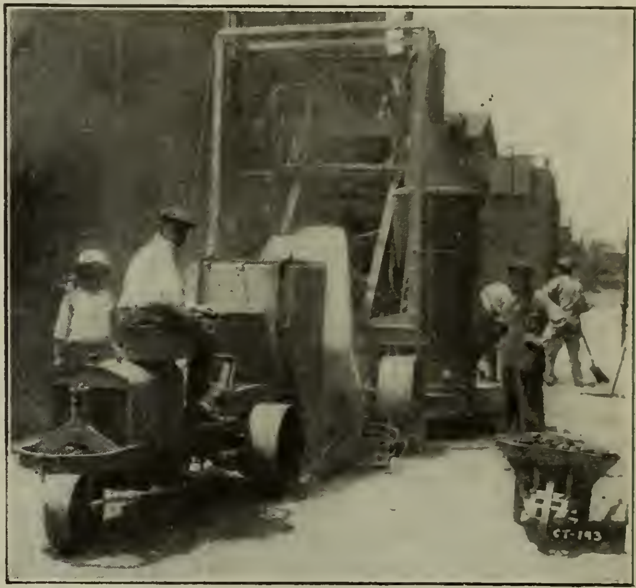
Dump Car Loaded Through Hopper

In loading trains of small steel dump cars from a revolving steam shovel on a grading job in Australia, the bucket dumped its contents into a steel hopper supported over the track on a steel frame mounted on small wheels. This method avoided spilling of the material and possible damage to the cars by striking them with the bucket or its door.

Increase Alley Pavement Output

An OUTPUT increase of nearly 40 per cent has been accomplished on recent alley paving in Chicago by adopting mechanical loading from stockpiles and truck-tractor dry-batch haulage. With hand loading from stockpiles and wheelbarrow charging the output per day of 15 ft. 4 in., alley pavement 7 in. thick averaged about 550 sq.yd., with favorable weather. A crew of twenty-seven men was required. Using the mechanical equipment and the same crew the output, regardless of weather conditions, was increased to 750 sq.yd.

As alley paving, generally, is prosecuted it consists of about 1,100-sq.yd. operations often widely scattered so that many moves of the outfit are necessary during a season's work. Alleys in Chicago average about 15 ft. 4 in. in width and are paved full width using 1:2:3 concrete. With the limited width and no side space, stock storage is complicated. In general the conditions are such as tend to retain simple mixer outfits and hand methods to supply the mixer and to place the concrete.



PROPORTIONED BATCH DUMPED DIRECTLY INTO MIXER SKIP

In choosing the mechanical outfit, attention was given to the fitness of each unit for its particular task. For loading stone from piles a Barber-Greene loader was selected and for loading sand a Jeffrey loader. These loaders lift the stone and sand into hoppers whence they are measured 9 cu.ft. of stone and 6 cu.ft. of sand into the bodies of the four trucktractors. The cement is loaded by hand. A round trip haul of 1,000 ft. is made from stockpiles to the paving mixer in about 3 min., which keeps the mixer, making a 1-min. mix, busy. The accompanying view shows a truck dumping the dry batch directly into the mixer hopper.

The operating crew of 25 men in charge of a foreman and a receiver, consists of one operator and two laborers on each of the loading machines; four truck-tractor operators; three men loading cement, and, at the mixer, one man on the dry side, four on the wet side, two mechanics, one fireman, one man on expansion joints, two fine graders and two form setters. The contractor is the Schmidt Construction Co., Chicago.

NEWS OF THE WEEK

New York, August 5, 1920

Bureau Public Roads To Report on California Highway System

A complete economic study is to be made of the highway system of California by the U. S. Bureau of Public Roads. The evolution of the California highway system will be investigated carefully and a study made of its relation to the development of the state. The survey will also include a careful analysis of the traffic now being carried by the California roads.

It is believed that the survey in California will develop many facts which will be applicable throughout the country. In addition, the study will enable the Bureau's engineers, it is believed, to give some helpful professional advice to guide the California Highway Commission in the future.

The study is to be undertaken in response to a request for such a survey from the California Commission as noted in the *Engineering News-Record*, July 15, 1920, p. 140.

Associated Contractors Urge Consideration of Construction Needs

General R. C. Marshall, Jr., formerly Chief of the Construction Division of the Army, who lately accepted an appointment as general manager of the Associated General Contractors of America, has addressed to the chairmen of the Republican and Democratic National Campaign Committees the following open letter emphasizing construction needs as one of the big domestic issues in the coming campaign.

It is with interest that I note the attention given to the need for construction of various kinds in the platform recently adopted by the National Convention of the Republican Party.

In that document the Republican Party goes on record in favor of liberal appropriations for the construction of highways, the encouragement and development of water transportation and facilities, the restoration of railroad credit to furnish enlarged facilities, the promotion of water-power development, and the encouragement of home ownership and town-planning by the federal government. Every one of these problems touches a vital spot in the work of reconstruction which we are facing, in which construction so long deferred must play an important part.

When it is realized that the construction industry is second in importance only to agriculture in the United States, I believe it is not amiss to point out to you the need for giving this great organ of the body politic prime attention in the coming discussions of national issues preceding the presidential election.

The attention of the business men of the the issues presented by the platform of the issues presented by the platforms of the two great poltical parties more than in any election for some time past. Nor will they be content with a discussion of international policies only at a time when domestic problems are pressing for attention. For example, we are facing during the present year a construction program estimated at the unprecedented total of

(Continued on p. 286)

Fire Causes Slight Damage on Williamsburg Bridge

Short circuiting of a feeder cable on the night of July 29 caused a fire on the Williamsburg Bridge over the East River, New York City. The burning of a portion of the wooden floor construction, including ties and inside and outside guard timbers along the railway tracks, has made necessary the replacement of 33 weakened stringers, although, according to a statement of Samuel Hamburger, engineer in charge of the bridge for the Municipal Department of Plant and Structures, no major part of the span is damaged. Repairs are now being made. Orders for new stringers were received by W. Rees, plant superintendent of the National Bridge Works at Long Island City, at 10:30 a.m. July 30 and by 7 a.m. the next day, Sunday, the first load of new steel members had been fabricated and delivered by motor truck at the bridge site. The accident has not necessitated a shutdown of vehicular traffic over the structure, although service on the electric railway lines has been interrupted.

New York Plans New North River Piers

The first step in the replacement of a number of old North or Hudson River piers by new ones has been made by the city administration of New York City. This step consisted in the action of the Sinking Fund Commission authorizing the expenditures of funds to supplant thirty-two antiquated piers between Vesey and Perry Sts. on the lower part of Manhattan Island with eighteen new piers. Most of the old ones are of thirty years' standing and are narrow with narrow slips. Two of the new piers will be 100 ft. wide, seven 150 ft. wide, and nine 125 ft. wide. They will be from 900 to 1,025 ft. in length. The scheme for the new development has been worked out by Murray Hulbert, commissioner of docks, but its details have not yet been announced.

A. A. E. Has 20,000 Members

The American Association of Engineers passed the 20,000 membership mark July 28. The association was organized in 1915, five years ago. At the beginning of 1919 it had about 2,300 members. At the beginning of 1920 it had 10,450 members. The growth in 1919 was 8,150 members; that in the first seven months of 1920 was 9,550.

Since the first of the year 1919 the number of local chapters and clubs of the association has increased from 26 to 209.

Officials Urged To Accept Engineer Compensation Schedule

Governors of all states, mayors of leading cities, directing heads of federal bureaus having jurisdiction over engineering work and civil service commissioners have been urged by letter to accept Engineering Council's recommendations governing the classification and compensation of engineers. The communication, signed by Arthur S. Tuttle, chairman, and Charles Whiting Baker, secretary of Council's committee, follows:

It is doubtless known to you that engineers in all branches of the profession have suffered serious hardship during the past three years from the great decrease in buying power of the dollar. In few cases has their pay been increased sufficiently to offset any large proportion of the increased cost of living.

Engineering Council, which represents over 45,000 engineers in all parts of the United States, has had this matter under investigation for over a year. We send you herewith an abstract of the report of the Council's special Committee on the Classification and Compensation of Engineers. This report contains a standard classification of grading for engineering service, with a tentative schedule of standard rates of compensation in each of the proposed grades.

Engineering Council has approved this classification, and it is believed to be applicable to all branches of engineering service.

The classification was endorsed by the Municipal Engineers of the City of New York at a meeting of that society held on May 26, 1920, at which time a schedule was adopted providing for compensation at a rate approximately 20 per cent greater than that tentatively suggested by the committee. The classification has been closely followed by the Congressional Joint Commission on the Reclassification of Salaries in its recommendations concerning engineers in the Federal service (see *Engineering News-Record*, April 15, 1920), and it was approved by the Executive Committee of the American Society for Testing Materials on April 13, 1920. The endorsement of the tentative schedule of compensation was recommended to the Boston Society of Civil Engineers by its Committee on Compensation at a meeting of that society held on May 19, 1920, and is now being made the subject of a letter ballot by the full membership. It will thus be seen that substantial progress has been made in bringing about a recognition of Engineering Council's classification as *standard*.

The adopted classification and the corresponding schedule of compensation tentatively suggested are as follows:

Adopted Grades.	Compensation Schedule (Tentative)
Junior Aid	$1,080 to $1,560
Aid	1,680 to 2,400
Senior Aid	2,520 to 3,240
Junior Assist. Eng.	1,620 to 2,580
Assistant Engineer	2,700 to 4,140
Senior Assist. Eng.	4,320 to 5,760
Engineer.	5,940 and upwards
Chief Engineer	8,100 and upwards

We desire especially to urge upon you that this question of satisfactory compensation for engineering service is one which affects the public even more vitally than it does the engineers themselves. Upon the quality of service rendered by the engineers who design, plan and execute construction work, its cost and serviceability will largely depend. Our investigations have shown that the public is already suffering loss as a result of the great reduction in engineers' compensation.

The need of a standard classification and

(Continued on p. 287)

No Steam Auxiliary at Niagara

The Ontario Hydro-Electric Power Commission has decided not to proceed with the construction of an auxiliary steam plant, as tenders received show that, owing to the high cost of labor and material, the cost of a 50,000 hp. unit would exceed $5,500,000, and the extra power to be made available could not be secured for a year and a half. This initial expense and the cost of operation due to the high price of coal would, it is estimated, add at least $10 per hp. to the cost of power in the Niagara distict. The Commission has been advised by Hugh L. Cooper & Co., the New York engineers, who are preparing a report on the Chippawa-Queenstown power development, that two units of 55,000 hp. each will be ready for operation by Oct. 1, 1921, provided there is no further interference with the construction program of the Commission.

Pennsylvania Reports Arrests for Truck Overloading

Within the last few weeks a number of arrests of automobile truck drivers have been made at the instance of inspectors for the automobile division of the state highway department, and many men have been fined for carrying overloads on their machines, says a recent bulletin from the Pennsylvania Highway Department. Several weeks ago inspectors for the department and state policemen began an inspection of the trucks coming into Pennsylvania. These officials were equipped with lodometers, or "jack scales," with which it is possible to get the approximate weight of trucks. The lodometer is a mechanism with a jack attachment and is placed under the axles of trucks suspected of being over weight. Two lodometers are placed first under the rear axle, which is then jacked up. The dials on the lodometers give the weight carried on the rear end of the truck. Then the lodometers are moved to the front axle and that end is raised. The total weight registered front and back gives the approximate weight of truck and load. Under the state law trucks must have painted on the outside the maximum weight limit permitted by the manufacturer of the car. If the lodometers show that this weight limit has been exceeded the inspectors take the truck to the nearest scales where an exact weight is secured.

Under the law no commercial vehicle may carry a weight greater than that specified by the manufacturer. It is on this point that arrests are now being made throughout the state. The automobile division inspectors find that the greatest loads are being carried after dark; and they report steady streams of huge motor vehicles constantly plying between New York and New Jersey points and Philadelphia.

The fine for over-loading trucks is from $25 to $100 and in addition costs are levied, or a six months jail sentence may be imposed.

Hold Up $3,000,000 Pipe Line at Seattle

L. B. Youngs, superintendent of water of Seattle, Wash., has recommended that no action be taken toward the construction of the proposed $3,000,000 68-in. steel pipe line from Molasses Creek to Volunteer Park Reservoir, as part of the municipal water system. The lowest bid received early in the year for the construction of the 18-mi. line would involve an expenditure of $3,600,000, which is considered prohibitive. The bond market is also considered very discouraging at this time. Mr. Youngs states that he has reason to believe that by waiting until next February a saving of $25 a ton on the 14,000 tons of steel needed may be effected.

Street Cleaning and Other Bids Wanted at Philadelphia

Bids are wanted until Sept. 15 by the city of Philadelphia for (1) street cleaning for 1921; (2) collection and disposal of ashes for 1921; (3) collection and disposal of garbage, dead animals, etc., for 1921, and (3b) for disposal alone, for one year and also for five years; (4), (5) and (6) new equipment for street cleaning, collection of ashes and rubbish and collection of garbage, etc.; (7), (8) and (9) used equipment for (4), (5) and (6). Specifications may be obtained from the Bureau of Street Cleaning, 334 City Hall, Philadelphia. Frank H. Caven is director, Department of Public Works, and John H. Neeson is acting chief, Bureau of Street Cleaning.

The new charter of Philadelphia provides that the city must itself do the other work now being advertised *unless* the mayor and a majority of the new city council of 20 members decide to have it done by contract. A committee of engineers recently advised (see *Engineering News-Record*, July 29, p. 236) that the work be done by the city, beginning in 1921, with the exception that contract work for ash and refuse collection be continued during 1921. It is reported that the call for bids noted above is designed to secure cost figures for inclusion in the 1921 budget, in case the city concludes to have some or all the work done by contract. The mayor has requested the council to make an appropriation of $15,000 to pay for estimates of the value of the equipment now used to perform the work covered by the advertisement; but the council has adjourned until Sept. 7 without action on the request.

High Bridge Movement Endorsed

Supporting the movement for the preservation of High Bridge, New York City, described last week, p. 229, the New York Chapter of the American Association of Engineers has addressed the city's Board of Estimate urging favorable consideration of plans for the preservation of the structure.

Chamber of Commerce Members Approve Twelve Principles

Approval of a platform setting up twelve principles of industrial relations has been given by the membership of the Chamber of Commerce of the United States in a referendum vote, the result of which was announced last week. The vote taken was on the report of a special committee of the Chamber's board of directors. This report went deeply into the subject of the employment relation and recommended among other things recognition of the right of open shop operation and the right of employers and employees to deal directly with each other without participation by outside interests.

At the same time the Chamber's membership in another referendum vote has approved a report of its Committee on Public Utilities recommending that strikes by public utility employees should be explicitly prohibited and that tribunals should be created by law to adjudicate in decisions binding on both parties differences between public utilities corporations and their employees.

The vote on the two referenda was the largest ever recorded by the Chamber on any subject.

The twelve principles of industrial relations advanced by the committee and the vote on each are given as follows:

1. Every person possesses the right to engage in any lawful business or occupation and to enter, individually or collectively, into any lawful contract of employment, either as employer or employee. These rights are subject to limitation only through a valid exercise of public authority. —In favor, 1,675; opposed, 2.

2. The right of open-shop operation, that is, the right of employer and employee to enter into and determine the conditions of employment relations with each other, is an essential part of the individual right of contract possessed by each of the parties.—In favor, 1,665; opposed, 4.

3. All men possess the equal right to associate voluntarily for the accomplishment of lawful purposes by lawful means. The association of men, whether of employers, employees or others, for collective action or dealing confers no authority over, and must not deny any right of, those who do not desire to act or deal with them.—In favor, 1,677; opposed, 4.

4. The public welfare, the protection of the individual, and sound employment relations require that associations or combinations of employers or employees, or both, must equally be subject to the authority of the State and legally responsible to others for their conduct and that of their agents.—In favor, 1,671; opposed, 4.

5. To develop, with due regard for the health, safety and well-being of the individual, the required output of industry is the common social obligation of all engaged therein. The restriction of productive effort or of output by either employer or employee for the purpose of creating an artificial scarcity of the product or of labor is an injury to society.—In favor, 1,675; opposed, 3.

6. The wage of labor must come out of the product of industry and must be earned and measured by its contribution thereto. In order that the worker, in his own and the general interest, may develop his full productive capacity, and may thereby earn at least a wage sufficient to sustain him upon a proper standard of living, it is the duty of management to co-operate with him to secure continuous employment suited to his abilities, to furnish incentive and opportunity for improvement, to provide proper safeguards for his health and safety and to encourage him in all practicable and reasonable ways to increase the value of his productive effort.—In favor, 1,679; opposed, 2.

7. The number of hours in the work day or week in which the maximum output, consistent with the health and well-being of the individual, can be maintained in a given industry should be ascertained by careful

study and never should be exceeded except in case of emergency, and one day of rest in seven, or its equivalent, should be provided. The reduction in working hours below such economic limit, in order to secure greater leisure for the individual, should be made only with full understanding and acceptance of the fact that it involves a commensurate loss in the earning power of the workers, a limitation and a shortage of the output of the industry and an increase in the cost of the product, with all the necessary effect of these things upon the interests of the community and the nation.—In favor, 1,677; opposed, 3.

8. Adequate means satisfactory both to the employer and his employees, and voluntarily agreed to by them, should be provided for the discussion and adjustment of employment relations and the just and prompt settlement of all disputes that arise in the course of industrial operation.—In favor, 1,668; opposed, 8.

9. When, in the establishment or adjustment of employment relations, the employer and his employees do not deal individually, but by mutual consent such dealing is conducted by either party through representatives, it is proper for the other party to ask that these representatives shall not be chosen or controlled by, or in such dealing in any degree represent, any outside group or interest in the questions at issue. —In favor, 1,568; opposed, 54.

10. The greatest measure of reward and well-being for both employer and employee and the full social value of their service must be sought in the successful conduct and full development of the particular industrial establishment in which they are associated. Intelligent and practical cooperation based upon a mutual recognition of this community of interest constitutes the true basis of sound industrial relations.—In favor, 1,664; opposed2.

11. The State is sovereign and cannot tolerate a divided allegiance on the part of its servants. While the right of government employees, national, state or municipal, to be heard and to secure consideration and just treatment must be amply safeguarded, the community welfare demands that no combination to prevent or impair the operation of government or of any government function shall be permitted.—In favor, 1,663; opposed, 4.

12. In public service activities the public interest and well-being must be the paramount and controlling consideration. The power of regulation and protection exercised by the State over the corporation should properly extend to the employees in so far as may be necessary to assure the adequate, continuous and unimpaired operation of public utility service.—In favor, 1,649; opposed, 18.

Toledo Will Pay $1.45 a Ton for Garbage Reduction

A 10-year contract for garbage disposal has been awarded by Toledo, Ohio, to the Toledo Disposal Co. The city will collect the garbage and deliver it to the existing reduction plant of the contractor, and will pay the contractor $1.45 a ton for reducing the garbage, washing each garbage can immediately after it is emptied, and maintaining about a mile of road between the public highway and the reduction plant. David H. Goodwillie is director of the Department of Public Service. S. A. Greeley, of Pearse, Greeley & Hansen, Chicago, was consulted in connection with the garbage disposal contract.

Work for North Chicago District Totals $290,000

A $290,000 budget passed by the North Shore Sanitary District includes $186,000 for a sewage disposal plant at Waukegan, $75,000 for rebuilding the plant at Highland Park, and $7,700 for experimental wells to develop water supply. John Oliver, Highland Park, Ill., is president of the district.

Notes from the Corps of Engineers

Maj. Gen. Lansing H. Beach, Chief of Engineers, is engaged on a tour of inspection which will include Detroit, Chicago, St. Paul and St. Louis. The trip between St. Paul and St. Louis will be made via the Mississippi River. He will return to Washington Aug. 10.

Col. Mason M. Patrick is paying an official visit to Fort Dodge and Camp Grant.

Lieut. Col. G. A. Youngberg is at Camp Gordon inspecting the 7th Engineers.

Maj. U. S. Grant has been ordered to San Francisco to relieve Lieut. Col. William Kelly, who has been appointed chief engineer of the Federal Power Commission.

Col. Harley B. Ferguson has been ordered to Washington to attend the General Staff College.

Col. C. W. Otwell has been assigned to the Pittsburgh district.

The following officers of the Corps of Engineers, U. S. A., have been promoted to the rank of colonel: Merriweather L. Walker, Robert R. Raymond, William B. Ladue, Wm. J. Barden, E. H. Schulz, Harry Burgess, George M. Hoffman, John C. Oakes, Sherwood A. Cheney, Fred W. Alstaetter, Harley B. Ferguson, Frank C. Boggs, Clarke S. Smith, W. P. Wooten, Lytle Brown, Earl I. Brown and Curtis W. Otwell. Major Paul S. Bond has been promoted to be a lieutenant colonel. These promotions are made by virtue of seniority under sections 24a and 24c of the Army Reorganization Act.

Urge Engineer Licensing Law in Arkansas

The Little Rock Engineers' Club took the first active step at its weekly luncheon July 24 to secure legislation governing the practice of engineering in the State of Arkansas. It will be the plan of the club, if the present project carries, to ask the next state legislature to pass a bill which will license engineers to work in the state.

Arkansas is carrying on a road-building program which calls for about 6,500 miles of hard surface road. This work is done by road districts and not by counties, as in other states. Each road district is bonded, appoints its road commissioners and they select the engineer who carries on the work.

The feeling of the Engineers' Club is that Arkansas has been imposed on by incompetent engineers. Many who lacked the knowledge or experience have had themselves appointed engineers of road districts and the state has lost and will lose thousands of dollars because of poor work and ignorance.

Its present plan is to ask the next legislature to pass a bill which will appoint an examining board. Engineers will be examined and passed in the same manner that doctors and dentists are.

Union of Technical Men Favors Flat 20 Per Cent Increase

At a meeting July 29 in New York City of a special committee of members of the Union of Technical Men representing Local No. 37 of the American Federation of Labor, the proposed flat increase of 20 per cent in salaries of New York City employees was endorsed in preference to an alternative whereby low-salaried employees would receive a larger increase at the expense of the higher paid department and division heads. The committee's resolution, sent to the Board of Aldermen and the Board of Estimate and Apportionment and signed by B. L. Schneider, president, follows:

Whereas, The Board of Estimate and Apportionment adopted a resolution to increase the salaries of the major portion of the city employees to the extent of 20 per cent of their present salaries, the Board of Aldermen concurring,

And Whereas, There has arisen objection to having the higher paid officials receive the same proportional increase in their salaries, we respectfully desire to state that in our opinion this objection is not good policy. The men in higher positions need encouragement as much as the lower paid employees so that the city may obtain their best efforts in the directing of the many great enterprises in which they are engaged and in which hundreds of millions of dollars of taxpayers' money is yearly spent. The majority of these officials have advanced to their present positions through intense study of the projects which they supervise, and deserve the highest consideration of the city. It is therefore our belief that the best interests of the city will be conserved by allowing them to have a full share in the proposed increase in salaries. During the past few years many good executives have been lost to the city when outside corporations offered them double what the city paid,

And Whereas, It has been generally agreed that the proposed 20 per cent increase will still leave the lower salaried employees unable to properly meet the continual rising cost of living,

Therefore be it Resolved, That the Union of Technical Men urge upon you to make every effort to put the proposed 20 per cent increase into effect upon Aug. 20 as agreed upon,

And be it further Resolved, That each member of the Board be requested to indicate his intention by adopting *now* a concurrent resolution requesting the department heads to include in the proposed 1921 budget an additional increase in the salaries of the lower paid employees.

The above resolution was submitted to and approved by the Committee at its meeting on July 29, 1920.

Consideration of Construction Needs Urged

(Continued from p. 284)

$4,000,000,000, and during the coming four or five years an annual average which according to present indications will exceed that total. The problems of development, finance, transportation, production and distribution of every kind involved in such a stupendous program include the most important questions of industry and government. Just at this time no other domestic problem—other than those related to the production and distribution of food and fuel—demands such careful consideration as those involved in the construction problems presented by the needs of the people.

It is in the hope that you as Chairman of the Republican National Committee will bring these facts home to the members of your organization who are at this time preparing for the discussion of the issues contained in your platform that I am addressing you. I sincerely trust that they will make clear to the great representative body of men directly interested in the construction industry as well as to all citizens, every one of whom is indirectly affected by it, the steps which they propose to take to realize the aims referred to above as set forth in their platform.

Activities of the A. A. E.

The California Chapters have just completed the formation of the California Assembly of the American Association of Engineers. It is composed of one delegate from each chapter in the state. The officers elected are: President, T. E. Stanton, Sacramento; vice-president, Burdette E. Moody, Los Angeles; secretary-treasurer, Ralph E. Dodge, San Francisco. The other delegates are: I. H. Tielman, Fresno; Arthur H. Adams, Long Beach; George S. Hinckley, Redlands; Thomas H. King, San Diego. The assembly will handle all A. A. E. matters of state-wide importance or of interest to several chapters. It will also co-ordinate the work of the different state chapters and will co-operate with other technical and civic organizations in advancing matters of mutual interest.

The Executive Committee of the association has selected the following 16 railroad professional engineers to constitute its National Railroad Council: Chairman, George W. Hand, C. & N. W. Chicago; W. W. K. Sparrow, C. M. & St. P., Chicago; W. Evans, C. & A., Chicago; K. B. Lattimer, C. B. & Q.-E., Chicago; W. C. Bolin, B. & O., Chicago; F. C. Shepherd, B. & M., Boston; S. H. Brenaman, Penn., Pittsburgh; A. H. Utter, C. B. & Q.-W., Lincoln; Harold Knight, Erie, Youngstown; C. I. Long, N. Y. C.-W., Cleveland; C. C. Berritt, Southern, Washington, D. C.; Lef Winship, Mo. Pac., St. Louis; J. E. Debb, M. C., Detroit; J. T. W. Jennings, E. J. & E., Joliet; H. I. Benjamin, So. Pac., San Francisco; and F. C. Huffman, C. & N. W., Chicago.

The Montana Assembly, July 10, elected as president, William J. McMahon; secretary, C. A. Bowden, both associated with the Anaconda Copper Mining Co. of Butte.

Engineering Compensation Schedule

(Continued from p. 284)

standard rates of compensation which would be generally recognized as fair and just has long been felt by public authorities and other large employers of engineering service. We believe that this report is worthy of your very careful attention. In nearly all work on which technical engineering service is required, its cost is a very small percentage of the entire cost, so that an increase of engineers' pay to the standard scale will add a hardly noticeable amount to the total, and this in nearly all cases should be far more than offset by the economies which a higher grade of engineering service can effect.

Nor can the importance be overlooked, at this time of general industrial and social unrest, of maintaining the loyalty of professional men who should be leaders of thought and action to the organizations which they serve. This continued loyalty to professional ideals cannot be expected when men of education and intelligence receive lower pay than many unskilled laborers.

Our committee will be very glad to receive your views as to the feasibility of adopting Engineering Council's schedule of grading and compensation to the engineering and technical service employed on the work with which you have to do. We shall be glad also to furnish any information you may desire bearing on your special problems in this field.

Isham Randolph Dead

Isham Randolph, consulting engineer, of Chicago, for 14 years chief engineer of the Sanitary District of Chicago, died Aug. 2, in that city. He was born in Clarke County, Virginia, in 1848. At the age of 20 he began engineering as axeman and, later, roadman for the Winchester & Strasburg R. R., and was, successively, leveler on surveys of the Washington & Ohio R. R.; transitman on surveys for the extension of the Lehigh Valley Ry.; transitman in

ISHAM RANDOLPH

charge of locating party of the Baltimore, Pittsburgh & Chicago R.R. between Syracuse, Ind., and Chicago, later resident engineer on that work, constructing 26 miles of main line and roundhouse, shops and freight yard at South Chicago. With the Scioto Valley R. R. Co. he was assistant engineer on construction between Columbus and Chillicothe, Ohio.

From 1880 to 1885 Mr. Randolph was chief engineer of the Chicago & Western Indiana Ry. and the Belt Railway of Chicago, at the end of which period he began private practice in Chicago. The following year he became chief engineer on the construction of the Chicago, Madison & Northern Ry. and Freeport & Dodgeville Ry. for the Illinois Central R. R. In 1888 he resumed general practice in Chicago, and was consulting engineer for the Union Stock Yard & Transit Co., the Calumet Terminal Ry. and the Baltimore & Ohio R.R. From 1893 until 1907, when he resigned, he was chief engineer of the Sanitary District of Chicago. He was retained, however, as consulting engineer until the end of 1912.

In 1905, President Roosevelt appointed him on the Board of Consulting Engineers for the Panama Canal, and he was one of the five members of the board whose minority report was accepted by the President and the Secretary of War, approved by the Panama Commission and adopted by Congress. Again, in 1908, he was one of the six engineers who accompanied President-elect Taft to Panama to consider the advisability of changing the plans for the canal.

He was chairman of the Internal Improvement Commission of Illinois, which made plans for a canal from Lockport to Utica, Ill., of the State Conservation Commission, of the State Rivers and Harbors Commission and of the Chicago Harbor Commission. He made an engineering study, report and plans for a commercial harbor for Milwaukee, and was consulting engineer for Baltimore and Toronto, on track elevation work, and served as a member of the Toronto Water Supply Commission. He was also consulting engineer for the Little River Drainage District of Cape Girardeau, Mo., and reviewed the plans and estimates for the Lake Erie & Ohio River Barge Canal. He was chairman of the Florida Everglades Engineering Commission and made a complete report on the drainage of the swamp-lands of Florida. The report was accepted by the governor. He designed the harbor system for Miami, Fla. He was the designer of the Obelisk dam above the Horse Shoe Falls built for the Queen Victoria Niagara Falls Park Commission.

Mr. Randolph was past-president of the Western Society of Engineers, a member of the American Society of Civil Engineers and the American Institute of Consulting Engineers.

Water Power Commission Administration

For administrative purposes the Federal Power Commission has divided the country into five districts. District 1, which includes the most of the country east of the Mississippi River, has its headquarters in Washington. District 2, with headquarters at St. Paul, is much smaller in area and includes what may be termed the eastern Northwest. The headquarters of District 3 is St. Louis. It includes the territory directly south of District 2 to the Gulf, and in the South extends westward to the mountains. Denver is the head of District 4, which includes most of the intermountain territory, while District 5, with headquarters at San Francisco, includes the entire Pacific slope along with most of the states of Idaho, Nevada and Arizona.

The Power Commission will have its work divided under the following heads: Engineering, accounting, statistical, regulatory, licensing, legal and operation. The engineering division will be under the immediate direction of the engineer officer, who will be known as the chief engineer of the commission. For the present the accounting and statistical divisions will be operated as a unit and will be under the immediate direction of the chief accountant. The head of the legal division will be known as the chief counsel,

while the operating division will be in charge of a chief clerk.

The regulations for use in connection with the administration of the Water-Power Act are being drafted, but will not be promulgated until conferences have been held with all interests concerned.

St. Louis Limits Weight of Trucks

The City of St. Louis recently passed an ordinance regulating loads which may be carried upon the city streets. The ordinance sets a maximum limit of 28,000 lb. for truck and load, a maximum axle loading of 22,400 lb., and prescribes that the weight upon any wheel shall not exceed 800 lb. per inch width of tire. However, the director of streets and alleys is empowered to issue permits in certain instances for the movement of loads in excess of those mentioned above. Permits must prescribe the streets over which such excess loads may be carried and are limited in time to one week. Vehicles are to carry in conspicuous places certificates indicating the maximum loads they are allowed to carry, and a weight ticket, showing the weight of the vehicle and load, must be carried by the driver.

The ordinance further provides that any violation will be punishable by a fine of not less than $5 and not more than $500.

Two Concrete Ships For Sale

The United States Shipping Board announces that sealed bids will be received at the office of the chairman at Washington on or before Aug. 23 for the two reinforced-concrete tankers, "Palo Alto" and "Peralta," now under construction at the yards of the San Francisco Shipbuilding Co. at Oakland, Cal. These are the standard 7,500-ton tankers designed by the Concrete Ship Section of the Emergency Fleet Corporation.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Portland, Ore., Aug. 10-12.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Sept. 13-17.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Valparaiso, Ind.; St. Louis, Oct. 10-15.

The Washington State Associations of County Engineers and of County Commissioners will meet in annual convention in Everett, Aug. 25-27. F. G. Tegtmeier, county engineer of Snohomish County and president of the engineers' association, will address a joint session of the engineers and commissioners on Aug. 25. James Allen, state highway commissioner, and R. H. Thomson, consulting engineer of Seattle, will be on the program. Separate sessions for the election of officers will be held on the last day of the convention.

Personal Notes

E. C. Wenger is now resident engineer on Federal Aid Road Project No. 22 in Finney County, with headquarters at Garden City, Kan.

A. W. Galbreath has been appointed valuation engineer of the Missouri, Kansas & Texas Ry., with headquarters at Parsons, Kan.

V. B. Fredenhagen has been appointed resident engineer of Federal Aid Road Projects Nos. 44 and 45, with headquarters at Salina, Kan. He was formerly an assistant engineer with the Kansas State Highway Commission.

Hyde Forbes, engineer and geologist, for the past three years connected with the Lindsey-Strathmore Irrigation District of California in the investigation of underground water conditions and irrigation requirements of the Kaweah Delta for the purposes of litigation over water rights in which the district has been involved, has opened offices in Los Angeles.

Stephen E. Preble, formerly associated with I. W. Jones Co., engineers, Milton, N. H., has been elected vice-president and general manager of the Industrial Planning Corporation, Buffalo, N. Y., which company specializes in hydro-electric development and the design of pulp, paper and fiber mills.

Harland Bartholomew, engineer for the St. Louis City Plan Commission, has been appointed consulting engineer for the drafting of a zone law for Washington, D. C.

J. J. Ochs has been made office engineer of the Chicago & Alton R.R., with headquarters at Chicago. He succeeds J. E. Schwab, recently appointed city engineer of Alton, Ill.

L. M. Norelius has left the Emergency Fleet Corporation as construction engineer, at Philadelphia, for the concrete ship section on the construction of concrete barges. He is now vice-president of the Majestic Furnace & Manufacturing Co., Seattle, Wash.

George B. Ford has been appointed director of the city planning department of the Technical Advisory Corporation, New York City. Mr. Ford, who was chairman of the city planning committee of the American Institute of Architects and is a director of the American City Planning Institute, has recently been retained as adviser on foreign housing to the U. S. Senate Committee on Reconstruction and Production. Besides his city planning and zoning activities in this country, Mr. Ford has recently completed a long engagement in France, where he was city planning consultant to many of the cities of the devastated areas, including Rheims, Arras and Soissons.

Fred Brown, erroneously referred to as city engineer of Muskegon, Mich., in the issue of this journal dated July 1, is inspector for that city on its new pumping station now under construction. R. J. Buck is city engineer.

Frederick Glaeser, formerly section engineer with the Board of Water Supply of the City of New York, and recently engineer for the Emergency Fleet Corporation, at Bristol, Pa., has been appointed landscape engineer and superintendent of parks of Trenton, N. J., a newly created position.

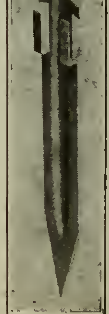
E. J. Terrill has been appointed resident engineer on Federal Aid Road Project No. 37, with headquarters at Independence, Kan. He was formerly assistant engineer on Federal Aid Project No. 4 in Shawnee County, Kan.

Obituary

August Heman, mayor of University City, Mo., and president of the Trinidad Asphalt Co. and the Heman Construction Co., of St. Louis, died July 15, at 64 years of age. He was actively engaged in construction work in the St. Louis district and his companies handled many large building and paving contracts. During the war the Heman Construction Co. built 18 warehouses at the Rock Island Arsenal at Moline, Ill.

Support for Concrete Floor Screed

Specially made steel pins to carry screeds for concrete floors are being marketed by the Contractors Specialty Co., of St. Paul, Minn., under the name of Kingpin Screed Supports. These pressed steel pins are lightly hammered into the floor forms and carry in the upper bracket screed guides. After the concrete has taken an initial set they can be readily pulled out, leaving no serious mark in the floor, and used over again.



KING PIN SCREED SUPPORT

The accompanying illustration shows the general features of the pin.

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

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How To Buy a Railroad

IN ITS latest monthly bulletin the National City Bank of New York suggests to railway employees how they may gain their desired control of or at least a voice in the management of the railways. It says: "The railroad wage bill after the new wage scale goes into effect will be about $3,600,000,000 per year, and if the employees would set aside 5 per cent they could begin to accumulate an interest in the railroads at the rate of $180,000,000 per year. If this was applied to the purchase of stock rather than bonds they would come quite rapidly into an influential position in the control of the roads, particularly if they concentrated their purchases upon certain systems. The New York Central system has $222,729,300 of stock outstanding, now selling in the market at about $70 per share, or at a valuation of $155,950,510 for the entire stock. A majority would give control and even a respectable minority interest would give representation." Here is a chance for Mr. Plumb to do some constructive organizing.

Construction Machinery in Europe

STRUCTURAL conditions in Europe before the World War were radically different from those in this country. There labor was plentiful and cheap, material was scarce and costly. Here we had plenty of material at a reasonable cost, but labor, though plentiful enough generally, was expensive. Designing, therefore, on the two sides of the ocean was on a different basis, for the European engineer could go to extremes unknown here to save material, regardless of the amount of labor such construction required. This is all changed now in Europe, for though material is as scarce and high as ever labor is demanding and getting higher pay, pay almost as high, in fact, as that now prevalent here. One immediate consequence of this is an influx to this country of visiting foreign engineers, all intent on studying our methods of construction, and particularly of inspecting our construction machinery. Plant in Europe is to mean more than anything else in future construction operations, and these men will have to know how it is to be provided and how to adjust their methods to its use. Making due allowances, therefore, for habit and precedent, we should see soon a greater uniformity of engineering practice on the two sides of the Atlantic. Even though financial conditions are adverse, this should afford an exceptional opportunity for American makers of construction machinery.

Flat-Slab Moment Coefficients

REINFORCED-CONCRETE flat-slab design is notably indeterminate. The theory is anything but exact and tests are not sufficiently numerous or in agreement to confirm any one method of computation. In general, though, such design is becoming standardized, the variations being practically confined to different moment coefficients. These differences, however, are quite marked, as the tabulation of the coefficients on p. 300 shows. Here surely is work for a standardization body such as the Joint Committee on Concrete. With evidence as to the exact numerical values so lacking the authority of this committee should be great enough to popularize its coefficients in the various big centers of the country, so that the somewhat ridiculous variations shown would be minimized if not entirely removed. While no one can claim that any particular coefficient is correct, certainly there is no excuse for half a dozen values for the same things. After the Joint Committee establishes values in its forthcoming new report it should do a little missionary or publicity work in defense of its standard.

Mobile Alley Paving Plants

AMONG paving operations of all kinds the last to be considered susceptible to improvement by machine methods is paving city alleys with concrete. As alley paving is usually planned the yardage of any one operation is small, the operations are scattered and plant room is restricted. Hand mixing persisted for a longer time in alley paving than in street paving and road construction. When finally the concrete mixer replaced the mixing board it was not until quite recently that the mehcanically charging and distributing paving mixer was commonly employed. Even now there are few alley paving operations in which all tasks, not accomplished by the mixer itself, are not manual processes carried out with hand tools. The example, therefore, in our issue of Aug. 5, p. 283, of alley paving operations in which all processes are about as nearly as possible a hundred per cent mechanical, suggests inquiry beyond the fact of a 40 per cent increased output obtained. What machine quality is responsible for the success of the experience described? Obviously it is the quality of mobility. Every unit of the equipment (loaders, truck-tractors, mixer) can either travel by its own power or can be hooked up and hauled from one operation to the next. The whole outfit is as quickly made ready to move and will travel as fast as an equipment of small mixer, wheelbarrows and carts.

Patience and Waterproofing

PATIENCE and persistence play a larger part in successful engineering than the textbooks teach. Every operation that contains new elements requires, in some measure, a working forward step by step, a trial-and-test procedure. The successful work is that in which the trial is most patient and the test study most searching. In the excellently performed grouting operations at Canal Street station, described on p. 314 by the engineer who put the work through, patient persistence found its reward of success. This phase of the matter merits as much attention as the technical points

involved. At the start the station had a hopeless appearance—passengers who had to use it daily said it leaked like a sieve. And only the most persevering step-by-step experimentation proved the truth of what some asserted from the beginning, namely, that the leakage was not general but was largely localized at a few points. That the task of restoring the water-invaded station was so tedious and problematical lays insistent emphasis also on the importance of carrying out waterproofing with full provision for settlement or other change that may vitiate its integrity. Leakage developing in any important structure located below groundwater level is so troublesome that no cost and difficulty are too great in making the details of the waterproofing permanently secure at the start.

Federation Calls for Charter Members

LAST week the Joint Conference Committee, representing the four founder societies of civil, electrical, mechanical and mining engineers, sent to a long list of national, state and regional organizations a formal invitation to become charter members of the Federated American Engineering Societies, for which a constitution and by-laws were approved by delegates to the organizing conference held in Washington, D. C., in June. The invitation is reprinted in the news columns of this issue. Summer is always a period of comparative inactivity in engineering society affairs and it is not to be expected that the machinery of the federation will begin to function until November, when, it is announced, the first meeting of the American Engineering Council, constituting the directorate of the federated societies, will take place. The time is now here, however, for societies to reach a decision regarding their own participation in the federation movement. Some engineers are frankly opposed to the plan, many others see in it a great opportunity for uniting a profession, split up into groups of specialists, and giving to it the influence which always goes with a big membership and without which, especially in matters where legislation is concerned, any particular group is almost impotent in securing a hearing, to say nothing of getting favorable action on measures under consideration. The engineering societies of the country now have the issue of the federation squarely before them, and with the constitution of the new organization printed and distributed widely there should remain no doubt as to just what obligations and advantages the movement for a unification of the engineering profession involves. The decision of national and local bodies should be made promptly, for November is not far away, and it is highly desirable that the first meeting of the federation's council should have a large and thoroughly representative attendance.

A New Opening for Engineers

MUNICIPAL engineers have always done more or less city planning, but along the narrow lines of one element of the city plan. Even at that the planning has generally been fragmentary, both geographically and as regards the future. Rarely has there been any serious attempt to correlate two elements of the city plan; almost never all of them. Blame for this rests far more with the city councils and citizens than with the engineers, but if the latter had only had more vision, foresight and initiative than they have yet shown the importance of broad city planning would have been recognized by city councils and people and the engineers would have been authorized—yes, instructed—to go ahead long before this. Fortunately a marked change is taking place. City planning is now widely accepted in theory and is being established in practice. It did not originate, as it should have done, with engineers, though a few have taken a leading part in it. Now that the movement is getting beyond the mere educational and promotional stage engineers are being drafted into the service—as yet more commonly in minor though fairly important positions, but sometimes at the forefront of the executive staff. The number and dignity of these city planning positions for engineers promises to grow rapidly. Wide awake engineers with even latent capabilities in the city planning field will be on the lookout for these new openings. They afford great opportunities for service and, like other work in comparatively new fields, warrant compensation above the average. But even if it yields no extra financial reward, city planning is an attractive field.

Restoration of French Roads

WHILE Mr. Mehren's notes on the highway system of France on p. 303 of this issue contain no sweeping generalization which forecasts the passing of the waterbound macadam road, evidence is presented to indicate that at least in the repair of the main national routes former standards of practice will be altered to meet the demands of an increased amount of motor traffic. In the plans for rehabilitating the principal thoroughfares after their period of severe war service it appears that the new types of surfacing will take the form of ashpaltic macadam, sheet asphalt and stone block. Concrete roads, apparently, will play a negligible part in the work of restoration, nor will concrete foundations for other types of wearing surface be so much in evidence as they are in the United States, for the French macadam roads, superbly drained and substantially built, will form an adequate foundation for new work. To those familiar with the conservatism of French practice this news is not unexpected. Tradition means much more over there than it does with us and radical departures from precedent are made, if at all, only after great deliberation. It appears, however, that experimental sections of concrete pavement are to be laid, but among French engineers it is felt that a concrete road through a rural district where a considerable amount of horse-drawn traffic continues would raise decided protest on the part of the great middle class engaged in the production of food products and wine. American engineers will find illuminating the figures which Mr. Mehren presents on the maintenance costs of waterbound macadam under traffic conditions very much less severe than those of our heavily traveled interurban routes. France's road problem is different from our own in many of its principal aspects, but a fundamental lesson—that of adequate drainage—is the one which American engineers should take to heart. It is not a case of our being ignorant of the best methods of road drainage, but rather of our neglect, oftentimes, to do what we know should be done. Mr. Mehren has presented the case so succintly that his words may well be repeated: "The only point to be emphasized is that they have actually applied these [drainage] methods. They have not merely considered them beautiful theories."

City Cleansing at Philadelphia

CITY cleansing is a term long used in Great Britain to designate all those activities that we in this country more cumbersomely express as street cleaning and the collection and disposal of garbage, ashes, and other city refuse. This very precise British term, though not used in America, might well be applied in a double sense to the subject which is now uppermost at Philadelphia. We say this because that city, after a long and seemingly inexcusable delay in meeting a mandate of the new city charter, stated further on, is now advertising for proposals for street cleaning and the collection and disposal of garbage, ashes, and rubbish, and also because upon the solution of the physical cleansing problem depends in large degree the success or failure of Philadelphia's most recent attempt in political cleansing.

Although most of the complicated details of the Philadelphia city cleansing situation are chiefly of local interest some of the main points at issue are of wide general concern. These include such evils as a contract system skillfully designed to favor unholy alliances between contractors and political bosses (factional instead of rival political bosses in Philadelphia) and to shut out almost absolutely any and all competition from contractors in other cities.

The controlling factor in the Philadelphia situation heretofore, but now possible of elimination—and that is where political cleansing is at issue—has been the letting of contracts for the absurdly short term of a year. To clinch the certaintly of throwing the Philadelphia city cleansing contracts into the laps of the factional political contractors in favor at the moment the common practice has been to withhold the advertisements for bids until a very short time before the contracts were to go into effect. Both the one-year contracts and the delay in advertising for bids have mattered less for street cleaning, and for the collection of garbage and other sorts of refuse, than for the disposal of garbage. The reason for this difference is that although capital investment for street cleaning and for the collection of various classes of refuse is large for a city the size of Philadelphia, yet a considerable portion of the equipment can be turned to other uses if a contract is not renewed, whereas the garbage disposal plant involves a heavy investment for special apparatus that can be used for nothing else.

A feature of the new charter that is directly pertinent to the present discussion, and that doubtless contributed materially to the election of the "reform administration" that took office last January, was specially designed to do away with the political contracting evils allied with city cleansing in Philadelphia. This portion of the charter made it compulsory for the city to clean its streets and collect and dispose of its garbage, ashes, and other refuse by its own forces instead of by contract, beginning Jan. 1, 1921, *unless* the mayor and a majority of the new and relatively small city council decide to continue to have the work done by contract. In case it was decided to continue contract work the new charter provided that before Aug. 1 bids for doing the work by contract might be invited. Although it was obvious that if a change from contract to direct municipal work were to be made there was no time to be lost in preparation for it the new administration was very dilatory in starting the necessary action. When the report on the subject was made a few weeks ago by three engineer-officials of the city it was unanimously in favor of the work being done by the city instead of by contract, with the exception that one of the three investigators advised that because of the magnitude of the changes involved a portion of the work should continue to be done by contract during 1921.

Judging from reports which come from Philadelphia it appears that much apprehension exists lest the main object of the present city administration should not be so much to free itself of the evils of political contractors as to throw the contracts from one local faction to another. This may be unjust, but if so it is the sort of injustice or misapprehension that must be suffered in a city where maladministration of municipal government has long been the rule and where due diligence and unmistakable intent to bring about reforms have not yet been shown by the new administration.

As to the specifications themselves, they are too detailed, present too many plans and combinations of plans and alternatives, and also are too local in character to warrant an attempt at analysis except by those who intend to bid—and we predict that few, if any, contractors outside of Philadelphia will be so venturesome. With the exception of an alternative of a five-year instead of a one-year contract for garbage disposal alone and the further exception that proposals are asked for the sale of old and of new street cleaning and collection equipment to the city the proposed new contracts are all for a single year. Philadelphia stands alone among the larger cities of the country in having its street cleaning done by contract. This work, as well as the collection of garbage and refuse, should be done by the city direct, or else, if by contract, under specifications and city inspection of a different sort than usually prevail in Philadelphia. As to the disposal of garbage, a one-year contract is a farce and a five-year contract is too short. The alternative for garbage disposal, at least, and probably for all the other work, should be either direct municipal work or else contracts of sufficient length to get back the money on the investment without unduly high prices on the one hand or a political gamble on the renewal of the contract on the other—most likely something of both.

It is only fair to say that the city cleansing situation at Philadelphia presents many difficult problems. They have been made harder by delay and apparent indecision. Some, but not all, would be eliminated by a change from contract to city service. In any case, a strong engineering staff needs to be provided in the Bureau of Street Cleaning—a fact recognized and emphasized by all three of the engineers in the report already mentioned.

Difficult as the Philadelphia city cleansing problem is, both physical and administrative, it can doubtless be solved in a satisfactory manner—due allowances being made for the inheritance of past evils and for dilatoriness—if it is handled in a businesslike engineering way. There are plenty of engineers connected with the city administration of Philadelphia who could bring order and efficient service into municipal cleansing in Philadelphia if they were given free hands and wholehearted backing. We do not mean to say that this is not the intent of the administration, nor that the bids now being asked may not be used as a step to that end, but in this respect the administration is on trial not only before Philadelphians but the rest of the country as well.

Principles of Channel Improvement in Miami Valley Flood Protection

Flow Capacity of River Increased to Supplement Action of Detention Basins—Bottom of Enlarged Channel Shaped for Low-Water Flow—Scour Protection by Concrete Revetment, Block Mattresses and Sills

NEARLY one-third of the cost of the $25,000,000 flood-protection works of the Miami Conservancy District in southwestern Ohio, is being spent on channel improvement. Though the project is commonly regarded as a detention-basin system, the channel work is a vital element of the protection to be given the industrial cities in the valley of the Miami, since the throttling action of the five great detention dams will not suffice to bring the maximum flood flow within the capacity of the river as it existed hitherto. Careful engineering study of river action, and designs adjusted to the results of this study, were involved in the planning of the channel work. From the review of the main elements of the planning given by the present article it will be seen that the final plans for the work represent a narrowly limited solution of a problem defined by the physical and topographic conditions existing in the valley.

At Dayton and Hamilton, the two key points of the flood protection territory, the channel of the Great Miami River has a bank-full capacity (prior to the present improvement) of 90,000 and 100,000 sec.-ft. respectively. The peak flow of the 1913 flood, the disaster which led to the formation of the Miami Conservancy District, was 250,000 and 350,000 sec.-ft. at the two cities. Fifteen years before, in the 1898 flood, a peak flow of 90,000 and 110,000 sec.-ft. was reached, which did much damage and led to costly levee-raising work at Dayton. Statistical studies made by the Morgan Engineering Co. just after the 1913 flood pointed to the conclusion, reached late in 1913, that a storm might at some future time occur which would produce a maximum flow (if unregulated) of 350,000 and 490,000 sec.-ft. at the two cities in question. The "maximum flood" will be controlled by the detention basins, but will still have a volume of 125,000 sec.-ft. at Dayton and 200,000 sec.-ft. at Hamilton, which considerably exceeds the present capacity between levees.

Economic Balance of Channel and Basin Work—Complete flood-protection could have been secured by either detention basin alone or by channel improvement alone, but at a cost that would have made the work impossible; a low-cost solution was found by combining the two.

The available reservoir sites were limited in number, partly by topographical and subsoil conditions, and partly by the distribution of population in the valley, the latter factor also limiting the storage height in some of the reservoirs actually adopted. Due to these and other reasons, while it would have been possible to provide basin storage (or detention) sufficiently great to reduce the river flow to the channel capacity, a much increased expense, and above all a serious disturbance of conditions in the valley, would have been involved. Such protection by detention basins alone would have cost $93,000,000.

Protection by channel enlargement alone would have required radical changes in the cities, since a flow volume fully three times the present channel capacity would have had to be provided for. The cost of such improvement has never been accurately computed, but rough estimates made five years ago showed that it would exceed $150,000,000. On the other hand, it was found that a group of detention basins capable of dealing with roughly two-thirds of the maximum flood volume could be built for about $15,000,000, and the river channel could be enlarged through the cities to accommodate one-third the unregulated flow at a cost of about $7,000,000, thus giving complete protection at a total cost (land and engineering included) of about $25,000,000. The figures quoted are strictly comparable, being based on pre-war costs, but they would of course stand proportionately higher today.

FIGS. 1 AND 2. VIEW AT JUNCTION OF MIAMI AND MAD RIVERS, DAYTON, LOOKING DOWN MIAMI FROM HERMAN AVENUE BRIDGE; WEBSTER AVENUE BRIDGE OVER MAD RIVER AT EXTREME LEFT

Upper picture: Before improvement, view taken May 21, 1918. Lower picture: Condition on June 24, 1920; new levee in foreground at right is up to full height, but short bank between it and old levee is still to be filled.

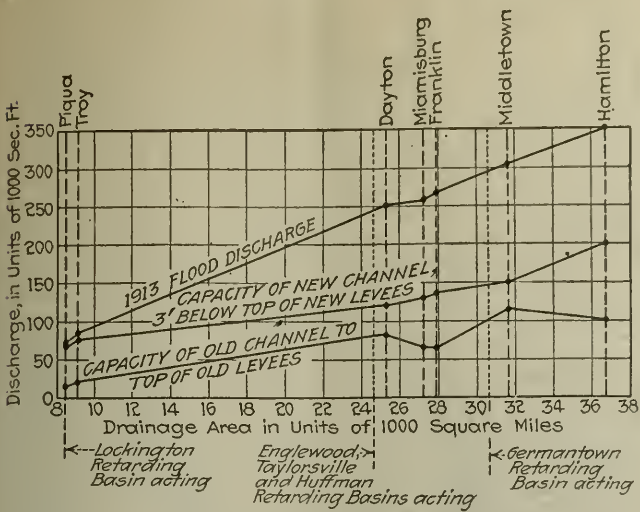


FIG. 3. FLOOD FLOW AND CHANNEL CAPACITY OF MIAMI RIVER

expose more vulnerable soil and thus initiate scour and instability of channel.

Increase of channel depth by raising the levees was subject to limitations not only as regards interference with city structures, but also as regards popular apprehension likely to be aroused by high levees. Topographic conditions, moreover, made it necessary to consider long section of river as units with respect to leveeing.

The two largest cities in the valley, Hamilton and Dayton, presented quite different channel-improvement conditions. With a normal flood flow 50 per cent greater than that at Dayton, Hamilton had a channel actually narrower in its most constricted sections than Dayton; encroachments had brought the minimum river width at Hamilton down to 390 ft., as against a 550-ft. minimum width (between levees) at Dayton. On account of the naturally deep channel, due to high banks, at Hamilton, there were no levees through the city except in one or two individual sections, and the adjustment of the city

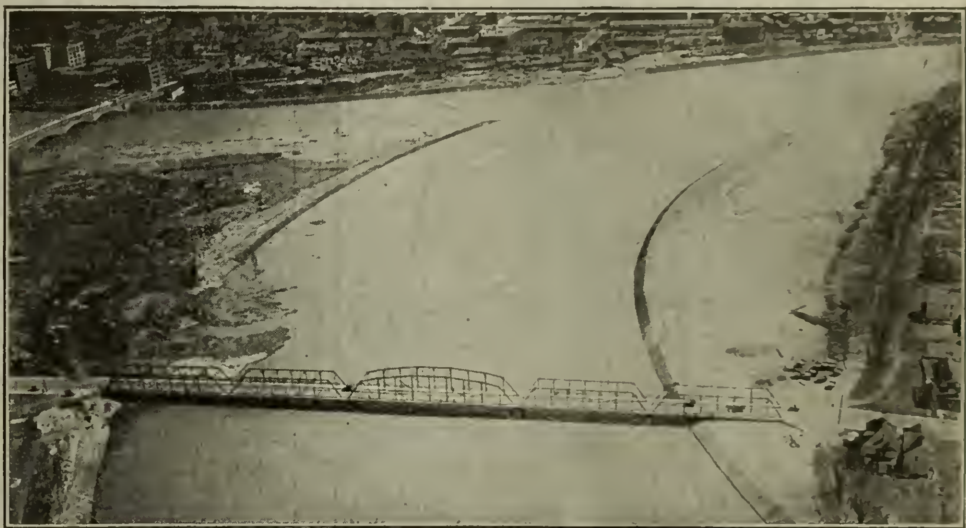


FIG. 4. AIRPLANE VIEW OF IMPROVED MAD-MIAMI JUNCTION IN A RECENT FRESHET

The great difference between the cost of the combination project and the cost of either pure basin or pure channel control is due to the topography of the valley and the distribution of population and improvements. Their effect is to make both reservoir construction and channel enlargement run up in cost at abnormally rapid rate beyond a certain capacity limit. The successful planning of the present enterprise depended essentially on finding out the economic limits of both channel improvement and basin work, and combining the two resources for the joint solution.

Limits of Channel Enlargement—Excavation is relatively cheap when confined to the natural width of the stream, where unencumbered by encroachments, but the cost suddenly rises when the widening is carried so far that streets and other city work and structures are encountered. Increase of depth, on the other hand, is limited in part by the channel slope, in so far as this leads to the necessity for extending the excavation downstream of the improvement section if the natural bed profile is lowered too much.

Scour effects also are involved in channel enlargement. The average slope of the Miami River, 3½ ft. per mile, is in itself quite steep, so that the high-water velocities are large. In its condition as found, the river was stable as to scour, but since it had formed its own bed the equilibrium was likely to be disturbed by the higher velocities necessarily resulting from improvement. These facts influenced the detail design of the channel work as noted farther on. With respect to the general planning their primary importance was to limit downward deepening of the channel to a minimum; as the river bed consisted of the larger gravel of the subsoil, selected and sorted by the action of the river, excavation below the natural bed would be likely to

to this condition tended to prohibit extensive levee construction as part of the improvement. Generally the flood exposure of Hamilton was considerably more serious than that of Dayton, and the destruction done in the 1913 flood was comparatively greater. Thus a decision in the matter of balance between channel improvement and basin construction could not be reached from a study of the limitations prevailing in one city alone but had to consider other cities; and where a basin location existed between two given points along the river, the planning of channel improvement for the lower point had to be considered separately in conjunction with this basin, as well as in its relation to the entire flood protection system.

Local conditions were fully as individual at the other communities along the river (Piqua, Troy, Miamisburg, Middletown and others) as at Hamilton and Dayton, but the two latter cities were the key points with respect to the planning of the system as a whole, due to the decisive limitations they placed on increase of channel capacity. For the other cities the local conditions controlled the planning of the local protection in detail, but were of quite minor influence in determining the economic extent of regulation by detention basins.

A limiting factor not mentioned above was found in

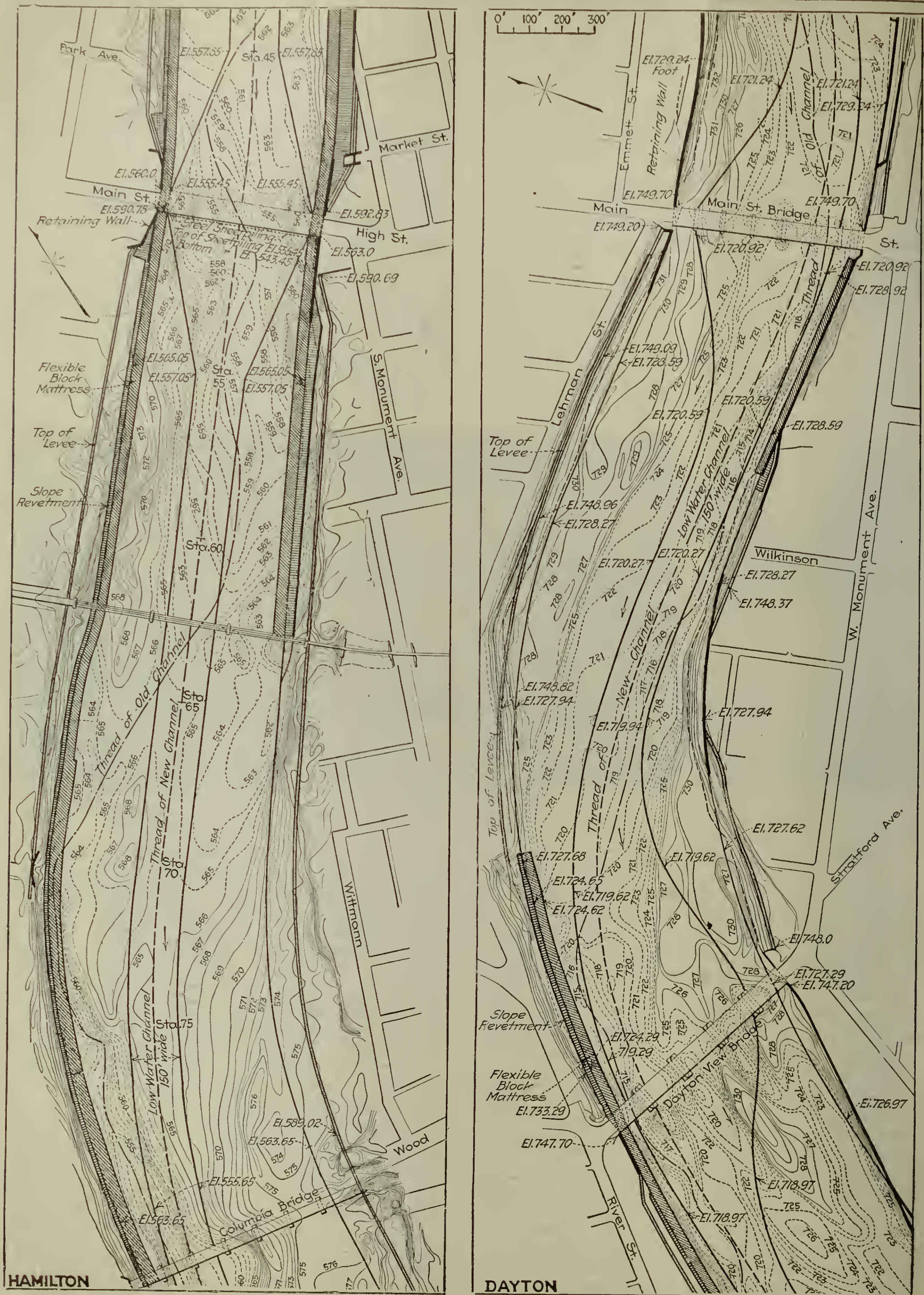


FIG. 5. PORTIONS OF MIAMI CHANNEL IN HAMILTON AND DAYTON, SHOWING ADJUSTMENT OF IMPROVEMENT TO PRIOR CONDITIONS

(Dot-and-dash line marks thread of old channel; dotted line marks thread of new channel.)

the bridges crossing the river. Dayton had a large number of street bridges, most of them of the reinforced-concrete arch type. Their elevation was such that the levee heights could be increased at most by 2 or 3 ft., unless the bridges were to be taken down and rebuilt. Further, no material deepening of the channel was practicable unless the bridge piers were underpinned, as their foundations in most instances were shallow. Consideration of these matters resulted in making the solution for Dayton a combination of widening, deepening, and levee raising, in each case carried practically to the point where further enlargement would have meant an abrupt rise in the cost. At Hamilton, however, bridges were not determinative to the same extent. There was only one street bridge left after the 1913 flood, though this was rather short and of low elevation, and only one railroad bridge. Because of the narrowness of the channel, however, and the existence of many encroachments, the major part of the improvement here necessarily consisted of widening.

The final result of the trial design is expressed in the diagram of river flow, Fig. 3, which gives channel capacities and 1913 flood flow. Briefly, the channel enlargement at Dayton and Hamilton represents an increase of 25 to 80 per cent over the channel capacities existing in 1913; at a number of the other cities, notably those above the Taylorsville basin, the capacity inside the new levees represents a much larger increase over the old channel capacity, as the effect of basin regulation is less at these cities.

Channel Cross-Section—The old levees generally had water-side slopes of 2:1, although some slopes were found that were even steeper than 1½:1. The old bottom consisted of gravel banks irregularly distributed, generally with a main channel located along the outside of the curves. The irregularity of the bottom and the existence of pools and minor channels of flow created undesirable conditions at all stages, flood flow being held back unnecessarily by the excessive roughness of the bottom, while during the low-water periods stagnant pools were present. The Miami River has a very low ratio of minimum to maximum; in fact at many points this ratio is zero, since hydraulic canals take the full dry-weather flow. There was in general no possibility of maintaining a definite minimum stage, or even a water flow, without ponding by dams, which was not considered favorable to free discharge of flood flow, or worth the cost.

To meet these conditions it was decided to shape the bottom with a relatively narrow dry-weather channel, 150 ft. wide, 8 ft. deep below levee foot. For purposes of hydraulic computation the cross-section as a whole was considered to be trapezoidal, with flat bottom 3 ft. below the levee foot and 5 ft. about the floor of the low-water channel. This channel was located so far as practicable along the existing thread of the stream, that is, it was placed along the outside of curves. In general its near side was kept at least 75 ft. away from the levee foot. Partial plans of the Dayton and Hamilton protection and some typical channel sections given herewith show the characteristics of the adopted design.

Uniformity of Channel—Uniformity of channel cross-section had received little or no attention prior to the Conservancy District's work, but in planning for the improvement it was regarded as an important feature. There were considerable irregularities of width, due in part to encroachment on the natural channel and in part to widening of the channel by excavations and the like. The new improvement was so planned as to take up these irregularities and make the channel approximately uniform along its length.

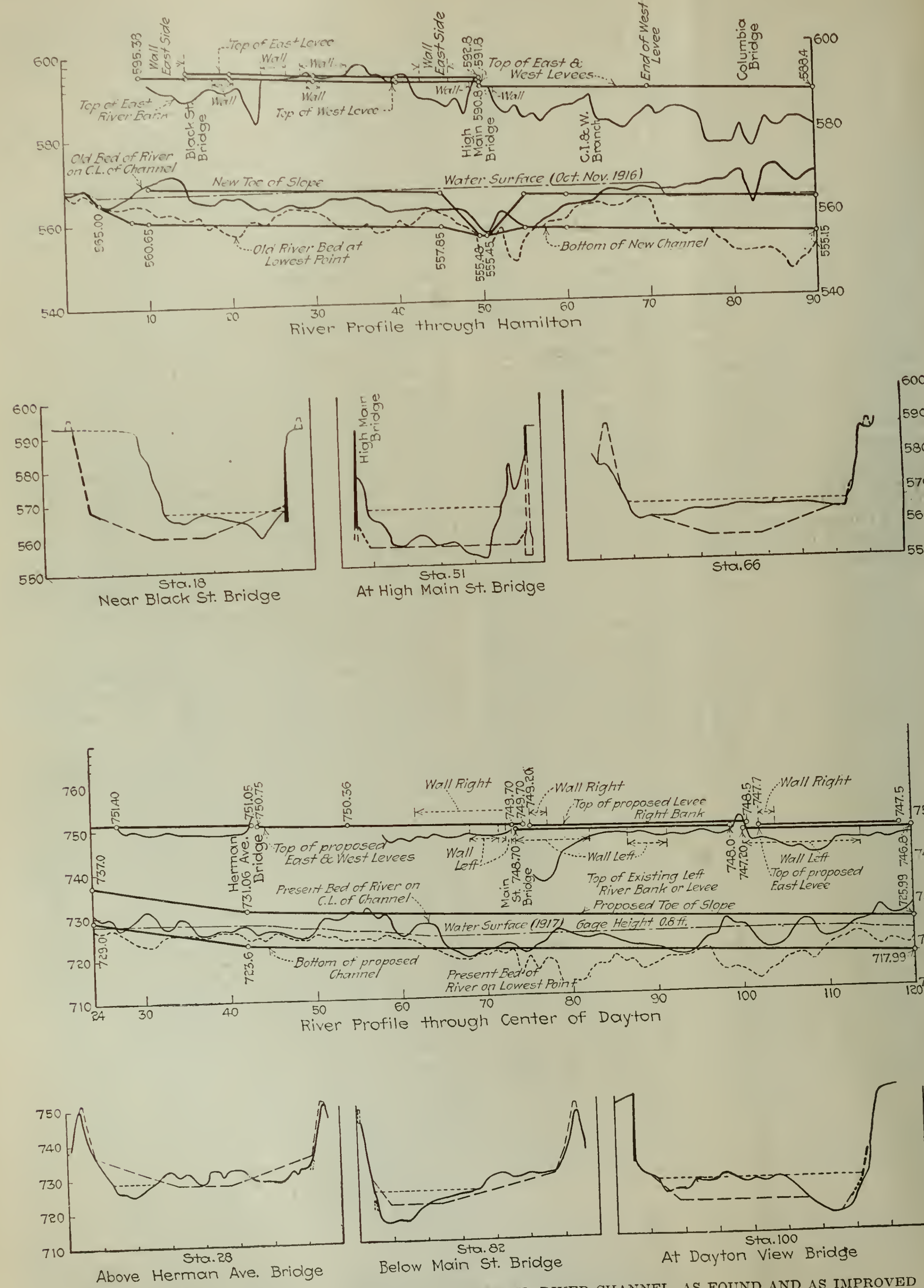
Just above the junction of the Mad River with the Miami in the upper part of Dayton there was a large basin, and the Herman Ave. bridge, which crosses just above this basin, is in fact the longest in the city. This basin is being filled, behind levees so laid out as to maintain the widths of both main and tributary streams and form a junction of good hydraulic character (see airplane view, Fig. 4). It is believed that this change avoids the formation of a break in the profile of the river, and prevents periodic deposition and cutting of the stream. The basin was of such shape and size as to favor the deposit of material and the growth of brush and trees (see view Fig. 1). While the improvement of the channel alignment has not been fully completed, and no test of the benefit that will be derived from the change has yet been obtained, it is worth note that a freshet during the last of April, 1920, which gave the highest stage at Dayton since 1913, reached a depth above the improvement very appreciably less than previous determinations of flow had indicated for the unimproved channel. Some distance downstream a wide bay-like expansion of the river above the mouth of Wolf Creek, which tended to form a bank in the river opposite the mouth of the creek, is being eliminated by narrowing, while a little farther down, toward the center of Dayton, some fills made many years ago by material excavated from the river bottom contracted the width, and these are to be cut away.

With the same general object of uniformity in mind, care was taken in laying down the alignment of the channel to obtain gradual transition from curve to curve, by interposing sections of tangent. The channel was also slightly widened at the curves.

To allow for the influence of curvature of channel on the transverse water profile, the levees are in some instance being built 6 in. higher on the outside of curves. However, the greatest observed cross slope (as computed from flood levels) is not over 0.3 ft.

Modification at Bridges—To allow for the contraction of waterway at bridges the channel was modified here by slight deepening. Instances of this may be seen in the plan Fig. 5. The flat bottom of the low-water channel is widened out from the normal 150-ft. width, in some cases to practically the full width between levees. and the slopes from channel bottom to levee foot are correspondingly adjusted. In one or two cases, particularly at Main St. Bridge, Hamilton, the channel is also deepened several feet under the bridge.

Scour and Scour Protection—From observations of the effects of the 1913 flood it was concluded that a maximum flood-flow velocity of 8 ft. per sec. might be counted on without introducing serious difficulties in maintaining channel works. This is slightly higher than the flood velocities under the old channel conditions. While the increase would mean scour, scour is not necessarily destructive, it was considered. The action of the river upon its bottom is essentially a replacement of material, the erosion and deposition largely balancing; and the result of this balance is the present stable bed. The same stability, it was held, could be secured still more dependably in the new channel, provided scour at the weakest points of the cross-section were prevented.



FIGS. 6 AND 7. PROFILES AND CROSS-SECTION OF MIAMI RIVER CHANNEL, AS FOUND AND AS IMPROVED

These weak points were the angle at the levee foot, and the piers of bridges.

Two radically different means were adopted for the protection of these points. Along the outside of curves in the channel, and on sections of straight channel where the velocity is extreme, the toe of the levee has concrete scour protection. This consists of two portions: On the levee slope itself, from the foot up to the level where a turf can be maintained, the slope is paved with a solid concrete slab; its average height is 6 ft. (vertical) above the toe of the slope, or 14 ft. above the channel bottom. Stages higher than 5 or 6 ft. seldom last more than a day or two and are not expected to drown the grass. From the toe outward, a flexible mat of concrete is provided. Its intended service is to provide protection against a possible 15-ft. depth of scour near the center of the channel; accordingly the mat is being built from 10 to 30 ft. wide, depending on the location of the low-water channel.

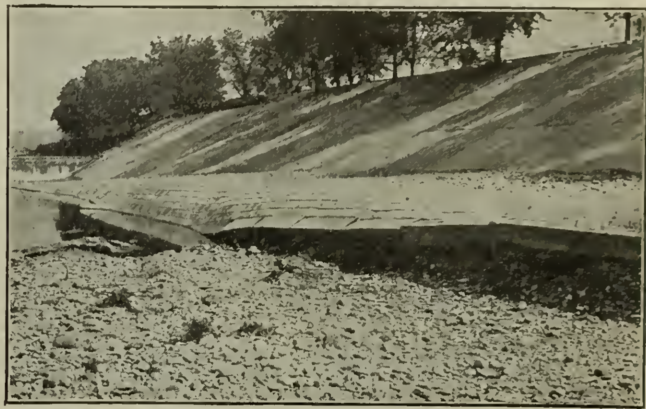
At bridges with shallow pier foundations, protective sheeting around the piers and various methods of underpinning were considered. Finally both these means of protection were rejected, however, and a sill of steel sheeting along the downstream side of the row of piers was adopted, as being both cheaper and safer. It is believed to be safer because longer piles can be driven in the sill than in an inclosure of sheeting around each pier and because the sill retains material between piers and so maintains the support of the pier foundation.

Levees—On account of the short time of exposure of levees to flood stages, along the Miami, the service required of them is not severe. With a few exceptions of damage by local scour, no difficulties had developed in connection with levees in prior floods, so long as they were not overtopped. Nevertheless, for the new levee construction and the levee raising required in the channel improvement, proportions somewhat more ample than those previously customary were adopted.

In the new design the top width is 8 ft. and the side slopes (both water and land sides) are 2:1 for the first 10 ft. from the top, 2½:1 for the next 10 ft. and 3:1 for additional height of slope. No core wall is used, and any of the usual methods of filling are considered acceptable in construction. Where necessary for permanence the soil of the natural ground surface is stripped of organic matter before building the embankment, and the natural surface is always roughened to bond the new embankment. Both slopes are sodded.

Where property damages make sloping bank and levee construction too costly because of space required, retaining walls are built. The foundation soil is in all cases excellent, being a firm gravel; nevertheless piles are driven for the wall foundation support in many cases, as extra protection against a rather remote chance of local undermining by flood currents.

Types of Channel Improvement—Much if not all of the preceding description relates to the work at Dayton and Hamilton, which is essentially a matter of channel enlargement. On the other hand, the local protection of a number of the small towns in the valley is pure levee protection (Miamisburg, Franklin, West Carrolltown, Tippecanoe City). At Piqua, Troy, and Middletown, cities of intermediate size, the local protection is a combination of channel widening and levee construction.



FIGS. 8 AND 9. CONCRETE PROTECTION BELOW ISLAND PARK DAM, AND EFFECT OF APRIL FRESHET ON FLEXIBLE-SLAB MAT

In the planning of the local protection work, property conditions and the like played a controlling part at many points. For this reason the broader engineering deductions that guided the work at Dayton and Hamilton were of little influence on the work at the smaller cities.

Hydraulic Calculations—Following the 1913 flood, when the Miami Conservancy District was formed, the engineers of the District made detail observations of every flood, determined the slopes, measured cross-sections, and calculated values of the roughness factor n of the Kutter formula. From these studies it was concluded that for the old channel the value of n is close to 0.025. The new channel, being smoother and more regular, is likely to have a lower roughness factor, but the same value 0.025 was used in calculations for flow in the improved channel. The effect is that all calculations for future floods indicate higher stages than are likely to be reached, so that the design includes a small extra margin of safety. On the other hand, no allowance has been made in the calculations for extra resistance in the curves of the alignment.

In determining flood profiles for the improved channel, the datum point was usually taken at the downstream end of a section, where the stage for a flood of volume equal to the "controlled maximum" could be approximated by interpolating between the 1898 and 1913 flood-stage marks. Thus, at the lower end of Dayton the elevations of the 1898 flood (90,000 cu.ft. per sec.), and of the 1913 flood (250,000 sec.-ft.) being known, the stage for the future "controlled maximum" with a flow of 125,000 sec.-ft. was interpolated by reference to an

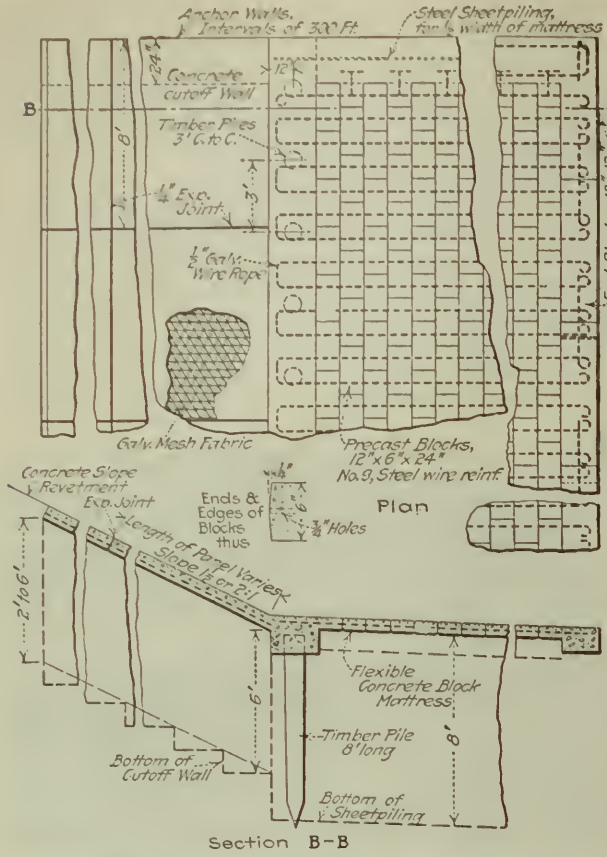


FIG. 10. DETAILS OF LEVEE REVETMENT AND FLEXIBLE CONCRETE MAT

assumed curve of relation between stage and discharge. Then, applying the Kutter formula with the roughness factor of 0.025 already mentioned, the backwater curve was constructed upstream from this point. Any error in the flood stage initially assumed tended to correct itself in a relatively short distance by the resulting adjustment of the rate at which the computed surface slope approached the channel bottom slope.

Under the uniform channel conditions which the construction through Hamilton and Dayton aims to secure, the hydraulic calculations involved no important elements beyond those mentioned. At some other points, however, special devices had to be used for meeting abnormal conditions. For example, in one of the smaller cities the Miami River, which here flows eastward, is crossed by an old highway bridge of inadequate size of waterway. On the north bank, opposite the city, lies a wide strip of land of relatively low elevation which under present conditions is overflowed every few years. In order to protect this land from overflow a levee and a bridge of ample waterway would have been required. The expense did not seem warranted, however, and it was decided to continue the plain north of the river in use as overflow channel. The land was therefore bought and is now being rented for farming purposes.

In making flow calculations for this part of the river, the flood-stage cross-section, consisting of a narrow, deep channel and a wide, shallow extension on one side, was divided into two parts for the computation, as the flow velocity in such a basin is by no means uniform. The main channel was taken as a section with full wetted perimeter, because of the retarding influence of the water in the shallow portion. For the shallow part, however, the hydraulic radius was computed from the bottom and landward side only. The separate discharge calculations for the two parts were added to give the total flow in the cross-section.

The flood project of the Miami Conservancy District is being worked out under the general direction of Arthur E. Morgan, Chief Engineer, and Chas. H. Paul, Assistant Chief Engineer. The details of the channel enlargement plans were worked out largely by J. H. Kimball, Construction Engineer, who has direct supervision over that section of the work.

Points in Elevated Railway Design From Philadelphia Experience

IN designing the new Woodland Ave. elevated structure of the Darby line which is to be built as an extension of Philadelphia's rapid-transit system, the engineers of the city's Department of Transit are making specific application of certain experiences resulting from the construction of the Frankford elevated line and the earlier Market St. line. The principal points in question are those relating to station-entrance location, cross-bent construction, and floor construction.

All station entrances of the Frankford elevated line were placed off the street area, to avoid obstructing the sidewalk with stairs, as the sidewalks are generally not over 12 ft. wide. But placing the entrances within the block area proved very costly. Land damages (fixed by condemnation proceedings) were in some cases as high as three times the assessed valuation of the properties taken; and, further, the buildings housing the entrances turned out to be rather expensive as mere stair enclosures and waiting rooms. For these reasons it has been decided to place the station entrances of the Woodland Ave. line on the sidewalks, which on that street are 18 ft. wide, says H. H. Quimby, chief engineer of the Department of City Transit, in the annual report of the department just issued. Mezzanine floor stations will probably be adopted, having fare-collector booths and other public facilities on a floor intermediate between the street and the track floor. This type, which is low in first cost and economical in operation, since one fare collector will serve traffic in both directions during slack hours, is considered to have proved satisfactory in its use on the more recent elevated lines in New York and Brooklyn.

Single-column bents were used on a part of the Frankford line to avoid obstructing the sidewalks by having columns near the curbs. This type was adopted there because of the urgent demand of local business men's associations and because of the exceptional narrowness of the sidewalks. However, it is not regarded as a desirable type, states Mr. Quimby, because of the impracticability of making it satisfactorily rigid and because of its obstruction to vehicular traffic. The bent consists of a wide base section or shoe, a column 5 ft. wide, and a cap bracketed out to carry the longitudinal track girders. The deflection of such a bent when carrying a train on only one track, which amounts to about $\frac{1}{8}$ to $\frac{3}{16}$ in., is distinctly perceptible and is considered undesirably large. Further, the 5-ft. width of column in the middle of the street reduces the effective width of the roadway excessively and tends to prevent fast-moving vehicles from passing others. Since the wider sidewalks of Woodland Ave. make side columns unobjectionable, the ordinary bent construction with trans-

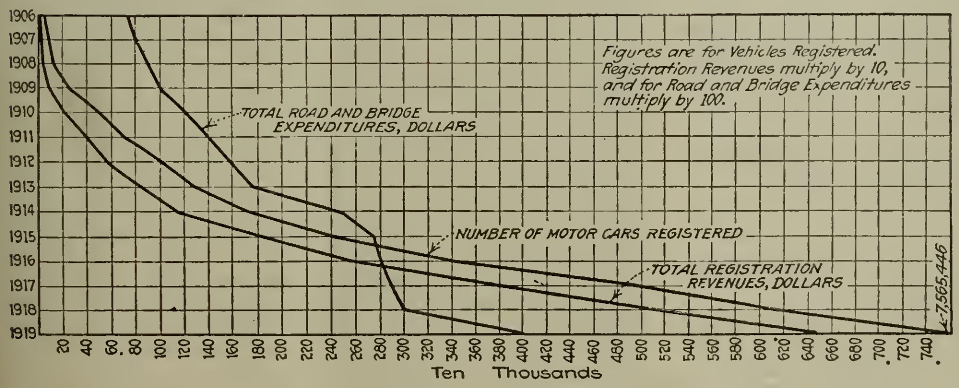
verse main girders carried by columns at the curb line is being adopted.

Ballasted solid-slab deck construction is to be used in general on the Woodland Ave. line "to give a high grade of street protection against dirt and noise, with economy of expenditure." The ballasted solid floor has proved very successful on the Market St. elevated line between the Schuylkill River and 63rd St. and is regarded as being the least noisy type. However, in front of station platforms, where trains are expected to be less noisy because they slacken speed and where litter is apt to accumulate and the track must be cleaned frequently, and at one or two other points, the track will be of subway type, with rails carried on short wood blocks embedded in concrete; this type, though costing a little more than the ballasted floor construction, is expected to be cheaper in maintenance and "may prove to be equally as quiet as the ballasted track." The concrete deck in either case consists of small arches carried on transverse steel beams, with concrete curb along either edge to retain the ballast. Mr. Quimby describes this construction as economical and substantial, having been found so not only on the elevated lines but also on many of the Philadelphia bridges.

States Register 7,565,446 Motor Vehicles During 1919

A TOTAL of 7,565,446 motor cars, including commercial vehicles, and 241,038 motorcycles were registered in 1919 in the forty-eight states and the District of Columbia. The registration and license fees, including those for chauffeurs, operators, and dealers, amounted to a total of $64,697,255.58. There are about 2,475,000 mi. of roads in the United States outside towns and cities, or an average of 3 cars per mile.

Compared with 1918 the data for 1919 represents an increase of 23 per cent, or 1,418,829 motor vehicles. This increase alone represents about 10 per cent more cars than the total number registered in the United States during the calendar year 1913. In this connection it is interesting to note that the number of cars registered during 1919 in the two states of New York and Pennsylvania exceeded the total number of cars registered in the entire United States in 1912, while the revenues derived from the New York and Pennsylvania registrations during 1919 were about double those derived from all motor vehicle registration and licenses in the entire United States in 1912. The revenues derived from all registration and licenses during the year 1919 exceed those of 1918 by 20 per cent, or a total of $13,219,838.97. In 1914 the total gross revenues collected amounted to only $12,381,951.



MOTOR VEHICLE INCREASE 1906-1919

The increase in motor car registration and revenues in the United States during the past dozen years presents many intersting comparisons. This is especially true in respect to the use made of the revenues. In 1906 the total registrations were approximately 48,000 cars, paying a gross revenue of about $193,000, or slightly more than that collected during 1919 by the state of Arizona. Furthermore, in 1906 the gross registration revenues were equivalent to less than three-tenths of 1 per cent of the total road and bridge expenditures for that year. In 1919 the motor vehicle revenues represented approximately 16 per cent of the total road and bridge expenditures for the year. Furthermore, while in 1906 practically none of the motor vehicle revenues were applied to road maintenance and construction, in 1919 more than 92 per cent of the gross returns, or $59,907,136.18 was devoted to this purpose, and of the total amount applied to road work, 70 per cent was expended more or less directly or under the control or supervision of the state highway departments. The remaining 8 per cent not applied to road work was expended very largely for number plates and carrying out the provisions of the motor vehicle registration laws of the state.

The approximate relations and rates of variation of the three factors—total rural road and bridge expenditure, motor vehicle registration and license revenues, and number of motor car registrations from 1903 to 1919, inclusive—are shown graphically on the accompanying chart.—*Public Roads.*

Lumbermen for American Forest Policy

A declaration for "an American forest policy which shall substitute for indifference and accident an intelligent, practical, equitable, and concerted program for the perpetuation of the forests" was made at the recent convention of the National Lumber Manufacturers' Association (Chicago) which represents about 75 per cent of the privately owned timberlands of the United States. Their platform contained this declaration.

The lumbermen believe:

That growing future timber crops must be largely, though by no means wholly, a Government [Federal] and state function;

That Government and states should be permitted to condemn any deforested land classified as suitable chiefly for forest growing and pay for it at prices comparable to those paid in voluntary transactions;

That land classification and studies should be undertaken jointly by industry, states and by the Government.

That the Forest Service should be the recognized leader of public forestry thought and effort along general lines;

That wise conservation requires the determination of better methods of waste prevention and of utilization of the forests we already have;

That a successful forest policy means much more than tree-growing. It means confidence and security in every legal and commercial phase, to industry and public alike.

New York City Concrete Flat-Slab Regulations

New Standards Adopted for All Boroughs of City After Conference with Engineers and Architects

REGULATIONS for the design of reinforced-concrete girderless or flat-slab floors have been adopted by the Board of Standards and Appeals of New York City for the uniform use of all the boroughs of the city. They went into effect Aug. 2, 1920, and superseded all previous regulations in force in the various boroughs. The new regulations were the result of a number of conferences between the city board and a committee of architects and engineers.

VARIOUS MOMENT FACTORS FOR CONCRETE FLAT SLABS

Capital = 0.225 L
Drop = 0.33 L

Authority	Moment Sections: 2-Col. Head	Midspan	Inner	2 Outer	Total Moment	Remarks
New York City 1920 Rules	—1/32	—1/133	+1/133	+1/80	1/17	
Bor. of Manhattan, Old Rules	—1/24	—1/140	+1/140	+1/48	1/13	
Chicago	—1/30	—1/120	+1/120	+1/60	1/15	On basis of f_s = 18,000
Philadelphia	—1/32	—1/128	+1/128	+1/80	1/16.9	
Pittsburgh	—1/29.6	....	+1/128	+1/64	1/15.4	
Detroit	—1/31	—1/116	+1/116	+1/62	1/15.3	
St. Louis	—1/33	—1/133	+1/133	+1/67	1/16.6	
Joint Committee	—1/26*	—1/104	+1/138	+1/58	1/13	Pos. Mom. = 37½% total ± Neg. Mom. = 62½% total.
Joint Committee	—1/32†	....	....	....	......	
Am. Conc. Inst.	—1/30.8*	—1/154	+1/128	+1/85.5	1/15.4	Pos. Mom. = 33⅓% total.‡ Neg. Mom. = 66⅔% total.
Am. Conc. Inst.	—1/38.5†	....	....	....	......	

* With drop panel. † Without drop panel. ± Minimum specified values for each section.

In connection with the new regulations there is also shown a table giving the moment coefficients in a number of the regulations standard in different sections of the country.

Rule 1. Application. The rules governing the design of reinforced-concrete flat slabs shall apply to such floors and roofs, consisting of three or more rows of slabs, without beams or girders, supported on columns, the construction being continuous over the columns and forming with them a monolithic structure.

Rule 2. Compliance with Building Code. In the design of reinforced-concrete flat slabs, the provisions of article 16 of the building code shall govern with respect to such matters as are specified therein.

Rule 3. Assumptions. In calculations for the strength of reinforced-concrete flat slabs, the following assumptions shall be made:

(a) A plane section before bending remains plane after bending;

(b) The modulus of elasticity of concrete in compression within the allowable working stresses is constant;

(c) The adhesion between concrete and reinforcement is perfect;

(d) The tensile strength of concrete is nil;

(e) Initial stress in the reinforcement due to contraction or expansion in the concrete is negligible.

Rule 4. Stresses. (a) The allowable unit shear in reinforced concrete flat slabs on *bd* section around the perimeter of the column capital shall not exceed 120 lb. per square inch; and the allowable unit shearing stress on the *bjd* section around the perimeter of the drop shall not exceed 60 lb. per square inch, provided that the reinforcement is so arranged or anchored that the stress may be fully developed for both positive and negative moments.

(b) The extreme fiber stress to be used in concrete in compression at the column head section shall not exceed 750 lb. per square inch.

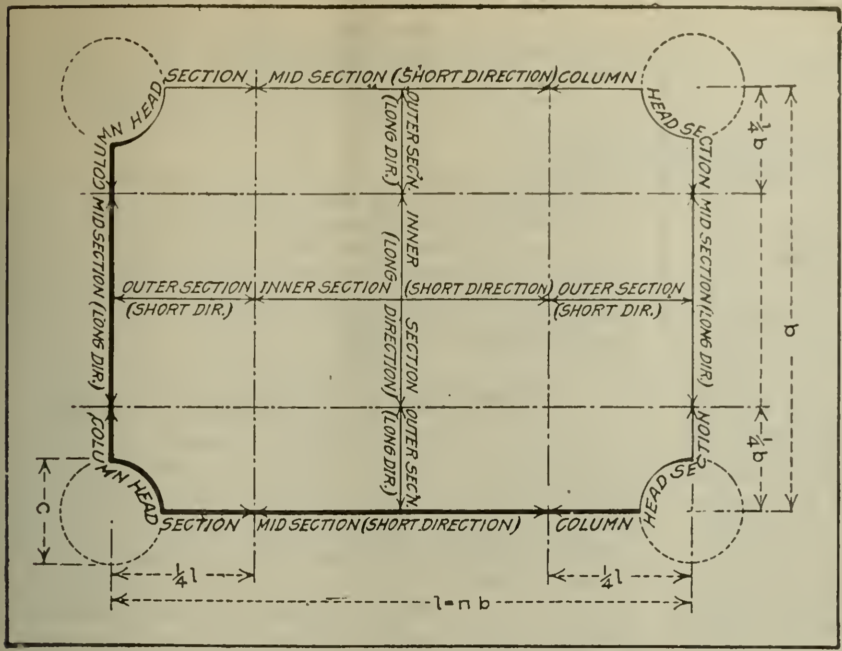
Rule 5. Columns. For columns supporting reinforced-concrete flat slabs, the least dimension of any column shall be not less than one-fifteenth of the average span of any slab supported by the columns; but in no case shall such least dimension of any interior column supporting a floor or roof be less than 16 in. when round nor 14 in. when square; nor shall the least dimension of any exterior column be less than 14 in.

Rule 6. Column Capital. Every reinforced-concrete column supporting a flat slab shall be provided with a capital whose diameter is not less than 0.225 of the average span of any slabs supported by it. Such diameter shall be measured where the vertical thickness of the capital is at least 1½ in., and shall be the diameter of the inscribed circle in that horizontal plane. The slope of the capital considered effective below the point where its diameter is measured shall nowhere make an angle with the vertical of more than 45 deg. In case a cap of less dimensions than hereinafter described as a drop, is placed above the column capital, the part of this cap enclosed within the lines of the column capital extended upward to the bottom of the slab or drop at the slope of 45 deg. may be considered as part of the column capital in determining the diameter for design purposes.

Rule 7. Drop. When a reinforced-concrete flat slab is thicker in that portion adjacent to or surrounding the column, the thickened portion shall be known as a drop. The width of such drop when used, shall be determined by the shearing stress in the slab around the perimeter of the drop, but in no case shall the width be less than 0.33 of the average span of any slabs of which it forms a part. In computing the thickness of drop required by the negative moment on the column head section, the width of the drop only shall be considered as effective in resisting the compressive stress, but in no case shall the thickness of such drops be less than 0.33 of the thickness of the slab. Where drops are used over interior columns, corresponding drops shall be employed over exterior columns and shall extend to the one-sixth point of the panel from the center of the column.

Rule 8. Slab Thickness. The thickness of a reinforced-concrete flat slab shall be not less than that derived by the formula $t = 0.024\, L \sqrt{w} + 1\frac{1}{2}$ for slabs without drops, and $t = 0.02\, L \sqrt{w} + 1$ for slabs with drops, in which t is the thickness of the slab in inches, L is the average span of the slab in feet, and w is the total live and dead load in pounds per square foot; but in no case shall this thickness be less than one-thirty-second of the average span of the slab for floors, nor less than one-fortieth of the average span of the slab for roofs, nor less than 6 in. for floors nor less than 5 in. for roofs.

Rule 9. Reinforcement. (a) In the calculation of moments at any section, all the reinforcing bars which cross that section may be used, provided that such bars extend far enough on each side of such section to develop the full amount of the stress at that section. The effective area of the reinforcement at any moment section shall be the sectional area of the bars crossing such section multiplied by the sine of the angle of such bars with the plane of the section. The distribution of the reinforcement of the several bands shall be arranged to fully provide for the intermediate moments at any section.



PLAN OF FLAT SLAB SHOWING NOTATION

(b) Splices in bars may be made wherever convenient but preferably at points of minimum stress. The length of any splice shall be not less than 80 bar diameters and in no case less than 2 ft. The splicing of adjacent bars shall be avoided as far as possible. Slab bars which are lapped over the column, the sectional area of both being included in the calculation for negative moment, shall extend to the lines of inflection beyond the column center.

(c) When the reinforcement is arranged in bands, at least 50 per cent of the bars in any band shall be of a length not less than the distance center to center of columns measured rectangularly and diagonally; no bars used as positive reinforcement shall be of a length less than one-half the panel length plus 40 bar diameters for cross bands, or less than seven-tenths of the panel length plus 40 bar diameters for diagonal bands and no bars used as negative reinforcement shall be of a length less than one-half the panel length. All reinforcement framing perpendicular to the wall in exterior panels shall extend to the outer edge of the panel and shall be hooked or otherwise anchored.

(d) Adequate means shall be provided for properly maintaining all slab reinforcement in the position as assumed by the computations.

Rule 10. Line of Inflection. In the design of reinforced-concrete flat-slab construction, for the purpose of making calculations of the bending moments at sections other than defined in these rules, the line of inflection shall be considered as being located one-quarter the distance, center to center, of columns, rectangularly and diagonally, from center of columns for panels without drops, and three-tenths of such distance for panels with drops.

Rule 11. Moment Sections. For the purpose of design of reinforced-concrete flat slabs, that portion of the section across panel, along a line midway between columns, which lies within the middle two quarters of the width of the panel shall be known as the inner section, and those portions of the section in the two outer quarters of the width of the panel shall be known as the outer sections. Of the section which follows a panel edge from column to column and which includes the quarter perimeters of the edges of the column capitals, that portion within the middle two quarters of the panel width shall be known as the mid section and the two remaining portions, each having a projected width equal to one-quarter of the panel width, shall be known as the column head sections.

Rule 12. Bending Moments. In the design the following provisions with respect to bending moments shall be observed. In the moment expressions used:

W is the total dead and live load on the panel under consideration, including the weight of drop whether a square, rectangle or parallelogram;

W_1 is the total live load on the panel under consideration;

L is the length of side of a square panel center to center of columns; or the average span of a rectangular panel which is the mean length of the two sides;

n is the ratio of the greater to the less dimension of the panel;

h is the unsupported length of a column in inches, measured from top of slab to base of capital;

I is the moment of inertia of the reinforced-concrete column section.

A. Interior Square Panels. The numerical sum of the positive and negative moments shall be not less than 1/17 $W L$. A variation of plus or minus 5 per cent shall be permitted in the expression for the moment on any section, but in no case shall the sum of the negative moment be less than 66 per cent of the total moment, nor the sum of the positive moments be less than 34 per cent of the total moments for slabs with drops; nor shall the sum of the negative moments be less than 60 per cent of the total moment, nor the sum of the positive moments be less than 40 per cent of the total moment for slabs without drops.

1. In *two-way systems*, for slabs with drops, the negative moment resisted on two column head sections shall be − 1/32 $W L$; the negative moment on the mid section shall be −1/133 $W L$; the positive moment on the two outer sections shall be + 1/80 $W L$ and the positive moment on the inner section shall be + 1/133 $W L$ and for slabs without drops, the negative moment resisted on two column head sections shall be − 1/36 $W L$, the negative moment on the mid section shall be − 1/133 $W L$, the positive moment on the two outer sections shall be + 1/63 $W L$ and the positive moment on the inner sections shall be + 1/133 $W L$.

2. In *four-way systems*, the negative moments shall be as specified for two-way systems; the positive moment on the two outer sections shall be + 1/100 $W L$, and the positive moment on the inner section shall be + 1/100 $W L$ for slabs with drops; and the positive moment on the two outer sections shall be + 1/74 $W L$, and the positive moment on the inner section shall be + 1/100 $W L$, for slabs without drops.

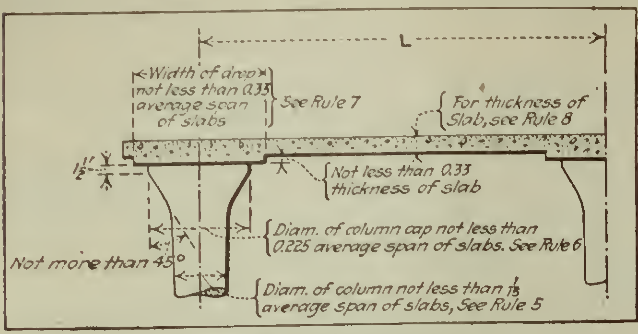
3. In *three-way systems*, the negative moment on the column head and mid sections and the positive moment on the two outer sections, shall be as specified for four-way systems. In the expression for the bending moments on the various sections, the length L shall be assumed as the distance center to center of columns, and the load W as the load on the parallelogram panel.

B. Interior Rectangular Panels.

1. When the ratio n does not exceed 1.1, all computations shall be based on a square panel of a length equal to the average span, and the reinforcement shall be equally distributed in the short and long directions according to the bending moment coefficients specified for interior square panels.

2. When the ratio n lies between 1.1 and 1.33, the bending moment coefficients specified for interior square panels shall be applied in the following manner:

(a) In *two-way systems*, the negative moments on the two column head sections and the mid section and the positive moment on the two outer sections and the inner section at right angles to the long direction shall be determined as for a square panel of a length equal to the greater dimension of the rectangular panel; and



SECTION THROUGH SLAB

the corresponding moments on the sections at right angles to the short direction shall be determined as for a square panel of a length equal to the lesser dimension of the rectangular panel. In no case shall the amount of reinforcement in the short direction be less than two-thirds of that in the long direction. The load W shall be taken as the load on the rectangular panel under consideration.

(b) In *four-way systems*, for the rectangular bands, the negative moment on the column head sections and the positive moment on the outer sections shall be determined in the same manner as indicated for *two-way systems*.

For the diagonal bands, the negative moments on the column head and the mid sections and the positive moment on the inner section shall be determined as for a square panel of a length equal to the average span of the rectangle. The load W shall be taken as the load on the rectangular panel under consideration.

(c) In *three-way systems*, the negative and positive moments on the bands running parallel to the long direction shall be determined as for a square whose side is equal to the greater dimension; and the moments on the bands running parallel to the short direction shall be determined as for a square whose side is equal to the lesser dimension. The load W shall be taken as the load on the parallelogram panel under consideration.

C. Exterior Panels. The negative moments at the first interior row of columns and the positive moments at the center of the exterior panels on moment sections parallel to the wall, shall be increased 20 per cent over those specified above for interior panels. The negative moment on moment sections at the wall and parallel thereto shall be determined by the conditions of restraint, but the negative moment on the mid section shall never be considered less than 50 per cent and the negative moment on the column head section never less than 80 per cent of the corresponding moments at the first interior row of columns.

D. Interior Columns shall be designed for the bending moment developed by unequally loaded panels, eccentric loading or uneven spacing of columns. The bending moment resulting from unequally loaded panels shall be considered as $1/40\ W_1\ L$, and shall be resisted by the columns immediately above and below the floor line under consideration in direct proportion to the values of their ratios of I/h.

E. Wall Columns shall be designed to resist bending in the same manner as interior columns, except that W shall be substituted for W_1 in the formula for the moment. The moment so computed may be reduced by the counter moment of the weight of the structure which projects beyond the center line of the wall columns.

F. Roofing Columns shall be designed to resist the total moment resulting from unequally loaded panels, as expressed by the formula in paragraphs D and E of this rule.

Rule 13. Walls and Openings. In the design and construction of reinforced-concrete flat slabs, additional slab thickness, girders or beams shall be provided to carry any walls or concentrated loads in addition to the specified uniform live and dead loads. Such girders or beams shall be assumed to carry 20 per cent of the total live and dead panel load in addition to the wall load. Beams shall also be provided in case openings in the floor reduce the working strength of the slab below the prescribed carrying capacity.

Rule 14. Special Panels. For structures having a width of less than three rows of slabs, or in which exterior drops, capitals or columns are omitted, or in which irregular or special panels are used, and for which the rules relating to the design of reinforced flat slabs do not directly apply, the computations in the analysis of the design of such panels shall, when so required, be filed with the superintendent of buildings.

Wire Mesh Army Roads in Egypt

By T. McLean Jasper
Assistant Professor of Mechanics, University of Wisconsin

LOOSE sand, smoothed and leveled and then covered with chicken netting, firmly pegged down, made roads which gave such good service during the British Army operations in Egypt and Palestine that this method of construction appears to offer possibilities for temporary roads for construction and engineering operations where travel over sand is necessary. Brief descriptions of the military roads received in letters from Brig. Gen. P. Link, of the Britsh Army, and Capt. Arthur Roberts, of Mather & Platt, Ltd., engineers, Manchester, England, furnish the following information:

As laid down by the army troops, states Capt. Roberts, the best results were obtained with chicken netting of about ¾-in. mesh. This netting, 2½ or 3 ft. wide, came in rolls and four or five rolls placed end to end were unrolled along the route so as to cover a strip about 12 or 15 ft. wide. The joining edges of the netting were fastened together either by clipping on loops of wire at about 3-ft. intervals or by a continuous wire woven in and out of the two edges. At intervals of about 5 ft. the outside edges were pegged down with 1½-in. stakes from 12 to 18 in. long. Roads so constructed were perfectly satisfactory for infantry but were badly damaged if horses or cars were driven over them. The life of these roads is difficult to state. Captain Roberts mentions one which had been marched over daily by 3,000 or 4,000 men and was in good condition after six months' use. Other roads, however, failed quite soon.

General Link mentions that the grade is leveled and smoothed before the netting is laid. No hollows should be left under the netting and the netting should be securely pegged down. As ruts form, the netting is lifted and the sand releveled. The netting lasts from three to six months, depending on the volume of traffic. Roads of this type, General Link points out, are of use only for mechanical transport with pneumatic tires; horse and wheel transport destroy them almost at once.

The World's Rainfall

The total annual rainfall upon all the land of the globe amounts to 29,347 cu.mi., according to a recent statement by the U. S. Geological Survey. Of this quantity, 6,524 cu.mi. drain off through rivers to the sea. A cubic mile of river water weighs about 4,205,650,000 tons and carries in solution an average of about 420,000 tons of foreign matter. In all, approximately 2,735,000,000 tons of solid matter are thus carried annually tc the ocean.

Notes on the French Highway System

BY
E. J. Mehren
EDITOR, ENGINEERING NEWS-RECORD

THE French road system was in bad condition after the war. In the war zone the highways were, necessarily, under continual maintenance, but elsewhere little or no attention could be given them. The restoration (bridges included) to pre-war condition will cost about 1,000,000,000 francs, assuming that the same type will be used as before the war—to waterbound macadam and stone-block. The work of restoration is now in hand, and good progress is being made. In the devastated regions there were new roads—stone-block chiefly—in such good condition that with a stiff-spring automobile —a *very* stiff-spring automobile—one could go along in comfort at 35 to 40 miles per hour.

As is well known, the French roads are paved chiefly with waterbound macadam. On the national highway system, the *routes nationales,* out of a total length of 38,000 km. the types comprised about 5,000 km. stone paved, 1,000 km. tar-sprayed waterbound macadam and the remainder, 32,000 km., waterbound macadam. The growing motor traffic, however, is forcing the preparation of plans for extensive strengthening of surfaces. Even now, though, the French traffic is very light compared with that of the United States or England. In the whole of France there are about 40,000 motor trucks and 100,000 passenger automobiles. Most of these operate only in the cities—the tremendous fleet of Paris taxis, for example, scarcely using the country roads at all

The French experience is, therefore, of relatively little value to us. On the other hand, we have much to learn from English experience, as has been pointed out in recent articles in the *Engineering News-Record.*

Strengthening of Surfaces

The plans being considered contemplate an extensive use of surface treatment, of asphalt macadam, of sheet asphalt and an extension of the mileage of stone-block pavement. The plans are not matured and, obviously, have not been put before the Parliament, but tentative estimates indicate that at present prices the strengthening of the more important routes will cost about 1,500,000,000 francs to be spent during six or seven years.

There is in France, because of our experience, considerable interest in concrete roads, but the attitude is a doubting one; in the surface-strengthening program concrete is not one of the types included. The general opinion is that it is unsuited to horse-drawn traffic, and the French engineers still remained incredulous after being told that in our farming districts objections from the farmers have totally disappeared.

However, they are giving concrete serious study and experimental sections will undoubtedly be laid. M. P. LeGavrian, *ingénieur en chef des Ponts et Chaussées,* has in fact just returned from a trip to northern Italy to study a patented type of concrete road being laid there.

In considerable favor is an asphaltic carpeting, 5 cm. (2-in.) thick, called "Mexphalt." It is virtually a sheet-asphalt wearing surface. Here, by the way, as in England, the new surfacing will be laid, not on concrete foundations, but on the old macadam, and for the same reason, that their well-matured roads make excellent foundations. By the end of this year there will be about 100 km. of Mexphalt surfacing, laid at a cost, including the reshaping of the old macadam, of 25 francs per square meter ($4.17 per square yard, normal exchange), as against 10 francs ($1.67) before the war.

The stone-block, so largely used in the north of France, consisting of porpyhry, granite and *grés* (the last being the same fine-grained sandstone used in Belgium), measure, generally, 14 x 20 cm., with depths varying from 11 to 16 cm. (5.5 x 7.9 in., by 4.3 to 6.3 in.) in depth. The cost is now 50 to 60 francs per square meter, against a pre-war figure of 18 to 19 francs. Stone-block pavements, under French traffic, have heretofore given from 20 to 24 years' service.

Cost of Macadam Roads

Naturally one is much intersted in the cost of the waterbound macadam roads—roads which have won such fame for France among highway engineers. Here are figures for stretches near Paris, where the passenger automobile traffic is considered very heavy, say a maximum of 1,000 cars a day, with probably 150 motor trucks. Under such conditions it is found necessary every three years to resurface the roads, while at all times a patrol system is maintained. The patrol work, if a patrolman has a 3-km. length (under the densest traffic this would be reduced to 2 km.), costs 400 francs per kilometer per year, or about $133 per mile per year. The resurfacing, 10 cm. (4-in.) thick, costs about 3 francs per square meter, and since it must be renewed every 3 years, the annual cost is 1 franc per square meter per year. This gives a resurfacing cost for an 18-ft. width of about $1,750 per mile per year. The cost of the maintenance stone used by the patrolman may be considered negligible. The total cost per mile per year, then, is $1,750 + $133 or $1,883. It must be remembered that this is not the average cost for French roads, but for roads under what they consider heavy traffic. Such a section has been purposely selected in order to afford some comparison without traffic conditions. *The figures are pre-war costs.*

French macadam roads, therefore, under traffic conditions similar to ours show an equally high maintenance cost, which, of course, one would have been justified in predicting.

Regarding the national road system generally, I was interested in learning why our engineers who had been in France during the war were very reticent about the roads. We had, in the past, heard so much about the *routes nationales* that one expected extended commentaries from the returned engineer officers. But the comments were not forthcoming. Particularly did one expect comment on the matter of drainage, for which France has a high reputation. The reason for the re-

ticence is simply this: That there is little to say that we do not already know. The roads, long under careful maintenance, have in the course of years been well drained, but the methods are those standard with us—ditches, longitudinal tile and French drains, and herringbone drainage. The only point to be emphasized is that *they have actually applied these methods*. They have not merely considered them beautiful theories.

Again, with reference to their macadam construction, there is nothing mysterious. Under light traffic and good maintenance it gives good service at relatively low cost; under passenger automobile traffic the maintenance cost is high; under heavy motor-trucks in wet weather, as was proved during the war, the crusts break through and the road goes to pieces, just as with us.

There was disagreement among our engineers who had served in the A. E. F. as to the thickness of the stone crusts on French roads. Some said they were very thin; others had seen depths of 12 in. Very likely both claims were correct. There are thin crusts and thick crusts, but the engineers of the *Direction des Ponts et Chaussées* stated that as a rule the crusts are relatively thin, that resurfacing is done only when the crust has worn considerably. Probably these crusts will not average more than 7 in., for the depth of stone laid in resurfacing is only 10 cm. (4 in.).

Motor Vehicles

Naturally the regulation of motor vehicles is receiving serious consideration. At present there is a maximum speed limit of 18 miles per hour, but it is constantly violated. New regulations will shortly be promulgated and it is expected that different maximum speeds will be set for vehicles of different weights. Under these new regulations maximum loads per centimeter width of tire will be stipulated. The figure will probably be 150 kg. per centimeter width (825 lb. per inch width) whether the tire be of steel or rubber. It is probable that a maximum limiting gross weight will not be set.

In addition to the *routes nationales* built and maintained at the sole cost of the National Government (even, as in Belgium where they run through cities), there are two subsidiary highway systems: (1) the *chemins vicinaux*, built and maintained by the departments, and (2) the *chemins rurals*, maintained by the villages and local communities. Except in the north and in the mountain sections in the east and northeast, where stone-block is used, these subordinate systems use water-bound macadam exclusively.

In general, therefore, while the French highway system was a very excellent one for horse-drawn traffic, the surfaces must now be materially strengthened. In this respect the experience is the same as our own and that of England.

City Planning Progress at Indianapolis

The Board of Directors of the Indianapolis Chamber of Commerce has indorsed city planning recommendations submitted by a subcommittee of the Chamber's Municipal Research Committee. The directors have asked the subcommittee to work out a definite program for consideration by the board. Some of the subjects already taken up by the subcommittee are specially constructed streets for trucking, expansion of railroad terminals, industrial housing, zoning, the elimination of jogs in streets, and the grouping of civic centers. Frank Noll is chairman of the subcommittee.

Three State Courts Hold Cities May Regulate Garbage Disposal

THE State Supreme Courts of Missouri, Michigan and Utah have recently upheld contracts for garbage disposal that entitled the contractors to all garbage produced, notwithstanding the contention of some that the garbage was their own private property. These decisions were noted in *Public Health Reports* for May 28, June 4, and June 18, 1920.

The first case centered in an ordinance of the City of Joplin, Mo. (Valley Spring Hog Ranch Co. *v.* Plagmann et al., 220 S. W., 1), providing that the city may "contract with a suitable person, firm or corporation, for the exclusive right to dispose of the garbage of the city." The defendant in this case removed garbage in defiance of the ordinance, contending that the ordinance was void because it authorized the city to make an exclusive contract and because it was destructive of property rights. The State Supreme Court denied the injunction, holding that the city, in the language of *Public Health Reports*, "is exercising its police power in the interests of the public health and is not establishing a monopoly; and "that the value of the owner's rights in garbage [quoting now from the decision] 'is so inconsequential that they are absorbed and lost in the greater rights of the state to protect such owner and the public at large from the dire effects of improper methods in the handling and disposition of the same.' "

The Michigan Supreme Court decision (Pantlind, et al *v.* City of Grand Rapids, 177 M. W., 302) is thus summarized by *Public Health Reports*:

> The plaintiffs, proprietors of hotels and restaurants, conveyed to their farms outside the city and there fed to hogs and poultry the garbage from such hotels and restaurants. This was done in a cleanly manner, but was in violation of an ordinance of the city of Grand Rapids, and plaintiffs were notified by the city to discontinue such conveyance and disposal of their garbage.
>
> The plaintiffs thereupon sought an injunction to restrain the city from interfering. The lower court granted an injunction, but on appeal the supreme court reversed the decree and enjoined plaintiffs from conveying the garbage through the streets and from violating the garbage ordinance in any manner.
>
> In answer to the contention of plaintiffs that they had a right to dispose of garbage produced upon their own premises because it was property of value, and that as to them the ordinance was wanting in the due process of law required by the Constitution, the supreme court held that the city had the right to regulate the disposal of garbage and that the plaintiffs were compensated for any loss in the common benefit secured by the ordinance.

The Utah Supreme Court decision (Salt Lake City *v.* Bernhagen, 189 Pac., 583) is not summarized in detail in *Public Health Reports*, but the note on the subject indicates that this case is similar, at least in the general effect of the decision, to those already summarized.

Federal-Aid Road Work

According to information recently made public by the Bureau of Public Roads, up to May 1, 1920, various states had filed with the bureau 2,885 project statements, of which 2,790 had been approved, representing 27,796 mi. of highway. Practically two-thirds of that number of project statements have been submitted within the past year. Up to May 1 of this year progress agreements had been actually executed and construction started upon 1,569 projects aggregating 11,987 mi.

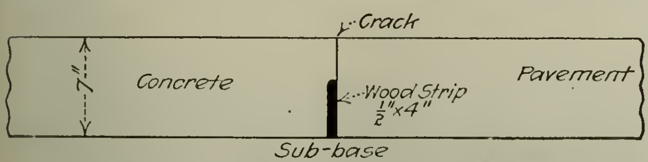
Concealed Joints in Road Slab Limit Surface Cracks

Extra Durable Road Procured by Wood Floating a Sifted Layer of Cement and Sand Into Green Concrete

By Samuel H. Lea
County Road Engineer, Keyser, W. Va.

CONCEALED weather-board joints and a float finish over dry sifted mortar produced a notably durable surface on the concrete road recently completed between Keyser and Piedmont, W. Va. Portions of the road which have carried heavy traffic for two years show no signs of wear. The surface is homogeneous and without breaks. These excellent results are attributed largely to the dry-mix float finish and to the unusual joint construction adopted.

The pavement is of one-course 1 : 2 : 4 concrete. It is 15 ft. wide, 5¼ in. thick at the sides and 7 in. thick



WEATHERBOARD, SET BASE DOWN, FORMS CONCEALED JOINT

at the center. A hard, calcareous sandstone, occurring locally, was crushed on the job and used for coarse aggregate; the sand manufactured from sandstone at the quarries was purchased. Construction was carried on at two different periods from 1917 to 1919.

On the work done in 1917, transverse expansion joints were made at 50-ft. intervals except when there was a temporary stoppage or work was discontinued at night. In such cases the spacing between joints varied from 35 to 75 ft. Joints were filled with ¼ in., prepared joint filler cut to proper shape and projecting ½ in. above the pavement.

After resuming work in 1919, concealed joints were used. At the beginning of each day's work the stop board, which had been left in place, was removed and a strip of weatherboard ½ in. thick was placed, thick edge down, against the face of the old concrete, the top of the board being 3 in. below the surface of the pavement at the center of the road. The new concrete was placed directly against the face of the old work, covering the wooden strip and forming an unbroken surface with the old work. Two days after placing the joint a thin crack appeared on the surface of the pavement directly above each wooden strip. These cracks are like fine lines, and are straight across the pavement. During the ten months since the completion of work these joints have been closely observed. Last fall they were filled or covered over with melted tar but no appreciable widening was noticed.

Aside from the joints, the construction was the same during both working periods. The concrete was mixed quite stiff and after being shoveled into place, was struck off and tamped with a wooden templet weighing 250 lb. The strikeboard after advancing a few feet, while being alternately raised and lowered, was brought back and again moved forward, while being sawed across the roadway. A roller was used to remove excess water from the concrete. The first rolling was about 30 min. behind the templet and two subsequent rollings followed at intervals of about 20 min. After rolling, a dry mix composed of 1 part sand and 1 part cement was distributed evenly through a sieve over the concrete surface, which was then floated by the finisher from a bridge. Wooden floats were used and the dry mix was thoroughly rubbed into the concrete, absorbing any water remaining after the roller and forming a hard, durable surface.

That portion of the road built in 1917 shows no signs of wear although it has been subjected to a heavy traffic. This durability is largely attributed to the method of surface finish used. By using concealed joints, a homogeneous surface was obtained whose continuity is not marred by breaks or inequalities. The cracks form joints that are sufficiently narrow to prevent the passage of much water from the surface through them. The wooden strips prevent the penetration of water to the subgrade. They are sufficiently compressible to take care of ordinary expansion stresses. The joints have passed through one summer without injury, and it is hoped they will continue to function. In future work it is probable that a prepared joint filler will be used in place of wood for the concealed joints.

Water Supply and Disease in Rumania

AN INVESTIGATION of the sanitary conditions in Rumania, especially in regard to the menace of infectious diseases, has been made by Prof. George C. Whipple, as chief of the sanitation department of the League of Red Cross Societies. His report, as published in the League's bulletin for June, includes the following:

Prior to the war the country had a good history as to this disease [cholera]. The large cities were well supplied with water, many of these supplies being taken from safe subterranean sources, and the river water supplies being filtered. Since the war the water supply situation has been very bad. The supply at Bucharest is of safe quality but the population of the city has so increased that the supply is inadequate. At certain hours no water will run from the taps in many parts of the city. At Constantza the pumps are out of commission and the people are dependent upon the sale of bottled water from local wells, which are always likely to be contaminated, especially if drawn upon heavily. At Giurglu the filter is out of commission, and raw Danube water is being pumped. At Sulina, Galatz and Braila the water systems are also in bad condition, the purification plants being inoperative. All of the Rumanian water supplies are in charge of local municipal authorities.

If the water supplies are enlarged to provide for the increased populations in the cities there will have to be extensions which will require much engineering work, and this work is not likely to be undertaken until business conditions become more nearly normal. The Danube is used as a source of supply by several cities. Slow sand filters, in some cases accompanied by the use of ozone, provide the means of purification. The Danube water is very turbid and the means thus far adopted are not appropriate for this type of water. Mechanical filters using alum or some other substance as a coagulant would be far more efficient. Most of the local wells in the rural districts which we passed through seem to be fairly well constructed from the standpoint of protection against pollution through the soil or at the surface. There are said to be only six Roumanian cities which have sewer systems.

With the present military cordon maintained cholera is not likely to be a menace to Rumania, but the sanitary situation of the country at present is one which, in my opinion, is of grave concern, in view of the bad condition of the water supplies.

Building the Earth Dams at the Bridgewater Project

Three Closures of Large Storage Reservoirs Built by Sluicing Earth Fill Into Pool from Dumped Embankments

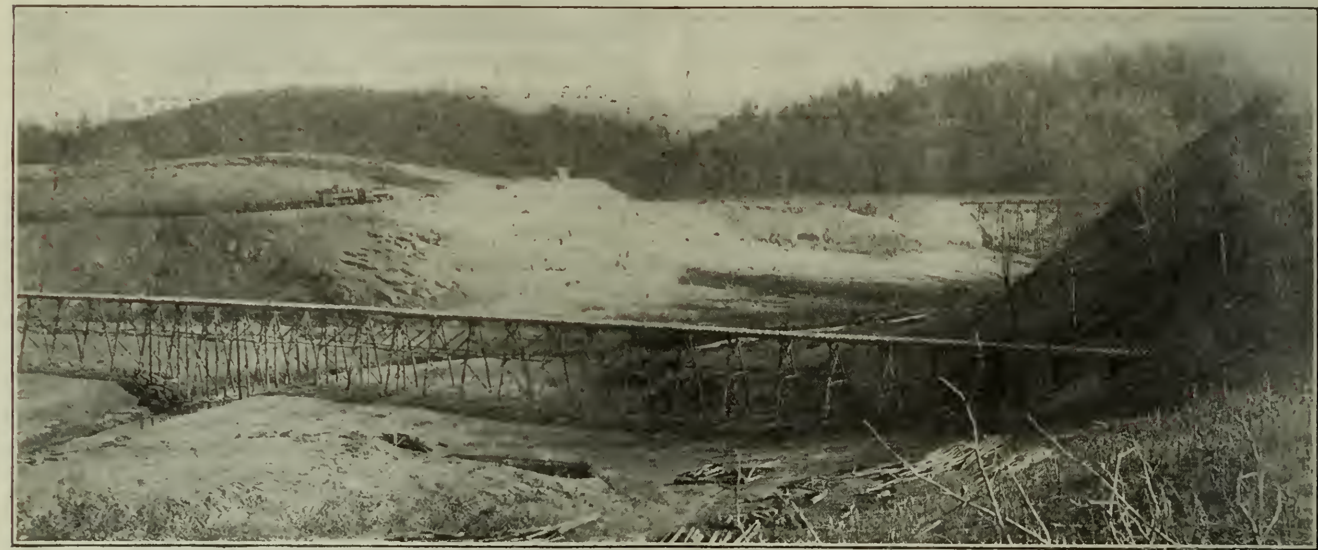
By Richard Pfaehler
Hydraulic Engineer, Western Carolina Power Co., Charlotte, N. C.

As DESCRIBED in the article in *Engineering News-Record*, June 3, 1920, p. 1088, the new Bridgewater reservoir for the Western Carolina Power Co. is formed by three dams, called the Catawba, Paddy Creek and Linville dams. Of these the Catawba has a gravity concrete section crossing the river, but the remainder of that dam and all of the other two are earthfills, built by hydraulic sluicing of earth brought in by trains from near-by borrow pits and deposited along the outer edges of the dam from timber trestles.

The dimensions and sections of the three earthfills are given in the previous article. They are of approximately the same design, with a 20-ft. top, upstream slopes of 1 on 3 and downstream slopes of 1 on $2\frac{1}{2}$, with a central bottom trench and a downstream low rockfill toe wall. Catawba is 120 ft. high and contains about 1,820,000 cu.yd., Paddy Creek 165 ft. maximum height with 1,450,000 cu.yd., and Linville 160 ft. high with 1,250,000 cu.yd. total fill. They were located within $2\frac{1}{2}$ miles of each other and the material used in building them was of essentially the same nature and composition.

Before the construction of any of the earth dams could be commenced it was necessary to unwater the dam sites, to strip the ground to be covered from all vegetable matter, to excavate a trench along the center line of each dam down to a surface of hard and impervious material and to construct a rockfill toe on the downstream side of the earthfills. While this work was going on suitable borrow pits were located containing the material used in the construction of the fills, consisting in general of disintegrated gneiss and mica schist, sand and clay intermixed with small stones. To determine the rate of seepage or frictional resistance of the various materials, a percolation testing tank was built.

Linville Dam.—To unwater the dam site, the combined flow of the Linville River and Paddy Creek was diverted through the tunnel and 20 ft. diameter penstock to below the powerhouse site. To this end, the penstock reducer and the 6 ft. diameter gates valves, including the bursting plate outfit, were temporarily left off, and the two penstock branches leading to the power house were closed up by the 11 ft. diameter butterfly valves. This work was, however, not completed in schedule time and keeping the river flow free from any obstructions in the meantime, a dike, forming a part of the upstream toe of that dam, was built on the left side of the river bank until it reached a height of 45 ft. above the normal water level. Similar work was done on the downstream side of the dam after the rockfill toe located outside of the river bed was constructed by depositing suitable stone materials excavated from the power-house foundation and the tunnel. When the tunnel and penstock were nearing completion, cribs filled with stones were placed across the river bed, and then the connection



VIEW OF STRIPPED PADDY CREEK DAM FOUNDATIONS, LOOKING DOWNSTREAM

of the upstream dike with the bluff on the right river bank was made. After this work was done the dam foundation between the two dikes was unwatered. Since the river bed and the bluff consisted of gneiss built up of saw-toothed strata giving a good bond for the earthfill materials, this portion of the dam foundation was prepared by removing all debric and washing down the prepared by removing all débris and washing down the thin layer of top soil and small stones by means of a hydraulic monitor.

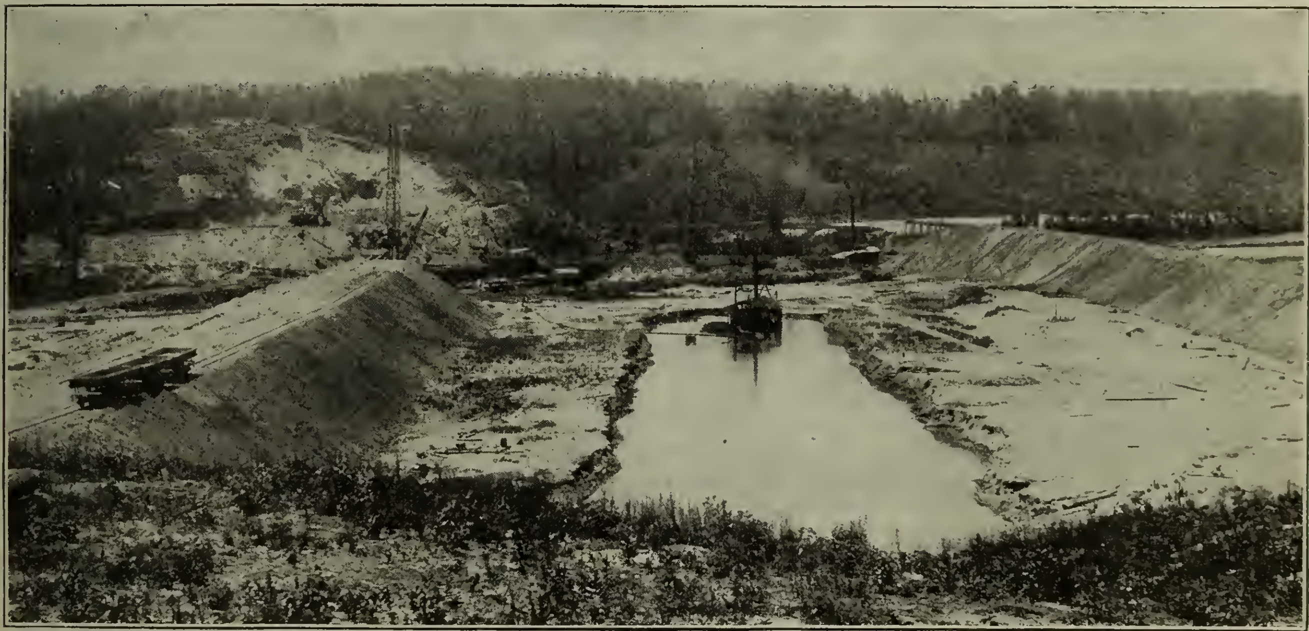
Catawba Dam.—For the trench excavation at the Catawba dam across the bottom land on the left side of the river, it was known beforehand that the silt and sand deposits, which had to be penetrated, would not permit the use of steam shovels for cutting the trench without incurring considerable expense. It was, therefore, decided to use a suction dredge, provided with a cutterhead for agitating the materials, having a capacity of 140 cu.yd. per hour. There were, however, numerous logs, brush and roots encountered which cut down the capacity of the outfit; delays were also caused by gravel and boulders clogging up the pipe. The material pumped from the water-filled trench was flumed

to a point above the upstream toe of the dam and later directly into the river. After the dredging work in this portion of the trench was completed, the extension up the hillside was made by sluicing down the materials into the bottom trench by use of a hydraulic monitor, and by subsequent removal of same with the suction dredge. This work was done within a few days as rock was soon encountered.

At the time the trench excavation was progressing, cofferdams were built partially across, and along the left edge, of the Catawba riverbed, and the foundations for the 274-ft. long masonry retaining wall and the 125-ft. long finwall were prepared. The dike forming the upstream toe of the earthfill was also built to a height of 25 ft. (the top being 45 ft. above the normal water level of the Catawba River) and temporarily connected with the upstream end of the cofferdam before it could be thrown against the upstream face of the spillway masonry. Along the downstream edge of the dam, the material for the rockfill toe was placed and

DOWNSTREAM SLOPE OF CATAWBA DAM PARTLY PLANTED WITH GRASS

following description applies equally well to any of the structures. The views show the progressive stages as illustrated in the three dams; the trestle erection at



SUCTION DREDGE WORKING IN TRENCH AT CATAWBA DAM

the depositing of earthfill materials begun. By this method the dam foundation was protected against possible floodwater carried by the Catawba River.

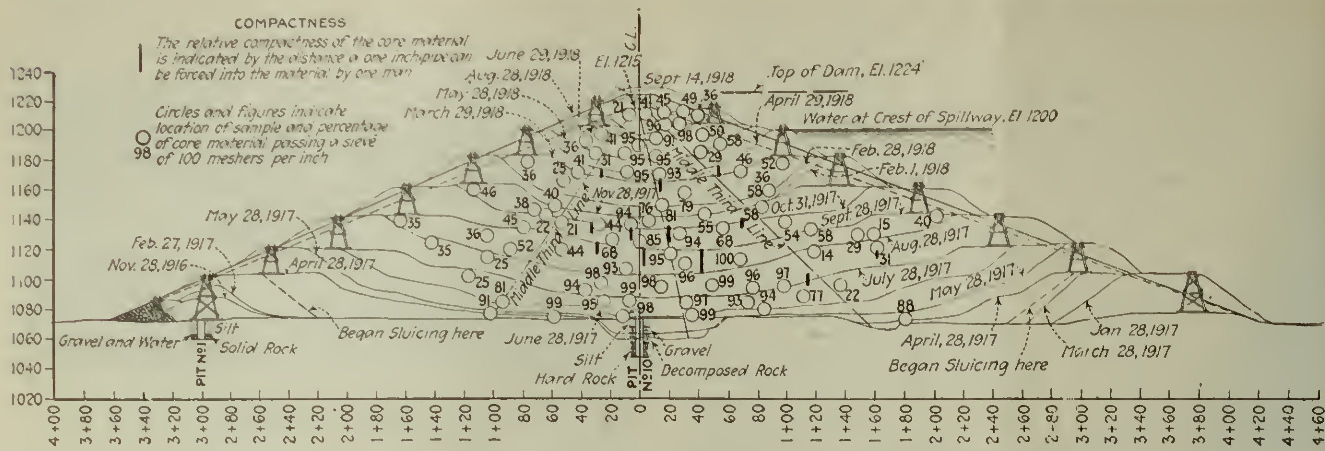
After all the sand and silt deposits were removed, the trench was unwatered and a steam shovel placed in the bottom to take out the gravel and boulder materials which the suction dredge was not able to move. Below the gravel strata decomposed rock showed up, which was excavated down to a depth of from one to two feet and the finishing of the trench was done by teams and handforces. Water was then pumped into the trench and the hydraulic sluicing of the earthfill materials begun.

Paddy Creek.—After the flow of Paddy Creek was diverted into the Linville River by excavating a channel through the ravine at the lower end of the ridge between the valleys, the excavation work for the Paddy Creek trench was commenced. This work was done by steam shovel and no difficulty was encountered.

The method of construction of the three dams above the trench excavation was essentially the same and the Paddy Creek, the suction dredge at the low stage of Catawba and the sluicing operation at Linville. A view of the sodding at Catawba and the method of procedure at Paddy Creek, illustrated by a cross-sectional drawing, are also included.

In line with the specifications calling for the construction of the interior of the earth dams by the hydraulic sluicing method, the materials from the various borrow-pits were loaded by steam shovels into side-dump cars, made up into trains and transported by locomotives to the timber trestles, the first set of which was built along and inside the upstream and downstream toelines of each dam. From these trestles the materials were dumped and after the two dikes thus created had reached the required size the trench excavated along the center of the dam was filled with water.

Two scows equipped with pumping plants capable of delivering 1,000 gal. of water per minute at each 2-in. nozzle of the sluicing monitors were then floated in the pool formed between the two dikes. After the second



CROSS SECTION THROUGH PADDY CREEK DAM SHOWING METHOD OF CONSTRUCTION

set of trestles was built, the inner portion of the fill materials side-dumped from these trestles was mixed with water and washed down by use of the monitors, the result being that the finer materials settled in the center of the dam. As soon as beaches began to form the surface of the pool was raised by pumping in additional water. Stones which were allowed to remain in the outer third of the fill were separated from each other by earth, and any roots, logs or timber uncovered by sluicing, or floating in the pool, were removed from within the area of the dam site. Due attention was also given to the height of the pool so as to prevent sliding of the deposited materials due to any excessive water pressure.

Both dikes of a pair were advanced at the same rate by frequent throwing of the tracks toward the center of the dam; it was, however, not permitted to dump materials which would fall inside the limits of the middle-third zone before being treated with water. In general, trestles of 20 ft. height were used, and with the exception of the stringers it was not required to pull the trestle timbers. When the earthfill had reached a height which was above the spillway crest, the hydraulic sluicing was discontinued and the selected material dumped in the small pool between the two dikes. Above the highwater level of the reservoir the pool was discontinued and the dam finished to the specified height allowing for shrinkage of the earthfill materials. The grading of the side slopes was done by teams and drag scrapers. Stone riprap was placed on the water slope of the dam, and the downstream slope was planted with grass.

To determine the compactness of the materials deposited in the middle third during the construction of the dam, a 1-in. pipe plugged up at the lower end was forced into the material by one man and the depth of penetration recorded. Samples of the core material were also regularly taken, dried and passed through a 100-mesh sieve, and the degree of fineness noted.

The complete Bridgewater project was executed under

HYDRAULIC SLUICING OUTFIT IN OPERATION AT LINVILLE DAM

the direction of W. S. Lee, vice-president and chief engineer of the Southern Power Co. Albert S. Crane, of the J. G. White Engineering Corporation, was retained as consulting engineer in connection with design and construction of the earth dams and masonry structures, and F. H. Cothran was resident engineer.

Comparison of Wood Stave, Iron and Concrete Pipe

THE comparative cost, durability and efficiency of wood, concrete and cast iron for the pipe line of a proposed additional water supply for Norfolk, Va., are discussed by Dabney H. Maury, consulting engineer, Chicago, in a report recommending a supply from Lake Prince. On this 20-mile pipe line the soil and other local conditions will vary so that no one material will be the best for the entire distance.

In first cost, wood stave pipe is shown to be by far the lowest. For a given diameter and pressure the ratios for wood, reinforced concrete and cast iron are 1, 1.7 and 2.4 respectively. In carrying capacity, the wood and concrete pipe are about equal and the capacity would be maintained throughout their life, as neither material would have the inner surface affected by the acids in the local waters. It is estimated that the capacity in either case would exceed that of cast-iron pipe by 20 per cent at the outset. Further, the report states that owing to the rapid formation of tubercles of rust in cast-iron pipe by the corrosive action of the local waters, this difference would increase probably to 40 or 50 per cent within 15 or 20 years.

Leakage to a small amount will be unavoidable with any kind of pipe. It is estimated that each 100 gal. of leakage per 24 hours per inch of diameter and per mile of pipe that must be provided for will add about $1 per lineal foot to the first cost of the pipe line. It is assumed that the leakage of wood stave pipe would exceed that of concrete or iron by 100 gal. per 24 hours per inch per mile, thus adding $1 per foot to the cost. In durability, wood stave pipe is expected to give a life of at least 30 years, the clayey soil along the Norfolk line being favorable to the preservation of the steel bands. Although the life of cast-iron pipe is commonly estimated at 80 to 100 years, the report puts it at 60 years under the conditions at Norfolk "because of the known fact that cast-iron pipe is affected rapidly by the local waters." For concrete pipe a life of 60 years is assumed, in view of the short periods of experience with this pipe under such conditions as exist at Norfolk.

A strong local prejudice in Norfolk against wood stave pipe is noted in the report, this prejudice being based on experience with a 24-in. pipe of the Norfolk County Water Co. It is explained, however, that this pipe is of pine (instead of redwood or fir) and is machine banded in short lengths instead of being continuous stave pipe, which would be used in the new pipe line. Although this existing pipe is leaky it is said that the wood is sound and that the bands are in good condition.

Comparative Cost of Pipe

The first cost of 36-in. wood stave, concrete and cast-iron pipe for 100 ft. head, laid complete, but without allowance for engineering and contingencies, is given as $8.60, $15.25 and $20.50 per lineal foot, respectively. The relatively small carrying capacity of the iron pipe per inch of diameter is stated to add 40 per cent to its actual first cost, making this $28.70 instead of $20.50. The assumed greater leakage of wood stave pipe adds $1 to its first cost, making $9.60.

Taking the life at 30 years for wood stave pipe and 60 years for concrete and cast iron, the first would have to be charged with the cost of one complete renewal. The present value of $9.60 due 30 years hence, with interest compounded annually at 4½ per cent, is $9.60 x $0.267 or $2.56. With this additional charge for renewal the first cost of wood stave pipe in comparison with concrete and iron would be $12.16. Thus the final comparison of first cost on an equivalent basis would be $12.16 per lineal foot for wood stave pipe, $15.25 for concrete and $28.70 for cast iron.

As an alternative comparison, the report assumes a life of 25 years for wood stave pipe and 90 years for the other materials. In this case the figures are $14.04, $15.25 and $28.70 Even under these conditions, says Mr. Maury, it would be more economical to use the wood stave pipe wherever the conditions are favorable to its durability and to use cast-iron pipe only where it is impracticable to use either the wood stave or the concrete pipe. From the surveys it is estimated that the supply main would be composed of 58,000 ft. of wood stave pipe, 25,000 ft. of reinforced-concrete pipe and 17,700 ft. of cast-iron pipe.

New York Zoning Ordinance Upheld

THE New York State Court of Appeals has upheld the constitutionality of the zoning regulations adopted in 1916 by the New York City Board of Estimate and Apportionment. The case arose through an action brought by the Lincoln Trust Co. against the Williams Building Co. to secure cancellation of a land purchase contract on the ground that owing to the zoning regulations an unencumbered title could not be given. The court holds that both parties ought to have known of the regulations and that the property under contract was not encumbered because the use to which it can be put is limited by its location in a residence district. A portion of the opinion follows:

In a great metropolis like New York, in which the public health, welfare, convenience and common good are to be considered, I am of the opinion that the resolution was not an incumbrance, since it was a proper exercise of the police power. The exercise of such power, within constitutional limitations, depends largely upon the discretion and good judgment of the municipal authorities, with which the courts are reluctant to interfere. The conduct of an individual and the use of his property may be regulated.

The resolution in question simply regulates the use of property in the districts affected. It does not discriminate between owners. It is applicable to all alike. Therefore the general and wellnigh universal rule should be applied, viz.: That where a person agrees to purchase real estate which at the time is restricted by laws or ordinances he will be deemed to have entered into the contract subject to the same. He cannot thereafter be heard to object to taking the title because of such restrictions. (Bennett vs. Buchan, 76 N. Y. 386.)

The contract was deliberately entered into. It is not claimed that defendant was misled, deceived or improperly influenced in making it. The situation, so far as the resolution in question is concerned, was precisely the same when the deed was to be delivered as when the contract was executed. Defendant was not buying the property for a particular purpose.

Need for Sub-Grade Study Evidenced in Road Upheavals

New Jersey Experience with Asphalt Type Stresses Necessity for Adequate Drainage—Concrete Base Resists Frost Action

FAILURES in so-called durable types of highway surfacing were frequently noted in the Middle Atlantic and New England states during the spring thaw this year, and highways, especially those of bituminous types, which were thought to have but begun useful lives, became almost impassable because of numerous "blowups." Failures have been of such a character as to necessitate examination of all the details of construction in the effort to determine whether poor construction methods, poor materials, increased traffic, or inadequate drainage have been responsible for the failures; or whether it is a combination of any two, or all of these factors entering into the construction of weak pavement. Engineers who have studied the situation thoroughly, however, appear to agree that the inadequacy of subsurface drainage is the chief contributing factor to road failures.

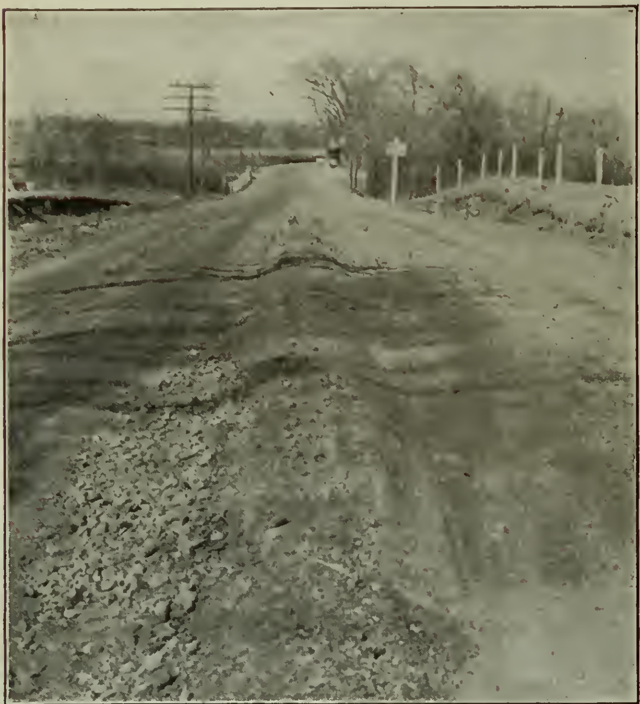


FIG. 1. A 50-FOOT LENGTH BLOWN UP FROM THE CENTER

During the past few months, travelers over that part of the New Jersey State Highway known as State Route No. 1, between New Brunswick and Trenton, which is a part of the main New York-Philadelphia road, have experienced at least the inconvenience of traversing a road badly "blown up" by frost action. Traveling from New York this spring, one left a new concrete road at Metuchen to enter upon stretches of bituminous types that grew extremely bad just south of New Brunswick and continued beyond Cranbury. From this point, however, a smooth, unimpaired surface, also bituminous, stretched on to Trenton.

Examination of the details in the construction of these good and bad sections of State Route No. 1—that in Mercer County and that section in Middlesex County—offers an excellent comparison between two types of bituminous surfaces laid upon practically the same foundation and with apparently slight difference in the composition of the subsoil, and indicates clearly to the highway engineer the care which he must employ in designing drainage structures for heavily traveled highways.

Both of these sections of highway are of comparatively recent construction. That portion in Middlesex County, known as the Cranbury Turnpike, was constructed in 1917 in four sections as follows: Section 1, New Brunswick city line to Black Horse Inn; Section 2, Black Horse Inn to the Dayton R. R.; Section 3, Dayton R. R. to Plainsboro Road, Cranbury; Section 4, Plainsboro Road, Cranbury, to the Mercer County line. A 2-in. Warrenite surfacing with a squeegee coat was laid upon the reconstructed waterbound macadam base, which was scarified and brought to a uniform thickness of 6 in. and a uniform width of 18 ft. The standard New Jersey specifications for macadam and Warrenite were followed in the construction of this section, and the work was done under the extraordinary repair act permitting reconstruction to existing grades and line. The original macadam was a very old pavement and not laid to any definite grade, a fact accounting for the present irregular profile. In general there were added to the old macadam 3 or 4 in. when compacted, of 1½-in stone. The old macadam road was in many places but 16 ft. wide, and where widened the base was built to a depth of 8 in., as were also the 2-ft. shoulders.

FIG. 2. TREE SHADOWS INDICATE SURFACE IRREGULARITIES

In accordance with the specifications ditches were constructed to provide for the unobstructed flow of surface water. At places where previous trouble had been experienced in maintaining the macadam foundation, a concrete base was constructed, and where there was any indication of trouble from subsurface water a 4-in. porous tile, covered with stone and laid approximately 3 ft. below the finished grade, was installed, either herring-bone fashion to the side ditches or longitudinally to the nearest cross stream. Several sections of this Warrenite topping were laid upon concrete bases and that portion of the road through the village of Cranbury was entirely constructed upon a 6-in. concrete base.

The Mercer County section of this State Route No. 1, known as Nottingham Way, was built in 1916 by the county, though the state furnished the laboratory in-

spection of materials. It is constructed of a 2-in. Topeka surface with a squeegee coat upon a 6-in. macadam base. The old macadam road was widened from 16 to 18 ft., scarified and thoroughly rolled to give a compact base. The standard New Jersey specifications for the laying of a Topeka mixture were followed, though the state did not participate in the construction, the forms being simply adapted to county requirements.

FIG. 3. SECTION ENTIRELY DISINTEGRATED—NOTE SURFACED STRIP ALONG ROCK SHOULDER

The asphalt used in the mixture was a Mexican product. The section between Mercerville and Robbinsville was provided with French drains where there were indications of spongy or bad subsoil conditions. French drains were constructed by using a 4-in. porous tile laid on hemlock boards 6 in. wide. Trenches for the drains were approximately 36 in. below the finished grade, were 15 in. wide and were filled with 2½-in. broken stone up to within a few inches of the sub-base. At this point the broken stone was covered with salt hay and then covered with a few inches of pervious soil.

Both the Cranbury Turnpike and the Nottingham Way, being adjoining sections of State Route No. 1, carry the same heavy commercial and passenger motor vehicle traffic from New York to Philadelphia.

All four sections of the Cranbury Turnpike showed bad blow-ups during the spring thaw, while Nottingham Way seemed to have suffered not at all from the severe winter. The first section of the Cranbury Turnpike was the worst. Blow-ups in the surface began by the appearance of slight longitudinal corrugations which became larger and more pronounced under the intensive traffic and which finally cracked along the ridges and depressions, admitting moisture. The surfacing then shredded under traffic and in some instances was little better than a poorly maintained waterbound macadam.

Examination of the details of the construction of these two sections revealed, therefore, that they were built with little variation either in design or construction methods employed. The traffic upon them was exactly the same. The question immediately arose, then, why should one section fail and the other show no ill effects whatever from the severe winter? The answer evidently was either in a further examination of subsoil conditions and the design of subsurface drainage structures or the care exercised during construction. Inasmuch as the pavements were duly accepted upon construction, and engineering inspection was furnished by the county, it is presumed that the construction methods employed were satisfactory. The answer, therefore, seemed to be in investigating further the subsoil conditions.

In this examination two facts were outstanding: (1) That the French drains sufficed for the Mercer County section of the highway, yet did not for the Middlesex County section; and, (2) where the Warrenite surfacing was laid upon a concrete base of adequate thickness, no failures were noted, the shining example of this type of construction being through the village of Cranbury.

Though cursory examination would indicate that the subsoil underlying the macadam bases of these two sections of highway was of the same character, a close inspection proved the contrary. In the Mercer County section or on Nottingham Way the subsoil conditions were excellent, the subsoil nearest Trenton being of

FIG. 4. WHAT THE FROSTS DID TO SIDE DITCHES

sand offering the best sort of natural vertical drainage. From such a sandy material the subsoil, north from Trenton, changes to a sand-loam mixture, which, farther on, becomes less pervious through its admixture with a stiff clay. Upon passing into Middlesex County and upon encountering those portions of the state highway that have blown up badly, the subsoil is mostly clay with some portions of a clay-loam mixture. To this difference, then, in natural vertical drainage is attributed the success and failure of the French drains to protect the Topeka and Warrenite surfacings from disintegration through a combination of heavy frost action and intensive motor vehicle traffic. In some places where bad blowouts had occured inhabitants living along the highway who had known the history of the road even before waterbound macadam had been laid asserted that those parts had been quagmires, practically impassable during the winter season. Numerous replacements have been made along Nottingham Way since its construction, though the most serious failure in its entire history occurred this spring.

In constructing the concrete section extending from Rahway to Metuchen, built last year by the New Jersey State Highway Department, what some engineers may consider too careful attention to subsurface drainage was made. Besides the side ditching—which, in cuts is provided for by an integral curb gutter—to care for the surface water, a line of 4-in. open joint tile was laid on either side of the road at a depth averaging 42 in. below the finished surface. Lampholes of the

same diameter were provided at every few hundred feet. Broken stone covers the tiling up to the sub-base, and such a drainage structure has formed a cut-off wall, which effectively protected the concrete pavement from any injury during the heavy winter. Only one or two longitudinal cracks appeared in the surface in the entire 12-mi. length.

Though the State of New Jersey has taken over Cranbury Turnpike constructed by Middlesex County as part of the state highway the expensive replacements necessary through the recent blowups are taken care of by the contractors' five-year guarantee which does not expire until the summer of 1922.

Several photographs showing road blowups along Cranbury Turnpike are reproduced herewith.

Contractors Enunciate Principles of Employment Relations

RECOGNITION of the facts that the public interest is of prime importance, and that mutuality of interest between employer and employee is the only solid basis underlying industrial relations, is the salient point in the statement of fundamental principles governing employment relations recently enunciated by the Committe on Labor of the Associated General Contractors of America. In presenting the report embodying the statement of principles, the Committee on Labor asserts through publication of the report in the Association's Bulletin, that the interests of employers, employees, and investors, as well as the public interest, must be defined and protected and to this end public opinion be kept informed and enlightened. The first step toward industrial peace, continues the report, will be "a realization of the interdependence of all elements related to industry, and a recognition of the responsibility one to another."

The eleven principles which are closely patterned after the statement of principles recently enunciated by the Chamber of Commerce of the United States, and which are only tentative and may be amplified by general discussion, are given herewith:

(1) *The Employment Relation.* Every person possesses the right to engage in any lawful business or occupation and to enter, individually or collectively, into any lawful contract of employment, either as employer or employee.

(2) *The Open Shop.* The right of employer and employee to enter into and to determine the conditions of employment relations with each other (without reference to the affiliation or non-affiliation of either with any organization) is an individual right of free contract possessed by each of the parties.

(3) *Right of Association.* All men possess the equal right to associate voluntarily for the accomplishment of lawful purposes by lawful means. The association of men, whether employers, employees, or others, for collective action or dealings, confers no authority over and must not deny any right of those who do not desire to act or deal with them.

(4) *Responsibility of Combination.* The public welfare, the protection of the individual, and sound employment relations equally require all associations or combinations to be subject to the authority of the state. As the public interest is paramount, full publicity of facts of industrial relations is necessary.

(5) *Obligation to Secure Production.* To develop, with due regard for the health, safety and well-being of the individual, the maximum capacity and output required of the industry is the common social obligation of all engaged therein.

(6) *Wages and Management.* The wage of labor must be drawn from the conduct of industry and must therefore be earned and measured by its contribution to production. All employees are entitled to complete business information in matters affecting the terms of their employment; and frankness is essential. In order that the worker, in his own and the general interest, may develop his full production capacity, it is the duty of the management to assist him to secure regular employment suited to his ability, to furnish him with incentive and opportunity for self-improvement, and to provide proper safeguard for his health and safety.

(7) *Hours of Labor.* The number of hours in the working day or week in which required maximum output, consistent with the wellbeing of the workers, can be maintained in a given industry, should be ascertained by careful study and never should be exceeded except in case of emergency. One day of rest in seven, or its equivalent, should be provided.

(8) *Adjustment of Employment Relations.* Adequate means satisfactory both to the employer and to his employees, and voluntarily agreed to by them, should be provided for mutual discussion and adjustment of employment relations.

(9) *Community of Interests.* The greatest measure of reward and wellbeing for both employer and employee, and the full social value of their value to the public must be sought in the successful conduct and full development of the industrial establishment in which they are associated. Intelligent and practical co-operation based upon a mutual recognition of this community of interest constitutes the true basis of sound industrial relations.

(10) *Government Employment.* The state is sovereign and cannot tolerate a divided allegiance on the part of its officers and servants. While the right of government employees, national, state or municipal, to be heard and to secure consideration and just treatment should be amply safeguarded, the community welfare demands that no combination shall be permitted to prevent or impair the operation of government or of any governmental function.

(11) *Public Service Employment.* In public service activities, the public interest and wellbeing must be the paramount and controlling consideration. The power of regulation and protection exercised by the state over the corporations should properly extend to the employees in so far as may be necessary to assure the adequate continuous and unimpaired operation of public utility service.

The chairman of the Committee on Labor of the Associated General Contractors submitting this statement of principles is Leonard C. Wason, of the Aberthaw Construction Co., Boston, Mass.

Shortage in Building Construction

According to a bulletin recently issued by the Guaranty Trust Co., of New York, the shortage in building construction at the end of the year, 1919, was one and one-third times a normal year's building. Such a conclusion was arrived at by comparison of building permits for from 143 to 151 cities in the United States covering the years 1913 to 1919 inclusive, figures which were compiled by the United States Geological Survey. The value of building permits upon which the calculations are based are as follows: 1913, $859,657,250; 1914, $785,525,746; 1915, $799,735,860; 1916, $1,024,211,675; 1917, $687,415,605; 1918, $430,014,365; 1919, $1,281,000,000.

These calculations are based upon the assumption that 1913 was a normal year. The value of building permits during 1917, 1918, and 1919, corrected by applying the index numbers for those respective years, and referred to the value of building permits in 1913, show an accumulated deficit of 134 per cent.

Building Operations by Federal Reserve Districts

THE Federal Reserve Board, in its review of general business conditions during July, has the following to say regarding building operations:

There appears to be no difference of opinion concerning the causes that are responsible for the difficulties that hamper building operations. The hindrances are summed up under the all-inclusive heads of high prices of structural materials and heavy labor costs; transportation troubles that make the securing of supplies problematical; and inability to obtain funds for financing contemplated projects, especially residential structures. It is true that, although all these factors are operative, reports from certain districts are inclined to stress some one factor while minimizing the importance of others. The situation in the west and southwest appears to be much more favorable than in other parts of the Country, Districts 11 (Dallas) and 12 (San Francisco) both reporting increased activity in the month of June as compared with May.

District 1 (Boston) emphasizes the shortage of lumber and other structural materials resulting from congested traffic conditions, and predicts that prices will remain high, probably into the spring of 1921. However, the total value of building permits in 13 principal cities outside Boston showed an increase of 47.1 per cent in amount for the first six months of 1920, as compared with the same period in 1919, although the actual number of permits declined from 3,614 to 3,440.

District 2 (New York) thinks that the principal deterrent to the execution of housing programs is scarcity of mortgage money, the New York situation being made worse by the fact that industrial projects have secured the limited amount of labor and materials available. District 4 (Cleveland), although stating that there has been some improvement in securing raw materials, especially cement, through the use of lake vessels, says that building operations are very low for the season and the outlook for the fall is uncertain. In District 5 (Richmond) no improvement is noted—a decrease in value of permits issued as compared with May is recorded. As for building materials, it becomes increasingly difficult to secure them and a number of lumber mills have shut down because of inability to make deliveries, while cement, crushed stone, steel, brick, etc., are practically impossible of acquisition. Cessation of construction in Richmond is threatened unless the local situation is relieved. In District 6 (Atlanta) on the other hand, there has been an increase in the value of permits in some of the large cities such as Atlanta, Augusta, Savannah and Mobile. A marked drop in the total volume of building permits in New Orleans was no doubt the result of the local carpenters' strike.

In District 8 (St. Louis) as a result of better weather and improvement in transportation, work already begun has been resumed or continued, but new projects are few. There is no improvement in the housing situation. Labor troubles have also been experienced. Both in the Minneapolis and Kansas City Districts the June reports show a reduction in building permits by number and value as compared with May.

In District 11 (Dallas), on the other hand, improvement has occurred in June, an increase of 15 per cent in total valuations over the month of May being noted, although the total is 16 per cent below the record for June a year ago. For the first six months of the year, the 1920 valuations exceeded those of 1919 by 147 per cent. Similarly in District 12 (San Francisco) building is inactive, permits issued in 19 cities showing valuation increases of 7.7 per cent as compared with May, and 63.3 per cent as compared with June a year ago. For the six month period an increase of 107.17 per cent was recorded.

City Planning Commission at Los Angeles

A City Planning Commission of 51 men and women has been created by the City Council of Los Angeles, California.

Reclaiming the Mines at Lens

Work is now in progress at Lens, France, on the reclamation of the coal mines. The destroyed shafts through which water found entrance to the mines are being sealed by forcing cement through a ring of bore holes around each of the damaged shafts. At two shafts the work had been completed on June 22, work was in progress at four shafts, and at the four remaining shafts requiring treatment work had not been begun. Such was the progress, however, that it was hoped that pumping could be begun in a month's time.

The coal at Lens is overlaid with several strata, one of which, of limestone, 100 m. thick, is fissured and waterbearing. The top of this stratum is about 30 m. below the ground surface and through the entire depth of the limestone the shafts were lined with cast-iron plates. There are about 30 shafts in all, 14 for the extraction of coal and 16 for ventilation, all measuring 4.8 m. in diameter. At 10 of these the Germans had dynamited the lining, thus permitting the water to flow in and fill the mines.

To reclaim the damaged shafts a ring of holes, 15 in number, placed on the circumference of a circle 15 m. in diameter is bored concentrically with the shaft. The holes go to the impervious stratum underlying the limestone, and cement grout is pumped into them under a pressure of 5 to 10 kg. per square centimeter (71 to 142 lb. per square inch.) As a rule neat cement is used, though when the flow of cement is free cement-sand grout is used until the sealing has commenced. Experience thus far indicates that about 4500 bbl. of cement will be required to seal each of the ten shafts.

It was expected that the extraction of coal would begin in about 6 months (from June 22) but full capacity will probably not be reached in less than two years. In other words, capacity operation is not expected until at least 3½ years after the signing of the Armistice.

About 1500 men are engaged on the reclamation work, contrasted with the 15,000 employed when the mines were in full operation. E. J. M.

Standing Timber in the United States

According to figures compiled by the U. S. Forest Service the standing timber in the United States in June, 1920, was distributed by species and geographically as follows:

BY SPECIES

	M ft.
Douglas Fir	595,505,000
Southern Yellow Pine	257,691,000
Western Yellow Pine	249,578,000
Oak	157,372,000
Birch, Beech and Maple	90,784,000
Other hardwoods	211,519,000
Western Hemlock	95,092,000
True Firs	91,349,000
Redwood	72,208,000
Western White Pine and Sugar Pine	57,071,000
Western Red Cedar	53,348,000
Spruce (western)	39,822,000
Spruce and Fir (eastern)	31,572,000
Other Conifers	211,982,000
Total	2,214,893,000

BY SECTIONS

New England	49,799,000
Middle Atlantic	44,857,000
Lake	110,110,000
Central	144,470,000
So. Atlantic and East Gulf	220,577,000
Lower Mississippi	280,908,000
Rocky Mountain	223,141,000
Pacific Coast	1,141,031,000
Total	2,214,893,000

Leaking Subway Station Successfully Grouted

Inflow of More Than 150 Gallons Per Minute Through Broken Joints in Waterproofing Checked By Grout Injection Through Pipes Tapping the Leaking Points

By M. H. Freeman
Resident Engineer, New York and New Jersey Bridge and Tunnel Commissions, New York City

EXTENSIVE leakage of groundwater through the roof and walls of a low-level subway station in New York City presented a very perplexing problem to the engineers of the Public Service Commission two years ago. Pressure grouting proved effective in stopping the leakage, though a seven-months campaign of cut-and-try working was needed to accomplish this result. On account of the unusual character of the problem solved, the difficulty involved in making an overhead joint with plastic waterproofing material, and the value of the experiences gained in the grouting, a comprehensive statement of the enterprise is given here.

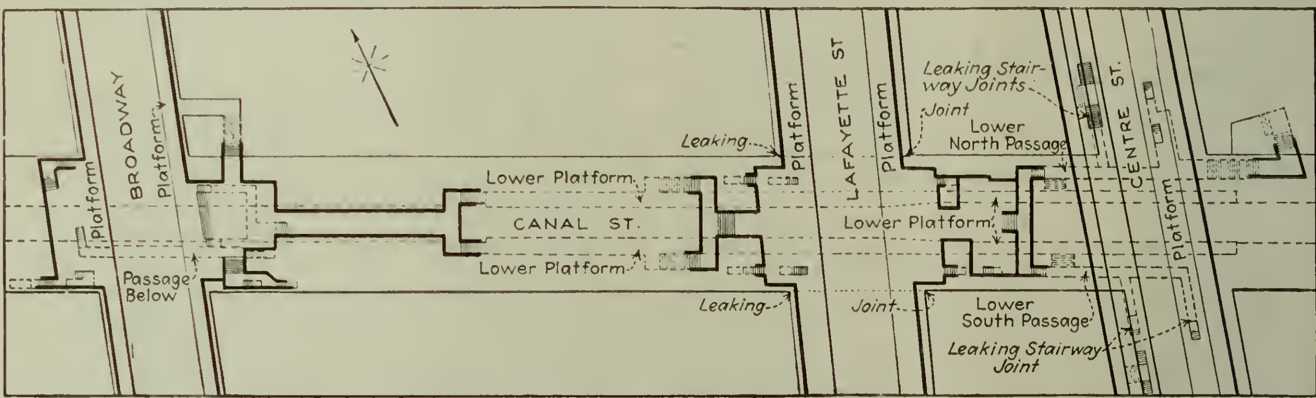


FIG. 1. GENERAL PLAN OF FOUR-UNIT SUBWAY STATION AT CANAL ST., NEW YORK CITY (BROADWAY TO LAFAYETTE ST.)

The Canal Street-Broadway subway station is a group of four stations, three of which extend north-south in three parallel streets (Centre St., Lafayette St. and Broadway), while the fourth extends east and west in Canal St., underlying and connecting the other three. The general layout of these stations with their connecting stairways is shown in Fig. 1. The station in Centre St. (which is the Canal St. station of the Centre St. Loop subway) and the station in Lafayette St. (the Canal St. station of the original subway, now the east-side Interborough subway) have been in service for a number of years, the latter since 1905 and the former since 1911. The station under Broadway, including both upper and lower levels, was built during the years 1912 to 1915, and the transverse connecting station in Canal St., passing under the others, during the years 1914 to 1917; the construction of the latter has been described in the April 3, 1919, issue of *Engineering News-Record*.

During the construction of the two last-mentioned stations the groundwater was lowered by pumping 37 ft. below its normal level (El. 102.0), to the subgrade of the lower station, thus permitting excavation in fairly dry sand and gravel—the material which formed the bed of the old canal that once occupied the site of this street. Lowering the water level involved continuous pumping of from 6,000 to 7,000 gal. per minute. About six months after the station was finished and pumping of groundwater stopped, leaks appeared in the stairways connecting the two levels under Centre St., and later at the joint between the old and the new stations under Lafayette St. These leaks finally developed into a total inflow of 155 gal. per min.

The dead air spaces and the hollow tile of the station finish often carried this water some distance from the source of leakage before it broke through to the platforms and stairways, giving the appearance of a more general leakage throughout the station structure than actually existed. Metal pans were placed under roof drips, and channels were cut at the sides of the passageways and stairs, to collect and drain this water to the track invert, through which it flowed to the sump and pumping station. By this means the platforms, stairs and passageways of the lower station were maintained in condition for traffic. However, it was urgently necessary to undertake the earliest possible repair of the leaking structure.

The waterproofing of the old Centre St. structure consisted of a 5-in. course of brick and asphalt mastic, laid upon a floor of concrete about 6 in. thick, as shown in Fig. 2. Over the piles supporting the steel girders sheet lead was inserted, and was bonded in at both ends between the two courses of the brick and mastic. The waterproofing of the newer structure was of similar material, a 5-in. layer of brick and mastic on horizontal surfaces, an 8-in. layer on vertical walls. Where openings for stair wells were cut through the floor of the upper station the brick and mastic of the lower structure was brought up and joined to the old work as shown in Section c-c, Fig. 2. This new vertical wall of waterproofing possibly settled from its junction with the old waterproofing, or possibly the mastic was squeezed out of the brick by groundwater pressure and pushed over the top of the new 3-ft. concrete wall of the stairwell. This wall, though it was built on undisturbed material, had evidently settled slightly from the overhead structure supported by piles, for when the station finish was removed the joint was found to be open about ¼-in. and to be the source of considerable leakage.

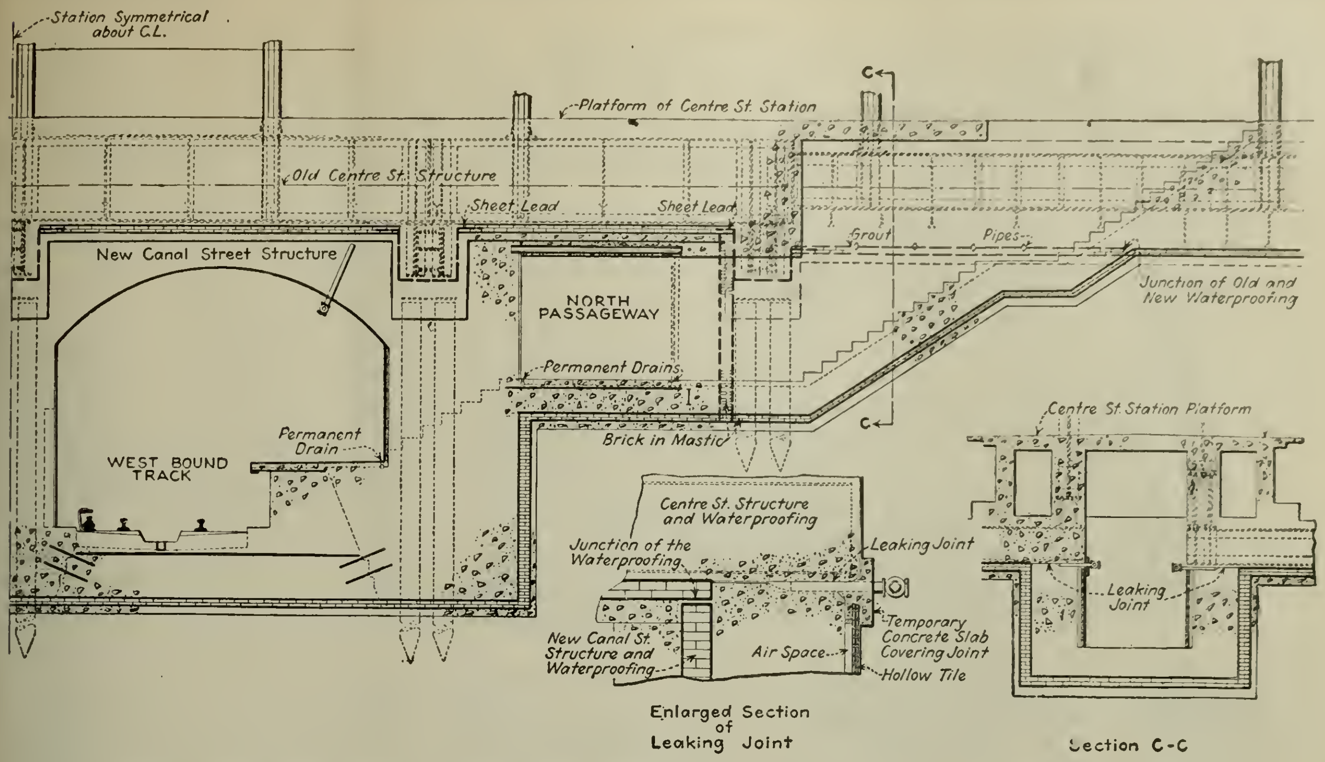


FIG. 2. WATERPROOFING AT STAIRWAY JOINTS—NORTH-SOUTH SECTION ALONG CENTRE ST.

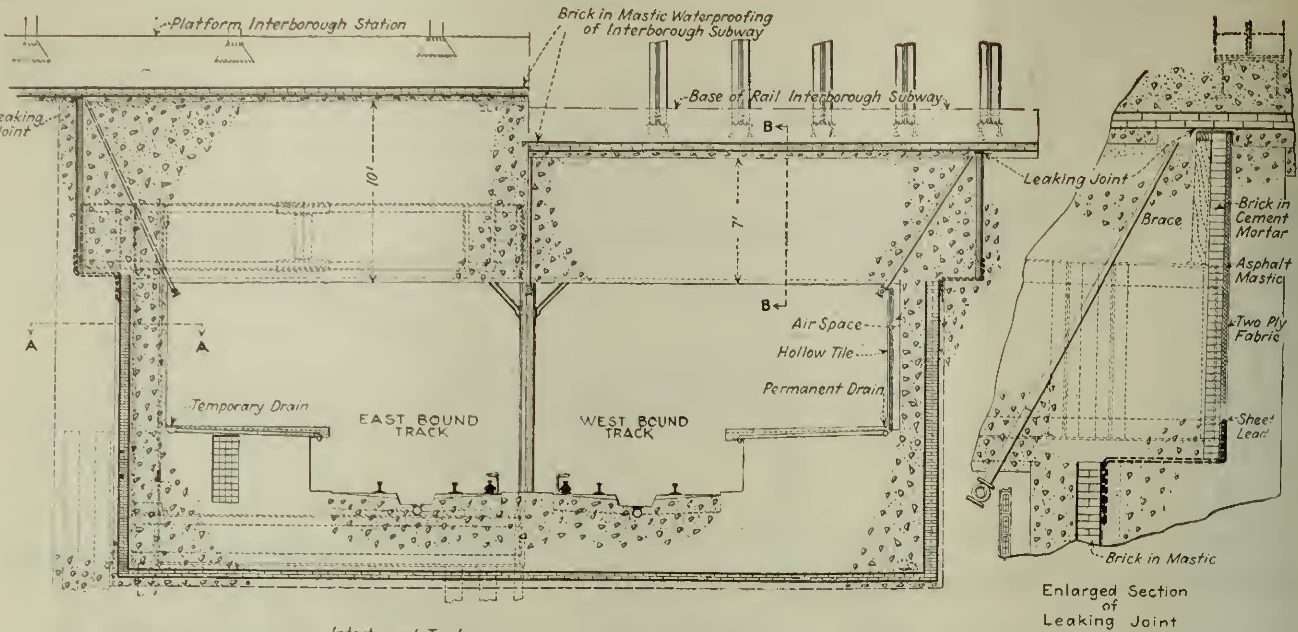
The floor waterproofing of the Interborough station in Lafayette St. also consisted of a 5-in. layer of brick and mastic resting upon a 6-in. concrete bed. A 6-in. layer of crushed stone on which the concrete had been deposited had later been removed, when the excavation for the underlying station was made. The waterproofing of the lower structure was similar to that under Centre St. but was brought up to a special junction with the overlying waterproofing (see Fig. 3). The 6-in. floor of concrete under the Interborough waterproofing was channeled out along the joint with the lower station, and the junction of waterproofing was made in this channel. A two-ply fabric coated with coal-tar pitch was placed against the outside wall of the lower structure and carried up and lapped under the overhead brick and mastic of the upper structure, in which position it was held by a longitudinal timber braced from the girders below. Inside of this fabric, allowing a space of 1½ in., a brick wall laid in cement mortar was built up and joined to the overhead structure. The 1½-in. space was then poured full of hot mastic, repouring as the mastic settled until the space was completely filled. This joint was not exposed, but holes drilled to it opened up such an inflow of water as to leave little doubt about a break in the waterproofing.

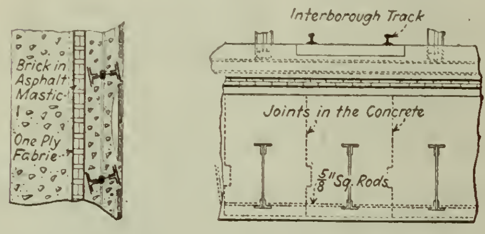
It is to be noticed that while the leaks occurred along the main wall under Lafayette St., they occurred principally in the stairways under Centre St. and not along the main wall. At the latter point the wall did not have an overhead junction of waterproofing but the brick and mastic were brought up beside the sheet lead that covered the pile caps of the old structure (as at right in Fig. 2); thus the waterproofing of the lower structure could settle without breaking contact with the lead. The method of waterproofing has been outlined, in considerable detail in order to show its substantial nature, and the effort made to secure a tight overhead joint, at this difficult point.

Early observations brought out many different ideas as to the cause of the leaks (many believed the joints to be intact) but as time passed conditions pointed more and more to the above-mentioned joints. Different methods of attacking the problem were considered. From the first, it was apparent that it would be much less expensive to work from the inside than to expose the outside of the structure, and it was finally decided to try plugging the breaks in the waterproofing with portland cement grout injected from the interior of the station. Early attempts to do this were so successful as to lead to the conclusion that this method would prove effective throughout. Arrangements were therefore made to go ahead with the work as fast as could be done without hampering train operation.

Experiments with Grouting—Work was begun Oct. 3, 1918, in the west stairway leading from Centre St. Loop to the north passage in Canal St. (see Fig. 1). The joint at this stairway was chosen for a trial because the leak was somewhat isolated from the others, and thus afforded a chance to test the pumps and other equipment and get the men accustomed to the work, in a place where the grout could not travel long distances; long travel of the grout would have involved the handling and injection of a considerable quantity of cement, and the work would have had to be conducted in continuous shifts of workmen. The station finish was removed, exposing an open joint between the old and new concrete about ¼ in. wide, through which a flow of 45 gal. per min. came in. Four holes 18 in. deep, spaced approximately 4 ft. apart, were drilled into this crack on each side of the stairway, and 2-in. pipes were set for grouting. The crack between pipes was then caulked with oakum and lead wool, forcing the incoming water through the pipes.

Grout was injected with a No. 2 Douglass hand pump equipped with a gage to register grouting pressures; a Gould pump was used to supplement the Douglass





Section A-A

Section B-B

FIG. 3. CROSS-SECTION THROUGH LOW-LEVEL STATION AT LAFAYETTE ST.

pump whenever it was necessary to repack cylinders or renew valves. The grout was mixed by stirring with a paddle in one tub and bailed to another, from which it was pumped. After placing valves on all pipes, connection was made to one, and thin grout ($\frac{1}{4}$ bag of cement to 12 gal. of water) was injected; as soon as other pipes flowed grout their valves were closed. Several batches of the thin grout were then pumped in. if the pipe took grout readily and the grouting pressure did not rise much above the theoretical back-pressure due to groundwater head, it indicated an open grouting channel beyond the pipe, and the grout was thickened to $\frac{1}{2}$ bag of cement to 12 gal. of water; if this thicker mixture went in without increase of pumping pressure, the batch was again thickened, through stages of 1, $1\frac{1}{2}$ and 2 bags of cement to 12 gal. of water. The last mixture was about as thick as the pump could use without undue clogging. Just as soon as the gage on the pump indicated an increase in grouting pressure the mixture was thinned, sometimes using the thinnest mixture at once, sometimes step by step, according as the grouting pressure increased quickly or gradually. The pipe was finally closed with as thin (or thinner) mixture as that with which it had been started, and under as great a pressure as could be used without danger of lifting the overhead structure, at this particular stairway about 50 lb. per sq.in. In ordinary grouting, of course, these pressures would be by no means high.

Under this pump pressure the grout traveled in the joint distances of from 20 to 30 ft., and before the east side of the stairway was completely grouted the joint on the west side was more than half silted up. To get best fluidity of grout, bags showing any evidence of lump cement were discarded, and also the mixing and suction tubs were kept continually stirred. When grout under pressure leaked through the caulked joint or porous spots in the concrete, such spots were recaulked, or else plastered over with mixtures of cement and plaster of paris, or cement and washing soda, the grouting being stopped from 10 to 15 min. until the newly applied material had hardened.

Grouting with thin mixtures as the crack became filled with cement was in effect a silting-up process: Large quantities of water were forced through the joint into the ground outside, until the cement held in suspension silted up and clogged the channel, making a seal through which water could not be forced, at grouting pressure. The object was to make the seal so complete throughout the joint and beyond the pipe, that each pipe would be left empty and dry when grouting stopped. Such a seal was seldom actually obtained. There was usually a slight drip and the valve was closed after grouting. On the following day all pipes were cleaned out and any showing drips were regrouted.

At this joint two of the holes were drilled to a depth of 30 in. but no water was encountered. Two-inch pipes were used, not only to furnish an open channel for the grout, but to provide an opening large enough for thorough cleaning and possible redrilling of the holes whenever desired.

At the west stairway, the first working point, a total of 45 bags of cement was used and all leakage was stopped except a slight dampness most of which disappeared about one week after grouting.

Extending the Work—The two stairways on the opposite side of Canal St., leading down to the south passageway, were grouted dry in turn, and with the completion of this work the greatest part of the leakage between the upper and lower structures in Centre St. had been stopped. Setting pipes could not be done very far ahead of the grouting, as cutting away the station finish to expose the joint so increased the leakage that there was danger of overflowing the temporary drains and flooding the platforms. One pipe alone in one of the south stairways discharged 90 gal. per min.

When the Centre St. leakage had been dealt with, work of drilling to the Lafayette St. joints was started. A compressor with rated capacity of 250 cu.ft. of free air per minute was installed upon the street, and air pipes were laid to both long platforms of the lower station. Stope drills were used and 26 holes, 13 on each side of the station, spaced about 10 ft. apart along the edge of the ceiling, were drilled toward the joint in the waterproofing. Besides the opening along this joint it seemed probable from the distribution of the roof leaks that there was some unfilled space between the two structures, for which reason holes were also drilled in the center betwen columns, where there was sufficient room to do the work without interference with trains (see Fig. 3). In the process of drilling these holes, when the drill broke through into the waterbearing channel, a stream came from the hole that temporarily flooded the station platform. In order to have this flow under immediate control, the pipe was set and caulked after the starting drill was withdrawn, and drilling was continued through the pipe. When water was encountered the drill was withdrawn, a valve screwed to the pipe and closed.

Air and Hand Grouting—It was planned to fill this cavity at one continuous operation, following up while the cement was still soft by forcing thick grout through the broken waterproofing. Later the joint pipes would be opened and thin grout used to silt up any unfilled spaces. Anticipating that more grout would be used than could be properly handled by hand pumps, four air grout machines supplied with power by the compressor on the street were set up, two on each platform. In general the work was carried out as planned except that the overhead space was so large that it could not be filled between rush-hour periods, and continuous shifts could not be arranged on account of the necessity for keeping the platforms entirely free for rush-hour traffic.

A total of 3,138 bags of cement was injected between the two structures as thick grout, and an additional 261 bags was squeezed into the joint along the sides afterward. The squeezing process was repeated a number of times at each pipe, covering a period of several days. The hand pump was used for this purpose, as the pressures were under better control and higher pressures could be used with safety; the afterblast of air which almost invariably followed the grout from an air machine penetrated a longer distance and over much larger areas than the grout from the hand pump, thereby subjecting a larger surface to grouting pressure without injecting a correspondingly additional amount of solid material. A trial of the air machine in an attempt to speed up the work resulted in a slight lifting of the overhead structure.

To do the grouting at this point a crew of ten men worked one shift per day for about two and one-half months, three-fourths of this time being spent on the squeezing process.

The over-arch spaces under Centre St. (the main section in Fig. 2) were treated in a similar manner and took considerable grout. Numerous small drips and trickles were dried up, but no great quantity of water was stopped, as the initial leakage was not large at this point.

Besides the well-defined joint leaks there were a number of drips, small trickles and wet spots on stairways and platforms of the station that were difficult to stop. In these cases a study of the details of waterproofing and concreting usually gave a clue to some channel carrying this water, such as a joint of honeycombed concrete, an empty space under the top flange of a girder, or some similar opening. Often many holes were drilled before finding the water-bearing channel, but the grouting of this channel, once found, would dry a number of small leaks.

Probable Action of the Grout—In the use of grout to stop the leaks in this station, it was not intended to substitute a cement waterproofing for that already in place, but rather to repair the original waterproofing by plugging the breaks whenever they occurred. The grouting did fill shrinkage cracks in the concrete, closed spaces which were formerly water channels, and made the concrete of the walls themselves (1:2:4 mixture) much more waterproof, supplementing the regular waterproofing in this respect. In fact, the work was done in the winter time when the structure was most contracted and shrinkage cracks open the widest, the best time for filling them.

The quantity of cement used in thick grout mixtures indicates the filling of over-concrete spaces of considerable size, all of which helped to make tight the concrete structure inside the waterproofing. But it was at the joint between structures where the main break in the waterproofing occurred, and the thoroughness of the seal at this point was given the most consideration. Squeezing this joint with thin grout at pressures considerably above the groundwater pressure was done again and again, until there was not only an impervious layer of cement in the break, but spaces in earth outside or in adjacent structure inside were thoroughly filled.

It is considered that further movement along the defective joints due to temperature changes will be slight, if any occurs at all, and that the resulting leaks will be negligible, for the following reasons:

The range in temperature is not great—practically that of the groundwater, which betwen February and August, 1919, ranged from 53 to about 65 deg. F.; the backfill has been placed since 1917 and has thoroughly settled and gripped the structures; the grouting of the shrinkage cracks (which furnish the give-and-take space for contraction and expansion) will tend to stop the movement; joints that have been exposed from January, 1919, to August, 1920, give little evidence of such movement (there is slightly more seepage in the winter than in the summer time) and the unexposed joints which have open pipes leading directly to them show no sign of increased leakage; the original waterproofing both above and below the break is elastic and can slide slightly on the injected cement plug. Since the concrete structure inside the waterproofing has been made practically impervious, even if the joint should open slightly only a seepage could come through.

Permanent drains leading from the hollow tile behind the station finish have been installed along the platforms and stairways to take care of seepage, should it ever occur. The grout pipes will be left open for regrouting until the effects of temperature changes have been fully found out. The leakage at present is less than 1½ gal. per min., distributed throughout the station in sweats and drips, the individual cases being too small for regrouting and so small that they will probably silt up in time.

Special Phases of the Grouting Work—In very fine cracks and for closing some joints a thinner mixture than regularly used was applied: ½ bag of cement to 24 gal. of water. For some of the very thin mixtures, clay to replace the cement was tried, in hopes that it might penetrate such small seams better, but without material success.

Standard brands of cement were used, of standard fineness (78 per cent passing No. 200 sieve). A considerable quantity of the coarser particles was eliminated by keeping the pump suction about 6 in. above the bottom of the tub. The coarser material settled to the bottom and was removed as soon as any quantity accumulated. In the squeezing of some of the finer cracks, 10 to 15 per cent of the cement was thus discarded.

Neat cement grout was used throughout, as it would work into smaller cracks and penetrate much farther under low pressures than cement-and-sand grout. The fact that station roof, walls and floor formed large flat surfaces, and the danger of lifting the overhead structures, limited grouting to comparatively low pressures, 40 to 70 lb. This was particularly a handicap in filling small seams, where the friction used up most of the grouting pressure rather than the groundwater head against which pumping was done.

The total amount of cement used throughout the station to fill open cavities was 6,000 bags, the total amount squeezed into cracks and joints 650 bags. The work was practically finished May 1, 1919, seven months from the time of starting; an average force of 12 men was employed one 8-hr. shift per day. The air compressor was in service three months. During the summer of 1919 grouting was done at different times to dry up a few remaining seepages in the stairways.

One of the most difficult features of the work and one that added much to the expense was the necessity of doing it on the same platforms over which thousands of people passed daily to and from trains. Night shifts helped to some extent, but New York City never sleeps, and besides there was some work that had to be done on day shifts. As much study was put upon methods to attain least interference with and greatest safety to the public as upon planning for the success of the grout injection itself. The officials of the Brooklyn Rapid Transit Company aided much in giving such privileges as they could, consistent with train operation.

The work was done by the Underpinning and Foundation Co., under the direct supervision of the engineers of the Public Service Commission. Many of the data given and many of the statements as to conditions at the leaking joints have been furnished by A. J. Mayell, Assistant Division Engineer of the Public Service Commission. The author had charge of grouting methods in the field, for the Public Service Commission.

Electrification of Railways

With a view to the electrification of the Chemin de Fer du Midi, preliminary work is being done on the harnessing of the waterfalls in the Valley of Ossau. In order to obtain the maximum water power a system of three falls is planned. The cost of the work is estimated at 100,000,000 francs, and the project will be completed within five years.—*Commerce Reports.*

Costs on Commission-Built Roads

By J. H. Philips
Principal Assistant Engineer, Essex County Park Commission, N. J.

THE COSTS given below for two pieces of road constructed by forces of the Essex County Park Commission are exclusive of any overhead costs or the cost of rental of plant used on the work. The plant employed was all the property of the Park Commission and the actual cost of plant repairs was charged against the jobs.

Valley View Drive, South Mountain Reservation, built in 1913 is 5,307 ft. long and contains 12,560 sq.yd. of pavement. It was constructed of a telford base of about 5 in. in depth. The stone for the telford base was obtained from the road excavation and from nearby stone fences in the reservation. On this telford base was spread about 3 in. loose of 1½ in. trap rock. This was thoroughly rolled and was penetrated with 1⅓ gal. per sq.yd. of Tarvia X put on with nozzle pressure distributor. On this was placed sufficient ½-in. stone to cover the tarvia, immediately after it was applied. This course was then thoroughly rolled and any excess ½-in. stone swept from the surface. About ¾ gal. per sq.yd. of bermudez road asphalt or pioneer road asphalt was applied by hand. On this was spread clean ⅜-in. trap rock, after which the surface was again rolled. The unit costs of this work are represented by the following figures:

Grading, drainage and fence	$0.3059
Hauling and placing Telford	.0808
Cost of 1½ in. stone	.2431
Spreading 1½-in. stone	.0141
Tarvia 1.32 gals. per sq.yd	.1585
Asphalt 0.795 gals. per sq.yd	.0903
Applying asphalt	.0632
Rolling	.0201
Screenings, both coats	.0528
Supervision	.0198
Total cost per sq.yd	$1.0486

This road has had one surface treatment that being in 1916. The treatment consisted of 0.35 gals. per sq.yd. of bermudez road asphalt applied by hand covered by about 20 lb. of clean ⅜-in. trap rock per sq.yd. at a cost of $0.0819 per sq.yd. It is now in very good condition. The traffic on this road is almost entirely pleasure automobiles.

In the addition to Weequahic Park, we laid 24,375 sq.yd. of bituminous macadam in 1914 and 1915. The road had been previously rough graded by contract and no grading is included in this work except the fine grading of the subgrade.

This road is a 6-in. macadam roadway laid in two layers and given a double penetration of Tarvia X and Standard Oil asphalt, binder B. The tarvia was applied with a nozzle pressure distributor and the binder B asphalt with a Standard Oil pressure distributor. The unit costs were as follows:

Labor, fine grading, spreading stone, etc	$0.1836
Stone, including screenings	.5528
Rolling, including coal, water and repairs	.0411
Tarvia X about 2 gal. per sq.yd	.1966
Asphalt about ¾ gal. per sq.yd	.0330
Drainage	.0021
Total cost per sq.yd	$1.049[illegible]

The traffic on this roadway is restricted to pleasure vehicles. This road was given a surface treatment of about $\frac{4}{10}$ gal. per sq.yd. of binder B Standard Oil asphalt in 1917, applied with a pressure distributor at a cost of about 6c. per sq.yd.

Removal of Vegetation from Twin Falls Irrigation Canals

Modified Disk Harrow Successful After 8 Years' Trial of Various Methods and Machines—Cost $24 Per Mile

By R. M. Adams
Superintendent of Maintenance, Twin Falls Canal Co., Twin Falls, Idaho

THE two costliest items of expense connected with the work of the maintenance department of any of the irrigation systems in the Snake River valley are the removal of aquatic plants, or "mossing" as the process is called, from the bed of the canals and laterals, and that process called "grubbing willows," which consists of the removal of willows, sweet clover, weeds and vines and the puddling of gopher holes. Usually the willow grubbing must precede the mossing work, and as a rule the

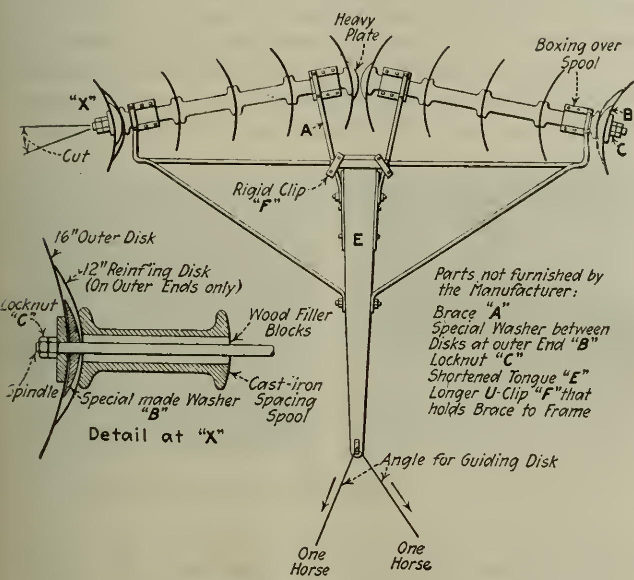


FIG. 1. DISK HARROW STRIPPED FOR MOSSING

two processes must be used on all waterways not over 6 ft. in depth, not flowing over 4 sec.-ft., the water not below 50 deg. Fahr. and not alkaline to any great extent. On the ordinary irrigation system of the locality most of the distributing canals in earth section do not fall under any of the above exceptions, and the mossing must be done regularly at least every year, and often every month during the period of maximum flow in the summer. Willows are usually cut off just under the surface of the ground during the winter or early spring so that the grass and weeds may be mowed along with the tender willow shoots at the time the mossing is begun. On the Twin Falls Canal Co. project the only sure way found of eradiction has been to uproot the moss, and for this purpose the disk harrow has been utilized.

A project having from 2,500 to 3,000 miles of laterals may well devote a considerable amount of money to investigate means for the control of the pest. Some of the larger projects having made long-time studies of moss and of machinery adapted to the work of taking it from the waterways effectively and cheaply. The Twin Falls Canal Company has made no special appropriation for the work but considerable thought and work has been expended on the subject over a period of eight years. A means has been found which is not too expensive, one which seems to be a long step toward eliminating the pest at least from the head-ends of the laterals and canals, and perhaps eventually of the whole length of each lateral. Any such result will be a great boon to operating and maintenance men throughout the intermountain country.

In the *Reclamation Record* for April, 1917, Barry Dibble mentions the methods tried out on the Minidoka Project of the U. S. Reclamation Service as follows:

> During the season of 1916, 260 miles of cleaning were done. The total cost of this work was $4,200, making the cost per mile a fraction over $16. The average cost per mile of the different methods is about as follows: Sawing (with Ziemsen submarine saws), $22; chaining late in the season, $8; cutting with scythes in the laterals, $11; spring tooth harrow in laterals, $9.
>
> Weeds, grass and willows growing along the inner slopes of the canals and laterals decrease the discharge to a considerable extent by retarding the velocity. These are removed by men with brush scythes at a cost of about $12 per mile. . . . In the past little attention has been given to willows on the Minidoka Project, but we now believe that it is advisable to cut them annually. The clearing during the past season was done with the idea of keeping the stumps down so that a mowing machine can be used to cut the new growth. Our cost on the removing of willows has been about $27 per mile.

In the same issue of the *Reclamation Record*, A. J. Hamilton, irrigation manager, Salt River Project, wrote as follows:

> The Acme harrow . . . slices off the top surface of the silt, and after the moss roots are thus cut the moss floats to the top and is then caught by men stationed below on bridges or checks. . . . The Acme is also useful in stirring up the silt in the bottom of the canal, again causing it to be picked up in suspension, with the result that the silt deposits are considerably lessened. The stirring of the silt with the resultant muddy water tends to retard the growth of the moss farther down the canal and it also helps to puddle the leaky places.

It is regrettable that this writer says nothing about the cost of the work done with the Acme orchard cultivator. It is a blade machine that does not stop the growth of the moss, for it acts largely as a harvesting machine. From the experience of the writer with similar apparatus, it requires a continual removal of the accumulations of packed moss from the frame and tongue, which is an expensive operation.

The project which this article concerns is on the same side of the Snake River and a short distance downstream from the Minidoka project, so that the conditions governing the growth of moss are the same. Mr. Dibble's costs are probably what would have resulted on this tract had the same machines been used. This was not done due to a lack of special appropriation for the purpose, and a tendency on the part of the managements of the past not to make large expenditures of money, even at the risk of a great depreciation of the system.

Early in 1918 the first experimental work with a disk harrow was done on one of the main canals, with results which seemed to justify a more extended use of some such machine, but it was evident that many changes were necessary to make the machine successful in general use on the larger canals and also on the laterals. Several machines were assembled in the repair yard, but none was sent out to the gangs until the style shown in Fig. 1 was perfected by using a John Deere orchard disk harrow with a tongue, stripping off all but the essentials, cutting off the tongue to a 7-

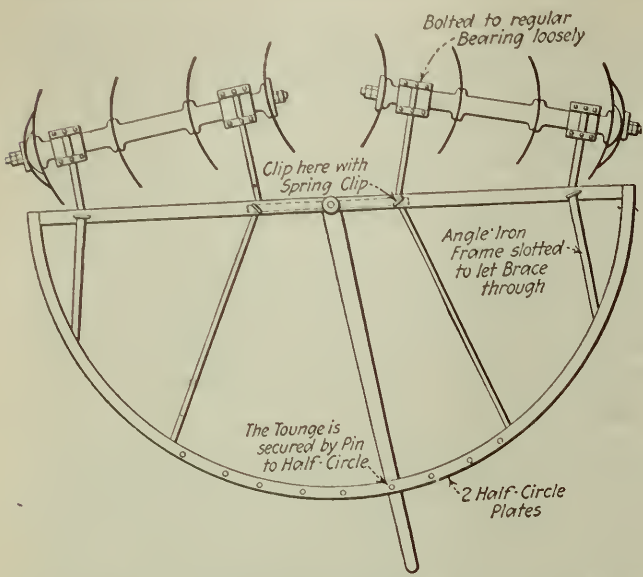


FIG. 2. TWO-PLATED CIRCLE ALLOWS ANGULAR MOVEMENT OF TONGUE

ft. length, and reinforcing the outside disk on each spindle with a smaller disk-blade. The reinforcing blade is placed on the inside of the outer end blade. A washer between the the outer and reinforcing blades thick enough to fill one-third of the space keeps the strain from breaking the blades should a thoughtless workman tighten the nut to much. The spring, obtained by squeezing the outer disk blade to the smaller one tends to keep the whole apparatus tight. In addition to this feature, the outer nut on the spindle has a lock-nut feature which maintains a uniform tension on the set of disk blades while disking over rough, rocky places in the canals. This locknut is essential, since the right-and-left thread of the respective spindles does not insure that the nuts will not loosen and allow the whole harrow to be wrecked. The boxes, with the wood fillers are retained, also the hard oil cups.

The tongue is supplied with a gage-coulter near the upper end to help get the machine upon the banks, as the horses often cannot assist. The tongue is set rigidly in the center of the machine, with all bracing dependent on it. This arrangement makes it necessary that the clips over the braces to the spindles be more or less rigid, which precludes any but a permanent set in the "cut" of the blades. This feature should have been avoided, because the cut causes considerable breakage on ditches with narrow bottoms and rounded corners. The main requirements are that the disk must sink into the silt of the bottom of the ditch, must not break if rock is encountered, and must not have anything on it which will break off if the whole machine turns upside down. With these points in view the disk is very successful, though it is not heavy enough for anything but mossing in silt deposits, and even for that does not stir the silt into suspension as was hoped.

Another type of frame was adopted in which the undesirable features in the first kind were eliminated. Fig. 2 shows the essential differences. The heavy, reinforced two-plated half circle allows lateral angular adjustment of the tongue, so that the horses may work abreast and can be handled on the smaller ditches by one teamster. The clip holding the spindles is not drawn up rigidly to the frame supporting the side, but a 2 to 4-in. play vertically is permitted, saving a great many disks from breakage. Because the frame is in the form of a half-circle the moss that catches on it slips off the end so that machine needs cleaning usually only twice a day. In the first type, if one horse pulled from each bank one of the cables was necessarily 30 ft. or over in length and ran from the singletree to the end of the tongue. A shorter cable to assist in guiding the harrow led to the other horse on the opposite bank. In consequence the forces applied to the end of the tongue were nearly (sometimes quite) at right angles to each other. It is evident that one driver could not drive both horses, and, unless the depth of the water and the temperature were such that horses could be worked as a team in the bottom of the ditch on a short cable-hitch to the disk, two drivers were supplied. This fact, coupled with the drivers dislike of wading in the cold water, led to the use of the second machine in the colder weather. Also it has been found that the second machine is heavy enough to uproot the mosses, and to turn and stir any material softer than shale. The workmen found that the most effective manner of using the machine was to disk, say, a mile of ditch with the harrow right side up, then to turn it over

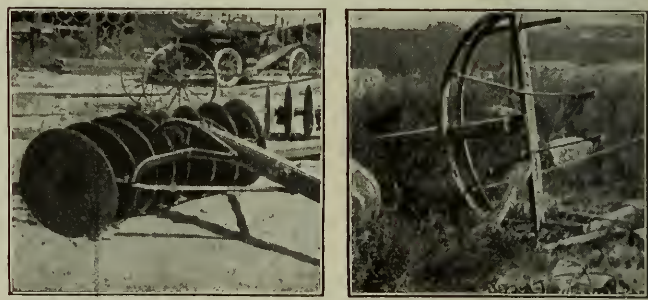


FIG. 3. MACHINE 1 AT LEFT. FRAME FOR NO. 2 AT RIGHT

and drag the machine upside down against the current over the disked material. All moss roots are turned out by this method, and much of the silt is moved. However diligent a crew may be, even using horses in the water, volcanic ash silt cannot be moved far by the disking process.

As the project of the Twin Falls Co. is a Carey Act project, the contract calls for a continuous flow of water in the canals during the irrigation season to every water user. When the water is shut off there is difficulty with the former, and it is for the purpose of getting all of the work done without shutting off any lateral that the cleaning devices were made. If the silt deposits can be eliminated while the water is running, the moss has not the best ground to grow in, and is more easily exterminated. Hence the second harrow is the more useful of the two.

A large saving in breakage resulted from reducing the number of blades used on a side from six and eight to four. The speed in handling the machines was so much increased that it was decided to use only eight blades on the machine for all ditches of a bottom width less than 14 ft.

A mossing crew during the season of 1919 consisted of four men, including the foreman, who was paid $4.50 per day, and a cook, who was paid $3.33 a day, two teams—if the horses were being worked in the water—$3 per day each. The outfit for the crew included a wagon camp, mess and bunk, one California wagon and a meat house enclosed with mosquito netting.

The average ditch with moss not over 6 ft. in length was covered at the rate of 1¼ miles per day. In other words, the cost of moss removal, not including the grubbing of willows, or other work, is $20.58 per mile. Adding depreciation on tools and equipment of $4 per day, the total cost per mile is about $24. The costs quoted from the *Reclamation Record* probably do not include depreciation. The feature of supplying the mossing crews with wagon camps is a large factor in efficiency. Men who work all day in wet clothing at a job as disagreeable as is mossing have much better morale when a good cook is in the party.

Pittsburgh Contractor Compares 1919 and 1915 Costs

THE accompanying table, comparing costs of labor and materials during 1919 with those prevailing in 1915, recently appeared in *The Bulletin* of the Associated General Contractors of America. The data were taken from the records of a Pittsburgh contractor.

Materials:	1915	1916	1917	1918	1919	Per Cent Increase 1919 Over 1915
Brick	$7.50	$8.00	$12.00	$17.00	$16.00	113.3
Hollow tile	21.20	26.00	46.00	52.00	59.20	180.0
Foundation tile	10.00	12.00	12.00	16.00	16.00	60
Cement	1.03	1.41	1.66	2.18	2.15	108⅔
Lime	10.00	10.00	11.00	13.70	13.70	37
Sand	.70	.90	1.20	1.70	1.80	157
Gravel	.60	.70	1.00	1.50	1.60	165
Steel, structural	36.00	46.00	120.00	120.00	92.00	155.6
Steel, reinforcing	40.00	48.00	75.00	80.00	65.00	62.6
Bill lumber	25.50	28.50	30.50	38.50	40.00	56.6
Mill work, wd. fr., sash and rim	4.75	4.75	5.25	5.75	6.85	44
Outside door fr. and trim complete	9.00	9.00	10.25	11.50	13.50	50
Inside door trim complete	5.00	5.00	6.00	7.00	8.00	60
Roofing	4.25	4.75	5.75	6.75	7.25	70.6
Hardware	335.00	482.00	624.00	663.00	632.00	88.1
Ceramic tile fl.	12.00	16.00	17.40	24.00	24.00	100
Glazed tile wall	22.50	30.00	32.50	42.00	42.00	87
Plaster Paris	12.00	12.75	14.75	20.50	24.00	100
Neat plaster	12.00	12.75	14.75	20.50	24.00	100
Wood lath	5.50	5.50	7.25	8.00	8.00	45.4
C.-i. fittings	.27	.41	.49	.81	.77	185.1
Steel pipe	.22	.33	.43	.64	.56	154.5
Radiators	16.88	19.25	28.00	42.25	36.12	114
Boilers	26.68	29.60	36.80	60.00	36.80	37.8
Plbg. goods	176.00	215.00	295.00	383.00	326.00	85.2
Electrical conduit	.39	.38	.65	.875	.915	134.6
Electrical wire	.18	.26	.38	.34	.28	55.5
Plate glass	......	12.00	15.00	18.00	18.00	50
Window glass	......	11.00	14.00	20.00	20.00	81.8
White lead	7.75	8.75	11.75	11.75	11.70	50.9
Varnish	1.50	2.10	2.55	3.15	3.15	110
Linseed oil	.53	.67	.98	1.42	1.44	171.7
Elevators	3,720.00	4,090.00	4,500.00	7,000.00	5,000.00	34.4
Sand stone	.65	.66	.75	.75	.95	45.1
Lime stone	.71	.77	.82	1.07	1.07	50.7
Labor:						
Common labor	2.00	2.34	3.00	4.25	4.62	131
Bricklayers	5.80	6.00	6.00	6.60	7.20	24.1
Hod carriers	.....	3.00	3.00	4.40	4.40	46.6
Carpenters	4.50	5.00	5.50	6.40	6.40	42.2
Roofers	4.40	4.80	5.60	6.40	6.40	45.5
Plumbers	5.50	5.50	6.00	7.50	7.50	36.3
Plumbers helpers	2.50	3.00	3.50	5.00	5.00	100
Steam fitters	5.00	5.50	6.00	6.43	7.20	44
Steam fitters helpers	3.00	3.00	3.50	4.00	4.80	60
Electricians	5.00	5.00	6.00	7.20	7.20	44
Tile setters	5.00	5.20	5.20	6.00	6.00	20
Tile setters helper	2.80	2.90	3.00	4.00	4.00	42.9
Steel workers	5.38	5.60	5.60	6.53	7.00	30.1
Hoisting engineers	5.00	5.00	5.60	6.40	6.40	28
Elevator workmen	5.50	5.50	5.80	6.30	6.60	20
Painters	4.60	4.65	5.10	5.60	6.00	30.4
Stone cutters	4.50	4.80	5.28	6.00	6.00	33.3
Stone masons	5.00	5.20	5.20	6.00	6.00	20
Stone helpers	2.00	2.40	2.60	2.60	3.00	50
Plasterers	5.62½	5.85	6.00	6.40	6.80	20.9
Hod carriers	3.20	3.40	3.80	4.60	5.20	62.5
Plaster laborers	2.00	2.20	2.60	3.20	3.60	80
Lathers	5.00	5.25	5.50	6.00	6.50	30

Stone Exportation in 1919

According to a recent bulletin issued by the U. S. Geological Survey, 1919 was the banner year for the exportation of stone from the United States. The value of the stone exported was $2,779,389.

Notes from Foreign Fields

FROM LONDON TO GLASGOW

BY E. J. Mehren
EDITOR ENGINEERING NEWS-RECORD

THE Whitsun holidays give a three-day break in England's springtime. Officially, only the Monday after Whitsunday is a holiday. As a matter of fact, the offices are deserted on Saturday, while this year the Government offices in London closed at noon on Friday. Being forewarned, I improved the occasion by going to Scotland by easy stages, visiting on the way some of the great cathedrals. It is a trip that can be heartily recommended. An engineer or a contractor is especially well fitted to enjoy these structures. He appreciates the problems involved—he is in a position to appraise the ability of the master workmen of the twelfth, thirteenth and fourteenth centuries.

Going from London to Edingburgh, Peterborough, Lincoln, York and Durham are convenient stopping places. Of the cathedrals at these points, Peterborough and Durham are Norman; York and Lincoln, Gothic, affording an opportunity to contrast the styles and to see how rapid was the advance in a century and a half from the heavy Norman, of Durham, to the lightness of the Gothic, at York and Lincoln. I shall not attempt a description of these cathedrals; *Engineering News-Record* is not the place for such details. I advert to the subject only as encouragement to engineers and contractors who visit England to visit some of the cathedrals and to live for a brief space in the ages that wrought these miracles in stone. After seeing them, no one will ever again class the Middle Ages as "dark ages." There was a dark period after the fall of the Roman Empire, but the darkness gave way to light in England and France, at least, by the eleventh century. Surely the dawn was past when Durham was built (in the eleventh century) and the day was at the full when the artisans of York, two centuries later, capped their work with the inevitable cross.

Of the five great churches I have seen (Westminster Abbey being the fifth), the greatest by far, in my lay opinion, is York Minister. I expect never to see a more impressive sight, architecturally, than the view through the crossing from the south into the north transept. The arches sweep upward with an overpowering mastery to a height of 100 ft. from the floor, a flood of light tinged a greenish amber pours in through the lantern tower, while in the north wall of the north transept are the Five Sisters, five great lancet windows filled with wonderful seagreen thirteenth-century glass. Like St. Peter's, as Byron puts it, "its grandeur overwhelms thee not." But it is completely satisfying. One is content to stand there drinking in the scene, the huge upward sweep of the graceful columns, the perspective of the aisle arches and the coloring from the great lancet windows. Men and women in the crossing, their shoulders not reaching even the tops of the bases of the mighty columns, look like pigmies in a structure of the giants.

Other sights there are in York Minster that repay the lingering visitor, but if the view through the crossing were the only one it would repay a trip across the Atlantic.

At Edinburgh

The evening of the third day found me at Edingburgh, early enough to stroll down Princes Street, to enjoy the view across the valley park called Princes Street Gardens, and admire the Castle on the hilltop, scene of many a heroic action in the warlike days of Scotland, and stronghold of Scotch power when the nation south of the Tweed was so often an active enemy. English towns are cities of brick; Edinburgh and Glasgow are cities of stone. There are no brick buildings. Everywhere is stone—in the business buildings in town, in the tenements, along the Canongate, in the apartment houses of the middle classes, in the homes of the wealthy, and even in the one-story, two-room cottages of the Scotch peasants which, on their beautiful Midlothian farms, touch elbows with suburban towns. Edinburgh has an indescribable charm. Possibly it is due to the contrast with the English cities with which the eye had been filled for a month. There the narrow streets and lanes, here the wide avenues; there the humbler looking homes of brick, here the stateliness of stone. Here also a snap in the atmosphere that keeps one hurrying along even when the sun is bright—reminiscent of that San Francisco step-lively period between 5 and 8 in the evening.

BUSES IN EDINBURGH RUN BY GAS

This is a war measure caused by shortage of gasoline. Gas carried by bag on top of bus. One charge is good for 22 miles.

Glasgow, also a city of stone, is distinctly more of a commercial and industrial city than Edinburgh. That is apparent when one sets foot in the business district. It has not the air of ease and elegance that one finds in Edinburgh; nor has it the advantages of close-by green hills with which Edinburgh is favored. Arthur's Seat and the Crags are a joy perpetual at the latter city.

The Clyde Disappointing

But if the Glasgow people have lacked location they have done marvelously well in improving on natural advantages for their commercial development. What a disappointing stream the Clyde is! Hearing for a lifetime of the great shipbuilding industry, one cannot help visioning a majestic waterway, something possibly in the class of the Hudson or the Delaware. One finds, instead, a narrow stream that with us would hardly get into the "river" class. In fact, so narrow is it that the shipbuilding ways are set at an angle of somewhat less than 45 deg. with the bank, and lines are put on the vessels in launching to prevent them being damaged by the opposite shore. Even then one wonders how a 500-ft. ship can be safely launched. Yet here, for miles, are solid lines of shipyards. The great ships, the *Lusitania* and the *Aquitania*, 900-footers, were built and launched at the yard of John Brown & Co., Ltd., at Clydebank, a suburb, but at this point a tributary comes into the Clyde and the ways are so placed that the ships run up the tributary in launching. At other points bends in the stream are utilized for the location of ways for the larger vessels.

ON THE FORTH BRIDGE

No engineer should go from Edinburgh to Glasgow without stopping at the Forth Bridge. View shows main members and support of floor system. Original track troughs are now in process of replacement.

Like all parts of England, Scotland industrially is very busy. Like England, too, conditions are disturbed by constant labor difficulties. Here, though, there is a noticeable hardening that is only talked of in England; that is, the shipbuilders and manufacturers feel that if further labor demands are pressed, without an increase in production, the industries will have to close. Orders are less plentiful than they were. In England this sort of thing is being experienced, but apparently Scotland is farther along in the process, and consequently the attitude of the employers is more matured. What happens here, of course, is likely to react on English conditions.

Glasgow, May 1.

STONE BLOCK PAVING IN GLASGOW

GLASGOW, I had been told, was one of the best paved cities in Europe. I am not in a position to approve or disapprove so sweeping a judgment, but certainly the pavements are remarkably good. The city engineer and master of works, Mr. Thomas Nesbit, is apologetic for them. The war prevented the high degree of maintenance on which Glasgow prided itself. The very best testimony to the excellence of his work, though, is the very good condition of the pavements after five years of relative neglect.

By far the greater mileage is in stone block. Obviously the excellent local supplies have been a factor in promoting this extensive use of stone. Traffic, though, has had an important bearing. Glasgow is a great industrial center and the pavements are subjected to exceptionally severe service. Thirty to forty-ton loads on four wheels are usual, while loads up to 100 tons are not uncommon. In one recorded case the gross load on four wheels was 140 tons and the bogie was drawn by five traction engines. It is hardly necessary to remark that these excessive loads (100 and 140 tons) leave behind them trails of destruction. Action is now being taken by the Corporation of Glasgow to test the liability of the street-user for the damage caused. There is no law that allows the Corporation to restrict the maximum loads.

The horse-drawn traffic of Glasgow is still in greater proportion to the total than is the case in London or in our American cities. Extensive use was made for a time of creosoted block, using many varieties of wood, but the results were unsatisfactory. Because of the heavy loads made possible by the excelient stone-block pavements and the frequency of wet days, the horses in Glasgow are sharp-shod. Their calks cut the wood

blocks badly, while the constant moisture kept the blocks wet and slippery. Glasgow has many steep gradients, so that slippery pavements are naturally unpopular.

These conditions have resulted in the very extensive use of stone block. The block used are generally 4 in. wide, 7 in. deep and about 9 in. long, set in a sand bed on a 6-in. concrete base. Their adherence despite their heavy traffic to a 6-in. base may cause surprise. I had heard in the States that good paving practice in Great Britain was tending in the direction of thicker bases. That is true in London, but the practice at Glasgow has been fully justified by results. Glasgow, however, is favored with excellent subsoil conditions—gravel and boulder clay. Moreover, a rich concrete is used, 1:1½:4, while the aggregate is a whin, resembling our trap, graded up to 1½-in. maximum.

WHEEL TRACKS ON UPGRADE, A COMMON PRACTICE IN GLASGOW

A fairly close dressing of the blocks is required and in general the joints are about ⅜-in. wide. The joints are cement-grouted when it is possible to close the street for a sufficient length of time, but as a rule pitch jointing is used. Their jointing practice presents an unusual feature. The joints are first poured with a course of pitch and ⅜-in. granite chips are then swept in followed by another pouring of pitch, another layer of chips and a final filling with pitch to the tops of the blocks. This practice originated in an effort to prevent granite-block on grades from canting under traffic. It not only prevents canting but insures a longer life by keying the blocks more securely.

In the selection of stone for blocks great care is taken—another example of the thoroughness that impresses a visitor on this side of the water. Long experience has indicated the stone that will wear uniformly. The hardness and toughness are such that the edges do not wear or chip faster than the surface. Two of these stones, to the eye at least, are in decided contrast. One is of exceptionally fine grain; the other is coarse. Both, though, have been found to give excellent results. Geologically the stones are andesites, though they fall under what we, in paving practice, generally term granite.

One of their favorite quarries is in a large group, but this is the only quarry in the district from which Glasgow will accept block. Moreover, in that quarry there are two kinds of stone, only one of which is approved. Stone, to Glasgow's paving engineers, is not merely stone.

In addition to stone-block pavements of the usual type, they have a stone-block pavement which is probably unique—of tool-dressed blocks 6 in. wide, 6 in. deep and from 9 to 15 in. long. The story of its development is interesting:

About 18 years ago there came a request for quiet pavements in the office and shop district. For such streets asphalt was adopted and has given satisfaction except on streets with street-railway tracks. Here there were the usual failures alongside the rails. The first remedial step was to pave between the rails and for 12 in. beyond them with stone block. This practice proving unsatisfactory, the 12-in. strip was paved with block 12 in. wide and from 2 ft. 6 in. to 5 ft. long. With both the small and the long blocks the line of distress was merely shifted to the edge of the stone paving. The decision was then reached to use a large tool-dressed block of the dimensions given above—6 in. wide, 6 in. deep and from 9 to 15 in. long. The results are considered very satisfactory. There is more noise, it is true, than with an asphalt pavement, but less than on the small-block street. The surfaces are remarkably smooth, the large blocks holding true much better than the smaller ones. The initial dressing leaves variations on the surface and sides of not more than $\frac{1}{16}$ in. The joints, therefore, are exceptionally close, while the stone is so well selected that even after long service there is no rounding at the corners.

Naturally the cost is high, varying before the war from 25 to 30 shillings per square yard, these figures including the foundation. In contrast, the pre-war cost of ordinary blocks, 7 in. deep, was from 10 to 12 shillings, and for rock asphalt (2½ in. thick, consolidated) 16 to 18 shillings. Now all paving work in Glasgow costs about three times the pre-war figure.

Against these costs must be set the life. Some of the large block pavements have been down 16 years and are good for another 16 years. Thirty years is a good average for ordinary stone block under the downtown business traffic, while the rock asphalt surface must be renewed after 10 years.

There is so much wet weather in Glasgow that a regular practice is made on wet days of scattering ¼-in. whin or granite chips on the rock asphalt pavements. This "sanding," as it is called, costs about $10,000 a year for labor and materials.

Glasgow, May 28, 1920.

Zoning Progress at the National Capital

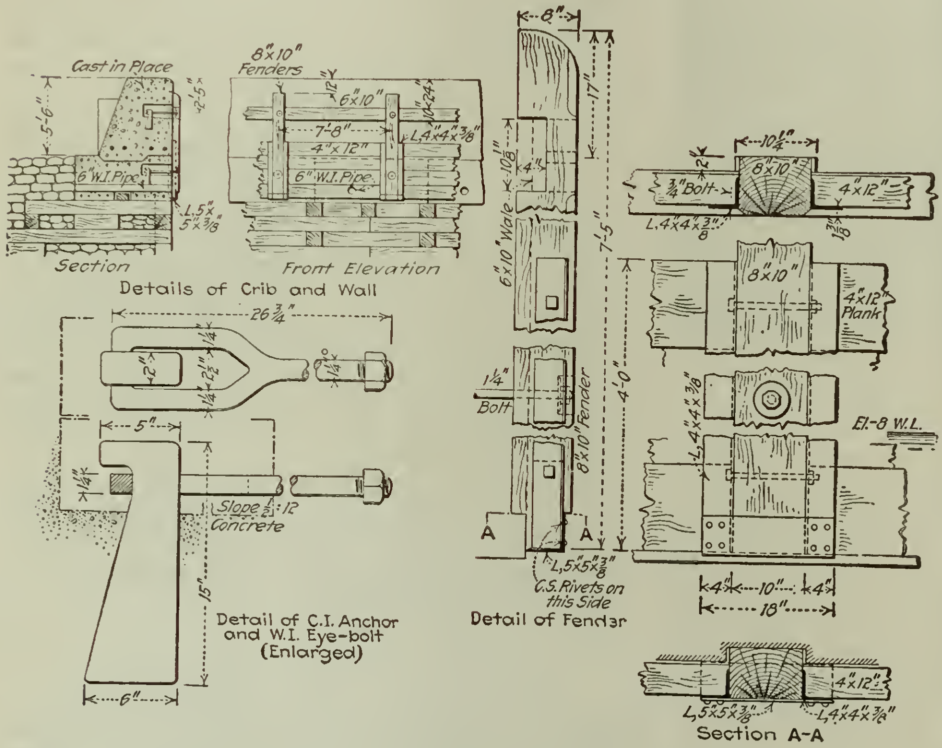
FOUR use districts are provided in the tentative zoning regulations for Washington, D. C., drawn up by the Zoning Commission. These districts, according to a circular issued by Major R. G. Powell, Corps of Engineers, U. S. A., executive officer, are: (1) Residential districts; (2) first commercial districts in which all classes of buildings permitted in the residential districts may be erected, except for 15 specified kinds; (3) second commercial districts, same restrictions as for residence and first commercial districts with 44 specified exceptions; (4) industrial districts, wholly unrestricted except for existing law or municipal regulations. A map has been issued to show the limits of the four districts named above. In a statement accompanying the tentative use regulations it is noted that: "In general, the main thoroughfares have been designated as first commercial. These now have street car lines, or will have them at a future date." Of the industrial districts, the statement says that these are "located along the railroads and on the water front" and adds that: "Each district has been restricted in area so as to prevent a too great concentration of smoke, gas, odor or noise in any one locality. Wherever practicable, small residential areas have been left for workers' homes in the vicinity of the second commercial and the industrial districts."

Timber Fender for Concrete Pier Made Removable

Wood Frame Units Hung From Hooks Cast in Recesses in Concrete—Main Protection Boards Slide into Grooves

ON ACCOUNT of the severe ice conditions and the shutdown of navigation in winter, it is desirable in Buffalo harbor to be able to remove readily the timber fenders to the concrete quay walls. A design permitting this adopted for the fenders on the Bird Island Pier Improvement is shown in the accompanying drawings.

The quay wall here is of the type common to the Great Lakes, that is a concrete section surmounting a



REMOVABLE TIMBER FENDERS FOR BIRD ISLAND PIER WALL, BUFFALO, N. Y.

rock-filled timber crib. The lower part of the wall proper is of precast concrete blocks and the upper of concrete poured in place. The fender system consists of vertical 8 x 10-in. timbers, with an upper 6 x 10-in. continuous wale and a rubbing face of 4 x 12-in. boards.

Recesses are cast in the blocks and left in the upper section of the wall at every fender, and at these recesses an iron hook is embedded protruding up into the opening. Every fender has two looped bolts passing through it which hook over the embedded iron, the fender being cushioned from the concrete face by the interposed horizontal wale. Alongside of each fender are fastened structural angles, forming grooves which act as guides for the rubbing timbers.

The fender can be taken down by lifting it in sections from off the hooks and similarly returning when its protection is again required. Rubbing boards can be replaced by slipping the damaged unit out of the guides and dropping a new one in, without any carpenter work or repair to any other part of the structure. The pier with the fender system, was built under the direction of George H. Norton, City Engineer.

Sea Water For Oil Refinery Condensers Secured By Gravity

Thirty-Inch Cast-Iron Pipe Extending 850 Ft. to Sea Lowered From Trestle as One Length—Water Jets Used To Dig Trench

By Leon H. Watts
General Superintendent, Mexican Refinery, Guayabalillo, Ver., Mexico

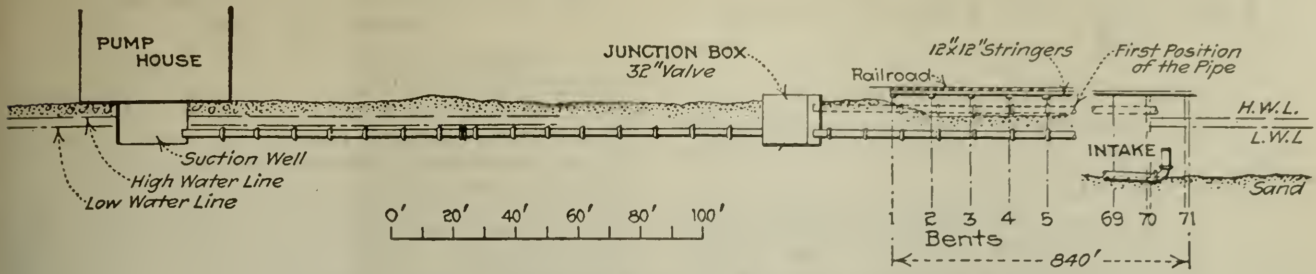
LA ATLANTICA Cia. Mexicana Productora y Refinadora de Petroleo, S. A., a subsidiary of the Atlantic Lobos Oil Company, is building a topping plant for reducing Mexican crude oil at Guayabalillo, on the Gulf of Mexico, 60 mi. south of Tampico. The property is a strip with 1 mi. frontage on the sea and extending 2 mi. back to the Tamiahua lagoon—a salt water inland lake. The soil is a fine beach sand throughout, of an average elevation of 3 ft. above mean tide. To secure a continuous supply of water to be used in the condensers of the refinery and main pump station, as well as an adequate supply for fire protection, was one of the main engineering problems.

Several plans presented themselves as being feasible—ditching to the lake, pumping from the lake or pumping from the ocean, but each of them chanced possible drying up during the hot season, or depended on mechanical units, which might fail at any time, thus putting the whole plant out of commission. It was finally decided to lay a 30-in. cast iron pipe 850 ft. to sea, to secure a gravity flow to the four centrifugals and two large fire pumps located in the main pumping station.

The general plan was to drive a wharf 850 ft. out into the gulf, hang the pipe below it just clear of high water on long threaded rods and then lower it to the bottom and jet it in. There was a bent for each joint of pipe, or every 12 ft. A concrete intake was sunk in

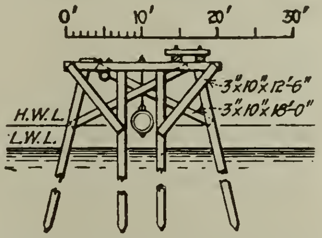
LOWERING THE PIPE

the pump house. From this point the 30-in. line was laid in a trench, sheeted, to a clean-out box 14 ft. deep, a distance of 188 ft. On the sea side an opening 32 in. was left from the top to the seat of the sea-end of the 30-in. pipe. Into this box the 30-in. cast-iron valve was placed.



SKETCH SHOWING ORIGINAL AND ULTIMATE POSITIONS OF PIPE

For handling the material on to the wharf a stiff-leg derrick was set up at the shore end of the wharf. Each joint, weighing, 3,500 lb. was placed on a small car and run out to where required, there to be picked up by a small hand winch and lowered into place. The lead for each joint, weighing 100 lb., was also handled by this winch. Three-quarter-inch cable was stretched below every ten joints and tightened up with a turnbuckle. On the shore end for the first 16 bents a fixed jet was attached, which had two sprays each way under each length of pipe. Farther out these jets were placed every 40 ft. In addition, provision was made for hand jets. In all there were 71 bents and 70 rods to handle.



TRESTLE DETAIL SHOWS SUSPENSION RODS EVERY BENT

A gang of 200 men, with a foreman in charge of each 10 bents, started to lower the line at 6 o'clock the morning of Feb. 11. The assistant superintendent directed the lowering from the shore from a position where he could view the whole line and control the relative speed of the lowering of each section. Difficulty was experienced when a few of the nuts became jammed, or cross threaded, which, of course, meant that the bolts on each side had to be held up. A messenger service was established between the shore control and each foreman and "lower" or "hold" was given by bent numbers.

Whole Length Submerged First Day

By noon the whole line was practically at water level. Jetting work was being pushed on the shore end, as there, in order to set the pipe in place, it had to be lowered in the sand 7 ft. As the pipe entered the water, inch by inch, the entire length of 850 ft. was found to be floating, so the valve in the clean-out box was opened, the line filled, and lowered until the pipe just touched the bottom. At 6 p.m. the whole line was under water. The jetting at the shore end was done in shifts, one foreman and ten men working every shift. Tank plates were jetted in at each side of the pipe, and distant 2 ft. from it, from the clean-out box to the sea, which kept the sand from washing in from the sides. It also made a channel down which the sand was washed. A pulsometer was also used in this trench at the shore end. Three joints were worked on at one time. The jets had a washing and loosening action and jacks were used to put the pipe down the last few inches.

From bent No. 20 to 70 it was proposed to use jets but as all this pipe was under from 4 to 11 ft. of water, it was impossible to get results, so that very little work was done.

It was known, however, that there is a strong current down the coast, especially after a storm and this fact was taken advantage of in putting the pipe to its present favorable position. A careful profile was taken of the pipe and bottom. This was studied and where possible the pipe was let down inch by inch until it rested on the bottom and the bolt held no weight. This was accomplished except between bents 43 and 49. On all but these bents the nuts were set up 2 in. From Feb. 27 to March 2 two severe "northers" came up and by keeping a few men on the wharf night and day the wash of the sand from under the pipe was noted, and as the pipe sank the 2 in., the nut would be raised again. A new profile of the top of the pipe, as well as of the ocean bottom, was taken every day, and with this drawn in, gave us data as to where the pipe was high and where low, where hanging and where buried. The rise and fall of the tide seemed to affect the wash as the lowering took place intermittently. But as soon as the nut was tight men were there to set it up another 2 in., provided the sounding justified it.

The pipe is now practically buried for its whole length, but during every successive storm, it must be carefully watched and lowered or held, as seems most expedient. The bottom shifts continuously and during a severe storm it may wash out from under the pipe for a distance of 10 bents. To prevent a possible settling to the breaking point, the cable is stretched below and the rods come into direct action. The wave action against the side of the pipe will not be the real test, I feel sure, but the end of the pipe, with its heavy elbow and nipple subjected to strong wave action, will be the point of greatest danger.

EXCAVATING TRENCH WITH WATER JETS

C. B. Buerger, Chief Engineer of La Atlantica Cia. Mexicana Productora y Refinadora de Petroleo, S. A., was responsible for the plans and specifications.

Letters to the Editor

Narrow Piers May Be Economical

Sir—I note in your issue of July 22, a number of articles attacking the design of the State Island piers in particular and the narrow pier in general.

Though the narrow pier has many disadvantages, limitation of water front may render it necessary, in which case much can de done to increase its accommodation by going upward. The ultimate capacity of a harbor with two story approaches to narrow piers and pier sheds of three or more stories will be greater than that of a harbor with wide piers, the water front being equal in both cases.

There are certain difficulties with regard to handling and checking freight through a many storied pier, difficulties not entirely of an engineering nature but which must be recognized and met by any engineer who hopes to produce a many storied pier capable of successful operation. These conditions may make it worth while to construct narrow piers with a single-story approach and shed provided that in the plans provisions are made for the addition later of a second elevated approach and several stories of sheds.

New York City. J. R. Wade.

Shrinkage of Earthwork

Sir—In connection with the article on shrinkage of earthwork, in *Engineering News-Record* of June 24, p. 1256, my experience covers nearly forty years, but not a very wide stretch of country and not with extremely heavy work: I have always found an average of somewhere near 115 yd. of cut going to make 100 yd. of fill and in at least two cases I have seen 140 yd. required to make 100 yd. of fill, this being surface soil and mainly from casting work. It is my experience that the slopes of embankments are not apt to overrun the stakes, but rather the opposite. In sewer work I have seen a trench made say 8 ft. deep, 10 or 12-in. pipe laid and then all the excavated material put back. This is of course not a fair comparison as the treatment would be very different in the case of the sewer.

Rockland, Me. O. H. Tripp.

No Bearing on Municipal Ownership

Sir—Your attention is invited to enclosed dispatch that appeared recently in the New York *Times* in hopes that you may see your way clear to find out wherein the rise in water rates "hits municipal ownership", what reasons there are, if any, why water rates should not be increased with the present tremendous increase of the cost of water plant and to give some publicity to your reply perhaps through the editor of the *Times* as well as through your own columns.

Newark, N. J. Arthur H. Pratt,
Acting Chief Engineer, North Jersey District Water Supply Commission.

The dispatch, which was sent from Chicago, reads:

> Municipal ownership of public utilities received a setback when announcement was made that the price of water in Chicago is to be increased.
>
> Thousands of property owners will be hit. Not only are they to be called upon to pay more for the daily supply of water, but the regulation discount rate is to be reduced from 25 to 10 per cent. This item alone will mean an estimated revenue of $1,000,000 annually to the municipality.
>
> Alderman Clayton F. Smith, member of the Finance Committee and former City Treasurer, has conducted extensive investigations, and his conclusions not only made clear the immediate necessity of raising the price of water, but swept away one of the biggest and most telling arguments of municipal ownership advocates.

[As a matter of fact, municipally owned utilities have been slower to increase rates than have privately owned, but this proves nothing as to the relative merits of municipal and private ownership any more than does the mere fact that Chicago is raising its water rates.—Editor.]

Why Water-Power Reports by Engineers Are Generally Favorable

Sir—In the report of a lecture by J. E. Aldred to John Hopkins University students, in your issue of July 1, p. 18, appears the following statement by Mr. Aldred: "Personally, I have seen hundreds of reports on water power projects, but I have never yet seen an unfavorable report."

This statement implies, and the context suggests, an aspersion on the ethics of the hydraulic engineering profession which it seems to me is not warranted by the facts. Generally speaking, it is the projects which possess at least some apparent merit on which engineering reports are made; at least it is as a rule only reports on reasonably meritorious projects which get very far in the hands of competent financial institutions, investment engineers, and development companies. It does not follow that because only favorable reports are generally circulated that others are not made.

The writer has himself made unfavorable reports on water power projects, and knows of other engineers who have done the same thing. What not infrequently happens is as follows:

A client asks to have a certain project investigated and reported upon. In the course of the work it develops that the project has insufficient merit, and either the investigation is stopped, or if the report is completed the client pays for it, charges the cost to profit and loss, and forgets about it.

In not a few instances it has happened that water-power projects have been called to the attention of engineers but no reports have been made, for the reason that the engineer foresaw the lack of merit and so advised the client in advance.

It does not seem at all fair to the engineering profession that so obvious a state of affairs should be construed with a meaning so opposite to the truth.

Robert E. Horton,
Voorheesville, N. Y. Consulting Engineer.

Why Not Open-Top Box Cars?

Sir—In connection with the series of articles relating to the design of the new piers at Stapleton in New York Harbor, which appears in your issue of July 22, 1920, it seems to be timely to draw attention to the archaic design of the box freight cars now in use by our railways.

Loading and unloading of freight cars of the type mentioned is now done through doors in the sides of the cars, and principally by manual labor. Why do we not, in addition to the side doors, build our box cars with doors in the roof?

While there may have been reasons which made it inadvisable to adopt this construction with the old type of wooden freight car, yet with the steel car now developing, it would seem that from a structural point of view, a design could be made which would be amply sufficient, and provide both side and roof openings.

Such a construction would permit the greatly increased utilization of mechanical means for loading and unloading in both land and water terminals, and in large industrial plants, thereby eliminating much unsatisfactory manual labor of high cost, poor efficiency, and much too prone to "take a holiday" whenever the notion strikes them with or without reason.

Would not the use of top doors and mechanical loading and unloading apparatus conduce to elimination of delay in railway equipment now so necessary to the economic life of the country?

The problem of design for cars with both side and top doors, as well as that of securing the contents against damage by leakage through the top doors, is not difficult of solution, and while I have not studied exhaustively the economics of the problem as affected by a possible slight increase of cost per car, plus the installation and operation of mechanical loading apparatus at terminals, yet the greater expedition of operation, avoiding delay in rolling equipment.

ease of piling for storage and sorting, loading or unloading between car and vessel, and the elimination of, or large reduction in, an uncertain labor element would seem to put the balance of economy well into the credit column.

KENNERLEY BRYAN,
New York City. Consulting Engineer.

Results from Alvord Separate-Digestion Sewage Tank at Swedeland, Pa.

Sir—During the last few months there has been some discussion as to the results obtained from the so-called Alvord tank in treating sewage. One meeting of the American Society of Civil Engineers brought out quite a little discussion on this subject. It seems to me that the following data, furnished by W. Collins, of the Alan Wood Iron & Steel Co., concerning the operation results of a plant using an Alvord tank, would be of interest to your readers.

The disposal plant was put in operation in August, 1919, at Swedeland, Pa., to take the domestic sewage from a housing development which the company named had recently built to care for some 350 to 400 persons. A domestic sewer was connected with 79 houses, and the settling tank, siphon, sprinkling bed, etc., were designed to treat from 50,000 to 70,000 gal. daily.

The Alvord tank consists of a settling tank on either side of a digestion bay, the sewage passing through the first settling tank underneath baffles and across the digestion bay into the second settling tank. The principle of operation is that the settled sewage and floating mat should from time to time be withdrawn mechanically by means of valves at the bottom and gates at the top into the digestion bay from which the digested sludge, after standing for a period period, should be withdrawn to the sludge drying bed.

The Swedeland plant has now been in operation for over a year, and Mr. Collins, on May 4, 1920, wrote as follows regarding it:

"The operation from the start has been almost mechanical, we, of course, flushing the screen chamber weekly with a hose, first removing any foreign matter which may have been washed down, such as orange peels or any substance not usually found in sewage. We also remove or siphon the sludge from the first and second tanks after about five months into the digestion chamber where a bag of hydrated lime is thrown in to correct acidity.

"In accordance with state requirements, tests of the sewage and effluent are made twice a week and are reported weekly, with other operating data, to the State Department of Health. The following is one such report taken at random from our files:

GENERAL OPERATING DATA

Day	Siphon Doses	Total Sewage, Gal.	Number Filter Nozzles	Chlorine Gas per Day, Lb.
Sunday	81	67,635	33	1¾
Monday	82	68,470	33	1¾
Tuesday	81	67,635	33	1¾
Wednesday	80	66,800	33	1¾
Thursday	77	64,295	33	1¾
Friday	79	65,965	33	1¾
Saturday	83	69,305	33	1¾

RESULTS OF PUTRESCIBILITY EXAMINATION

	Raw Sewage	Alvord Tank Effluent	Filter Effluent	Re-Settling Tank Effluent
Retains Color	25 hr	96 hr.	+	+
	48 hr.	30 hr	+	+

"All tests from the re-settling tank have been retaining their blue color for a period of two weeks, after which time they are thrown out.

"At the end of eight month the sludge was drawn off and we found that it fulfilled our expectations, it being apparently thoroughly digested, black in color and with scarcely any odor. We believe, however, that it would be a good thing to have all the sludge siphoned out of the digestion chamber instead of three-fourths of it, as is the case in our design."

The Swedeland disposal plant contains all the features as set forth by Mr. Alvord as typical for the U. S. Housing Corporation. The initial cost is less than that of the Imhoff tank; it requires very little attention and that only at long intervals; the sludge produced seems equal to Imhoff sludge, and there is no odor about the plant. Of course it may not be fair to compare these working conditions with those of a military camp, but it seems to the writer that the Alvord tank is very well suited to small communities and institutions producing from 50,000 to 500,000 gal. daily.

New York City. GEORGE L. ROBINSON.

Idaho Corrects Federal-Aid Figures

Sir—On p. 1169 of *Engineering News-Record*, June 10, I notice an article headed "Facts on Federal-Aid Road Work." If the data Mr. Eldridge gives concerning other states is no more reliable than that given for Idaho, I think that the word "facts" in the heading is out of place.

The State of Idaho has not applied Federal-aid funds on any roads except those included in the designated state system. Also, the bulk of Federal-aid so applied has been on the main east and west, and north and south highways. It is the policy of this department to complete two main north and south highways, one in the eastern and one in the western part of the state; and two main east and west highways, one in the northern and one in the southern part of the state, at the earliest possible time, and the Federal aid has been applied with that end in view.

In the table showing Federal aid used on the less durable types of road, Idaho is credited with using 90.1 per cent on earth roads. This is very wide of the mark. As a matter of fact, the lowest standard in Idaho is two-course gravel, and these roads are built wherever they are sufficient to withstand the traffic. It must be borne in mind that in a state situated as Idaho is, the problem is one which involves distance rather than dense traffic. There are only a few communities in the state where the traffic at present is of sufficient density to make concrete, bituminous or brick surfaced roads necessary. As a matter of fact, it would be impossible to confine expenditures in Idaho and many other western states of large area, small population, low assessed valuation and light traffic, to the high grade pavements mentioned above on account of financial conditions.

A new country which is being rapidly developed must be provided with highway communication, and these highways must be constructed of the best possible type, having regard for the traffic requirements and the financial limitations.

A correct percentage table covering roads upon which Federal aid has been applied in Idaho, is as follows:

	Per cent
Earth	14.5
Gravel	50.9
Macadam	21.9
Bituminous concrete or bituminous surfacing on portland cement concrete	12.7

In addition to the above a considerable mileage has been constructed with state and county funds without Federal co-operation. Percentages in this class of road are as follows:

	Per cent
Earth	19.8
Gravel	72.2
Macadam	5.0
Bituminous concrete	3.0

The earth roads shown in these tables do not represent the finished project. On account of financial conditions this year, it was deemed advisable to complete the grading and drainage structures and to begin applying the surfacing next year. In co-operation with the United States Forest Service, 116 mi. of earth roads have been constructed within the national forests. The primary object of these roads is to provide means of access to the forests in order that fire protection might be afforded and incidentally to provide means of transportation between different points within the forest boundaries.

A considerable mileage of this earth road has already been surfaced, and as funds become available, surfacing is being applied. As stated heretofore, it is not the policy of this department to construct unsurfaced roads.

I trust that you will present the corrected tables shown herein to your readers. I am sending copies of these tables

and the facts to the Senate Committee on Post Roads in order that Mr. Eldridge's testimony may be corrected. I cannot understand why Mr. Eldridge should have presented the tables he is credited with inasmuch as it would have been quite possible for him to have obtained the correct percentages from the Bureau of Public Roads.

WILLIAM J. HALL,
Commissioner, Idaho Department Public Works.
Boise, Idaho.

[A copy of Mr. Eldridge's reply to Mr. Hall is given herewith.—EDITOR.]

Sir—We are in receipt of your letter of June 21 enclosing a copy of your letter to *Engineering News-Record* calling attention to what you consider errors in the "facts" presented by me to the United States Senate Committee on Post Offices and Post Roads.

I am convinced from reading your letter to me and the letter written by you to *Engineering News-Record* that you were referring to one thing while I referred to another. The figures I presented to the committee to which you object referred to percentages of *miles* of Federal-aid roads—project agreement—approved by the Secretary of Agriculture up to Sept. 30, 1919. It appears, however, from your letters that you are referring to the percentage of *funds* expended on these Federal-aid projects.

I am satisfied that my figures are correct, as will be seen from a copy of the original table which was obtained from the official records of the U. S. Bureau of Public Roads, which is appended. Copy of the hearings above referred to are also being sent to you. You will see from these figures that the percentages referred to related to *mileage* and not to *funds*.

It is evident from your letter to the *Engineering News-Record* that your figures are for a later period than Sept. 30, 1919, for at that time no project agreements had been approved for your State for macadam, bituminous concrete, bituminous surfacing or portland cement concrete.

PROJECT AGREEMENTS EXECUTED TO SEPT. 30, 1919
IDAHO

	Earth	Gravel	Total
Fiscal year 1917	....	....	....
Fiscal year 1918	54.360	5.000	....
Fiscal year 1919	35.770	4.000	....
Total mileage	90.130	9.000	99.130
Per cent of total mileage	90.9	9.1	100.0
Total cost	$619,491.73	$126,679.00	$746,170.73
Cost per mile	6,873.00	14,075.00	......

M. O. ELDRIDGE,
Director of Roads, A. A. A. Good Roads Board.
Washington, D. C.

General Robert's Rules of Order

Sir—I have read with much interest the Biography of Brig.-Gen. Henry Martyn Robert, appearing in *Engineering News-Record* of April 22, p. 798. I am one of the many engineers who did not know that the author of the well-known "Rules of Order" was, and is, an engineer.

I first came in contact with the above volume when I was a student at Iowa State College, Ames, Ia., and am only too sorry that somehow or other my copy of the Rules went astray.

However, after I had been appointed to the faculty of the Grootfontein School of Agriculture in South Africa, I joined one of the societies here, and soon found out that the method of procedure during meetings was altogether wrong, according to Robert.

I pointed this out to some members with the result that at the next election of officers they put me in the chair, and meetings were then conducted according to Robert.

To give an instance of how things were done: Assume that there was a motion before the House, duly seconded. A member would move an amendment, get it seconded, and the amendment would then be put to the vote. If the amendment was carried, the original motion was then supposed to be defeated, without having been put to the House. This has happened when the amendment was in direct opposition to the original motion. Now as far as I remember, and I may be wrong, but I do not think so, if an amendment is moved, and it is in direct opposition to the original motion, it is the business of the Chair to refuse the amendment. It will then be the business of the opposition to "vote down" the original motion and move an entirely new motion in accordance with their wishes.

It is now many years ago that I was well versed in Robert's Rules of Order, and perhaps I have forgotten a lot of them, but what I would like to know is this: Are English assemblies controlled by the same rules of order, or have they a recognized set of their own? For very possibly meetings in this country would be held according to the English method.

If such is the case, it is very evident that they need to be brought up to the Robert standard.

E. J. VAN MEERBEN,
Engineer, Grootfontein School of Agriculture.
Middelburg, Cape,
Union of South Africa.

War Department Has Wide Field in Inland Waterway Investigation

Sir—In announcing in *Engineering News-Record*, July 15, p. 141, the formation of the Inland and Coastwise Waterways Service of the War Department, you refer to the duties of this bureau as "a hold-over from the war activities of the Railroad Administration." It seems appropriate to invite your attention to the real intent of the Transportation Act, in pursuance of which this new bureau has been created.

In that Act Congress directed the Secretary of War, with the object of promoting and developing inland waterway transportation, to investigate proper types of boats suitable for the different classes of such waterways; to investigate the subject of water terminals for both waterway traffic and joint rail and water traffic and to advise with communities regarding the location, design and finance of such terminals; to investigate the existing status of water transportation on different inland waterways with a view of determining whether such waterways are being utilized to the extent of their capacity; to compile, publish and distribute such useful statistics and data on inland waterways as might be deemed of value to the commercial interests of the country; and to investigate such other matters as might tend to promote and encourage inland waterway development.

As an incident to the performance of the foregoing, the Secretary of War was directed to take over and either operate or cause to be operated the waterway equipment contracted for by the Railroad Administration.

It is evident from these facts that the functions of the Inland and Coastwise Waterways Service cannot truthfully be termed a "holdover" from the late Railroad Administration. While it is true that that organization was responsible for the design and construction of the fleet of 165 internal waterway boats which are now being operated by the War Department, it is important to note that the interests of the Administration in these boats was primarily for the transportation of freight during the war emergency as a measure of relief from the then existing railroad congestion. The present purpose of the government, on the other hand, is nothing short of constructive promotion and development of our national waterway resources, in connection with certain features of which the former Railroad Administration boats are being utilized.

The Secretary of War has considered this undertaking to be of such importance to commerce generally that he has seen fit to entirely separate this work from the normal military operations of the War Department; hence the establishment of the Inland and Coastwise Waterways Service. The work which this bureau is now undertaking presents such interesting and important possibilities that it seems to me essential that it be differentiated from the purely emergency activities of the Railroad Administration.

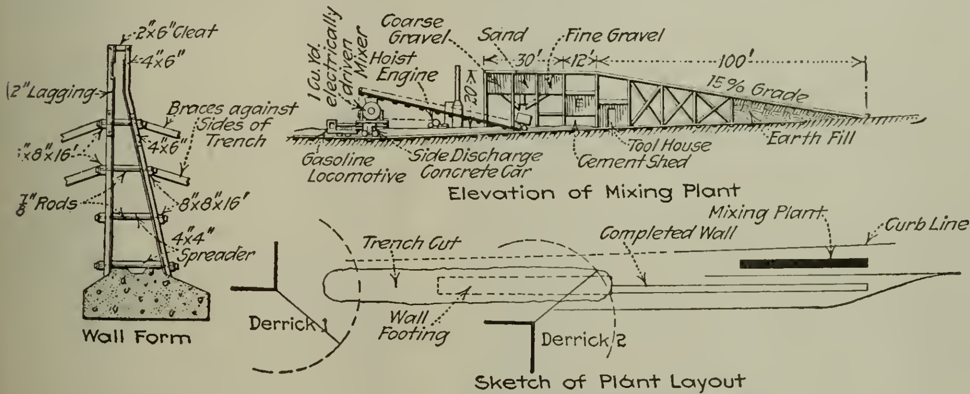
FRANK T. HINES,
Brigadier General, U. S. A.,
Chief of Inland & Coastwise Waterways Service.
Washington, D. C.

Hints for the Contractor

Mixing Plant Designed for Long, Narrow Site

A MIXING plant layout adapted to a long narrow site is a feature of one of the long retaining walls which replace levees where buildings restrict the width of the channel improvement works at Dayton, Ohio. The wall is 1,036 ft. long and 25 ft. high and is concreted in two lifts as indicated by the drawing. A very narrow strip of ground at one end of the wall was the only available location for the mixing plant, and indeed the whole operation had to be conducted along an area scarcely 50 ft. wide from the street line to the top edge of the old levee.

As indicated, Derrick 1 excavates the trench with a clamshell and Derrick 2 handles the concrete buckets and the 16-ft. sections of forms. Materials are hauled in 5-ton motor trucks to the mixing plant where they are dumped into hoppers at the top of an incline, leading to bins for the sand and aggregates. The sand runs from $\frac{1}{4}$ in. down, the fine gravel from $\frac{1}{4}$ to $1\frac{1}{2}$ in.; and the coarse gravel from $1\frac{1}{2}$ in. to 3 in. The bins hold about 15 cu.yd. each.



PLANT LAYOUT AND FORMS FOR RETAINING WALL

From the bins the materials are drawn through chutes into a bottom-dump car running on a track built at 15-deg. incline, which leads to a platform over the mixer. Between the chutes and the car, measuring boxes are interposed, which permit the proper proportioning of the material. These proportions are 4 sacks of cement to 9.6 cu.ft. of sand, to 10 cu.ft. each of the fine and the coarse gravel. This gives a 1 : 2.4 : 5 concrete.

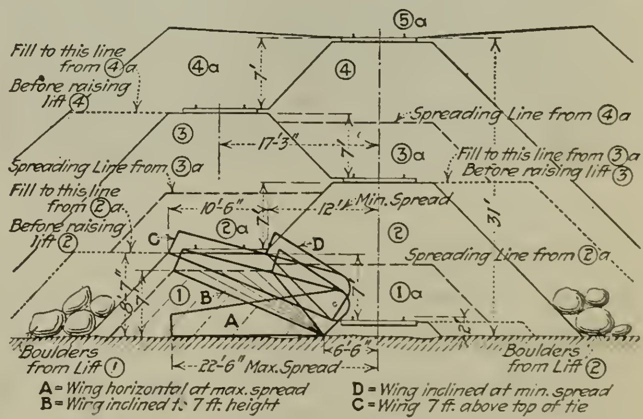
The car is hauled up the incline by a single drum hoist engine, and dumps at the top into a hopper which holds one complete batch. This hopper is kept filled. From the hopper the batch is drawn into a 1-cu.yd. mixer, driven by a $7\frac{1}{2}$-hp. alternating current motor, and is given a one-minute mix. From the mixer it is discharged into concrete cars running on a 3-ft. gage light railway leading alongside the wall excavation, whence it is discharged into the concrete forms. The cars are drawn by a 3-ton gasoline locomotive.

The concrete cars are of two types. One is a side-dump car, discharging its materials into the form for the footing through a sloping chute. Materials for the upper part of the wall cannot be thus chuted, the wall top being on a level above that of the concrete track. In this case a bottom dump bucket of special form is used, riding on a small platform car, from which it is lifted by Derrick 2 and dumped wherever wanted. Both types are of one cubic yard capacity.

The wall is a portion of the channel improvement works at Dayton, Ohio, of the Miami Conservancy District, Arthur E. Morgan, chief engineer, Chas. H. Paul, assistant chief engineer and C. H. Locker, construction manager. The division engineer in charge of the Dayton channel improvements is C. A. Bock.

Build Fill With Spreader Car

A METHOD of building fills by dump cars and spreaders, avoiding the use of trestles, is indicated by recent work of the Oliver Iron Mining Co., Hibbing, Minn., in forming a waste dump of gravel overburden. The spreader car used was described in *Engineering News-Record* of April 29, 1920, p. 866. Although the fill thus built was 7 ft. high the accompanying diagram shows the possibility of extending the process for a total height of 30 ft. Side-dump cars of 20 yd. capacity were employed. A 2-ft. fill was built first by dumping and spreading level with the rails, a trainload of waste gravel being then dumped from the track on this new fill. This dump was leveled in successive runs with the spreader car having its wing at an increasingly wide angle to the back. At the same time the heel of the wing was dropped gradually so as to throw material farther away and to cut below the rails to prevent additional dumped material from rolling back near the track. After the inclined wing had built up the fill, the wing was raised and set horizontal so as to level the fill. These operations are repeated in frequent runs until the fill had a height of 7 ft. above the rail



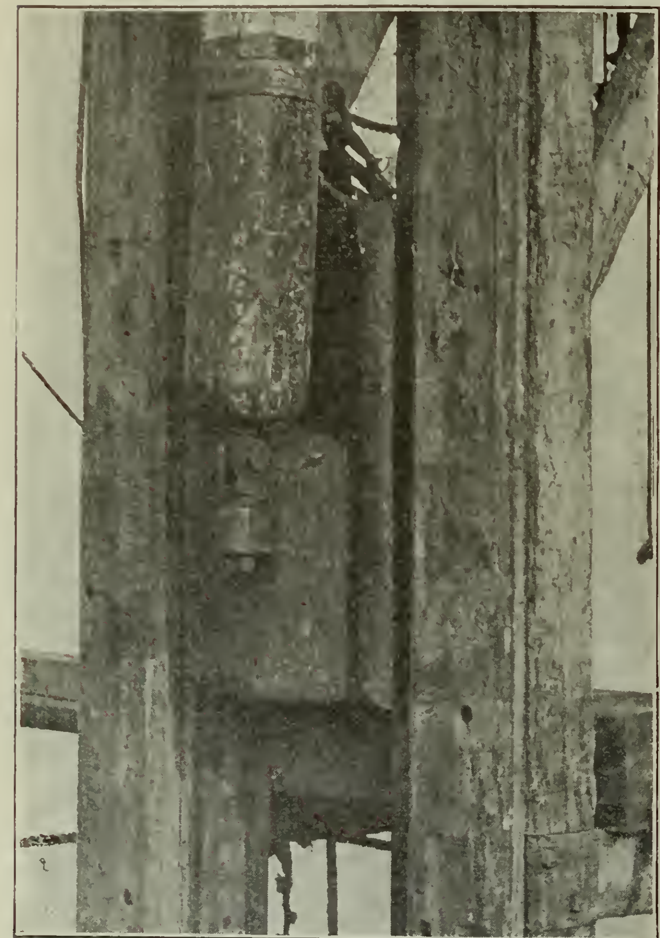
HOW TO BUILD A HIGH FILL WITH A SPREADER

and a top width of 10½ ft. This width would have been sufficient for the next position of the construction track if it had been desired to increase the height and width of fill.

Boom Attachment for Pile Drivers

By C. W. Geiger
San Francisco, Cal.

An unusually wide radius of operation is permitted by the pile driver boom attachment shown by the accompanying view. An eye-bolt set through the hammer receives the hinged pivot pin attached to the foot of the boom and provides for the horizontal and vertical swing of the boom. By raising or lowering the hammer the height of lift is varied as the conditions require. A line from the pile driver engine drum operates the boom which is employed largely for handling piles. When piles are to be driven, the boom is lifted from its socket on the hammer and is lashed to the pile driver frame; the shift can be made in a few minutes. The arrangement was devised and is being used by the Harbor Board of San Francisco.



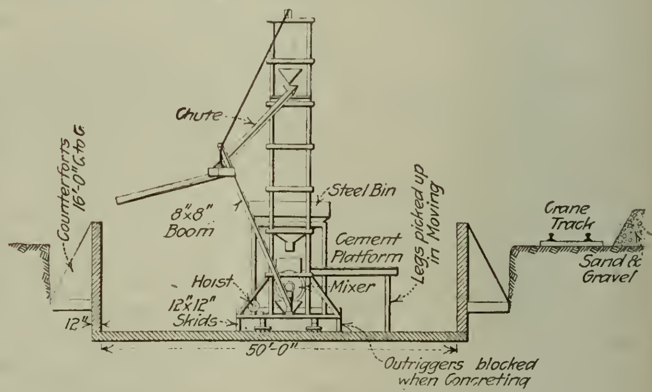
PIVOT HINGE FOR PILE DRIVER BOOM

Mobile Tower Chuting Plant

Operating at a rate of eighty-one bag batches an hour the tower chuting plant shown by the drawing placed concrete in the floors and walls of coal bins being constructed for the Amalgamated Sugar Co., of Ogden, Utah, at the rate of 155 cu.yd. in nine hours. Three bins were constructed at Ogden and at Lewiston, Utah, and at Paul, Idaho. They averaged 700 ft. in length, two were 50 ft. and one was 46 ft. wide and the total volume of concrete was about 7,500 cu.yd.

The plant consists of a 40-ft. self-supporting tower, a ½-cu.yd. Smith tilting mixer, a 10-cu.yd. steel gravel hopper, a cement platform and a steam hoisting engine, all mounted on 12 x 12-in. skids. A 38-ft. boom and a self-supporting chute 30 ft. long permitted concrete distribution to the walls abreast of the plant and to the floor 100 ft. ahead, it being necessary to use a few chutes on horses when running the floor The measuring hopper was mounted on the cement platform.

In operation, a locomotive crane supplied the gravel hopper and the cement platform. Two men on the cement platform prepared the batches which were one sack each. The floor was first poured, then the side walls, after which the plant was moved ahead by power from the hoisting engine. The average time required for each move was 15 min. Each day's run involved 155 cu.yd. By maintaining a speed of eighty batches per hour this was completed in an average time of eight hours. A nine-hour day was being worked and on only a few occasions was it necessary to work overtime to move the plant and make the day's run. A crew of ten men was used, including the crane operator.



TRAVELING TOWER PLANT CONSTRUCTS LONG CONCRETE BINS

The cost of erection of this plant was small as compared with a central mixer plant and a spouting system. The cost of mixing and placing was only 66c. per yard including the cost of fuel and the cost of the plant.

The work was conducted under the supervision of B. F. Dinsmore for the contractors, C. F. Dinsmore & Co. of Ogden, Utah.

Pennsylvania Townships Raise Large Road Sum

During the years 1917, 1918, and 1919, second-class townships of Pennsylvania counties collected $26,551,-297.67 for road purposes, says a recent bulletin issued by the Pennsylvania State Highway Department. Under the law township supervisors fix a tax rate for road purposes, moneys thus collected to be spent for the upkeep, repair or reconstruction of township roads. In 1917 the total sum collected was $6,122,812.79; in 1918, $8,972,190.67, and in 1919, $11,456,294.21. The townships of Cameron County were low for the state at large in 1919, collecting only $15,219.89; while Fayette County townships were high, the total sum collected being $1,010,351.37. Under an act of the 1919 legislature, townships of the second class are rewarded for work actually accomplished, and $1,000,000 is being distributed to townships which have qualified under the terms of the act.

NEWS OF THE WEEK

New York, August 12, 1920

Air Mapping Tested at Washington

To prove further the reliability and the utility of maps made from the air, representatives of the Rand-McNally Co., in co-operation with the Army Air Service, are making detailed maps of the immediate vicinity of Washington. On the success of this venture will depend certain projected larger ventures in map making from the air.

Tunnel Progress on Hetch Hetchy Totals 3 Miles

More than 3 mi. of tunnel have been excavated on the Mountain Division of the Hetch Hetchy Aqueduct, according to a statement issued recently by the City Engineer's office. The Construction Company of North America, which began operations on May 17, has excavated almost half a mile of tunnel since taking over the city's forces.

Two tunnel contractors have applied to the construction company for sub-contracts on this work. One of these contractors proposes to excavate the portion of the tunnel between Casabaum Adit and Priest's at a cost of $45 per lineal foot, exclusive of concrete tunnel lining. The bid of the Construction Company of North America for this work, including the lining, is $81.58 per lineal foot.

The City Engineer estimates that the lining will cost $25 per lineal foot, so that the offer is regarded as advantageous from the city's standpoint. The other sub-contractor offers to sub-contract the work on the enlarged section of the tunnel from Casabaum to Early Intake at a cost of $55 per lineal foot complete. The bid of the Construction Company of North America on this portion is $66.87 per lineal foot.

The following is the progress to date at each of the tunnel headings where work is being carried on: Priest Portal, 6,320 lin.ft.; Big Creek, west heading, 1,400 lin.ft.; Big Creek, east heading, 1,000 lin.ft.; South Fork, 4,280 lin.ft.; Early Intake, 4,000 lin.ft.

If the suit to restrain the Construction Company of North America from carrying out its contract were set aside, instead of work being carried on from five headings and with two shifts in each heading, as at present, the number of working faces can be tripled, three shifts put on in each face, and the entire 18-mile tunnel aqueduct finished within two years.

On the Hetch Hetchy Dam the Utah Construction Company has the stripping of the abutments practically completed and is working on the deep foundations.

Contracts are in process of preparation for the Moccasin Creek power house, which will cost approximately $4,000,000 and for the Priest Dam to cost $1,000,000. It is expected that bids for these structures will be called for within three months.

General Connor Named Chief of Waterway Division

Brig. Gen. William D. Connor will succeed Brig. Gen. Frank T. Hines as chief of the Inland Waterway Division of the War Department. General Connor is particularly familiar with Mississippi River conditions. During the World War General Connor held a number of positions of great responsibility in the A. E. F. in France, having been chief of staff, Headquarters, Services of Supply, under General Harbord, and, after General Pershing's return to the United States, commanding general of the American forces in France.

BRIG. GEN. W. D. CONNOR

Highway Engineering Scholarship at University of Texas

A scholarship in the University of Texas, with an annual income of $300, to be awarded every year by the faculty of the civil engineering school to a student specializing in highway engineering, has been created by J. G. Culbertson, a manufacturer of automobile trucks, Wichita Falls, Tex.

Engineering Societies Invited To Join Federation

November has been fixed as the time for the first meeting of the American Engineering Council, representing the Federated American Engineering Societies, and last week there was mailed to national, state and local organizations an invitation to join the federation and to name delegates for the organizing session in the fall. The communication, as issued by the Joint Conference Committee of the four national societies of civil, electrical, mechanical and mining engineers, is reprinted in full below:

"The Joint Conference Committee of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, acting as the Ad Interim Committee in accordance with the authorization of the Organizing Conference held in Washington, D. C., June 3-4, 1920, extends to your organization a cordial invitation to become a charter member of the Federated American Engineering Societies and to appoint delegates to the first meeting of the American Engineering Council, of which due notice will be given, to be held in the fall of this year.

"There has been previously sent to you an abstract of the minutes of the Organizing Conference, at which there were in attendance 140 delegates, representing 71 engineering and allied technical organizations. It was the unanimous opinion of the conference that there should be an organization—

> 'to further the public welfare wherever technical knowledge and engineering experience are involved and to consider and act upon matters of common concern in the engineering and allied technical professions,'

and that this organization should consist of societies or affiliations, and not of individual members.

"On the basis of these fundamentals the attached constitution and by-laws were unanimously adopted by the conference. These contain full information concerning the Federated American Engineering Societies, the American Engineering Council, its executive board, and of the various officers and committees. The basis of representation therein stated for the American Engineering Council is one representative for from 100 to 1,000 members and an additional representative for each 1,000 members or major fraction thereof.

"At the gathering in Washington, which was the greatest event in the history of the engineering and allied technical organizations in this country, steps were taken which created 'The Federated American Engineering Societies,' which will have a far-reaching influence on the future of these professions. The fact that this action was taken without a dissenting vote indicates that the psychological moment had arrived and that there was a unanimous desire on the part of the representatives of these professions for the organization formed.

"The Joint Conference Committee, the Ad Interim Committee, would ask each organization invited to take favorable action in the matter of membership in the organization at the earliest possible moment and to advise the committee promptly of the names of the delegates who will attend the first meeting of the American Engineering Counci in November of this year.

"The Joint Conference Committee is confident that with the universally acknowledged need for such an organization there will be a prompt affirmative response to this invitation."

Road Districts Avoid Construction Tieup by Open-Top Car Purchase

When the car shortage threatened to tie up construction on the Crittenden County, Ark., $3,000,000 road paving projects, where 50 mi. of concrete and 115 mi. of gravel roads are being built, the district road commissioners purchased outright for cash 105 open top automatic dump steel railroad cars of 80,000 lb. capacity from the Western Wheeled Scraper Co., paying approximately $300,000 for the equipment. About 70 of the cars have been delivered and the remainder of the order is expected to arrive by Aug. 15.

Arrangements have been made with the Frisco R.R. to handle the cars between gravel pits in southern Missouri and Arkansas in three solid trains, delivering one train load of gravel a day. Elevated spur tracks long enough to unload an entire train at one time have been put in at Clarkdale, Gillmore, James Mill, Dewey Mill and Marked Tree, Ark. When all the road building materials required at these points are delivered the tracks will be moved to other points convenient to the work as it progresses. The road districts own ten unloading cranes which will be used to move the gravel from the side of the track to storage piles, whence a fleet of 40 motor trucks will convey it to the works.

Instead of letting the paving by contract, the road commissioners are doing the work, with the Morgan Construction Co., of Memphis, engineers for the districts, in charge. The four districts in which the work is being done have invested about $5,000,000 in railroad and construction equipment. It is all new, high-grade equipment, which it is believed can be disposed of when the work is done, at little or no loss.

Professional Meetings of Canadian Engineers at Niagara Falls and Banff

The Ontario general professional meeting of the Engineering Institute of Canada is to be held at Niagara Falls, Ont., Sept. 16, 17 and 18. The full program has not yet been announced, but it will include a number of papers on the new Chippawa-Queenston development of the Hydro-Electric Power Commission of Ontario around Niagara Falls and the Welland ship canal, as well as visits to the construction operations on both of these works. The meeting will open Thursday noon with a luncheon and will continue through Saturday noon. The sessions will be held at the Clifton, which overlooks the Falls on the Canadian side.

The Western professional meeting will be held at Banff, Aug. 14-19, as has been noted in these pages before. Papers will be delivered on concrete in alkali soils, on Vancouver harbor work and on legislation affecting engineers.

Engineers Will Study Municipal Problems

The National Executive Committee of the American Association of Engineers will appoint twelve of the leading professional engineers to study the problems of civic administration of public works and report their findings to all chapters as a guide to local engineers in the exercise of their duties as citizens and engineers.

Oregon Grants 41 Engineer Licenses

Forty-one applicants were granted licenses to practice professional engineering in Oregon at the meeting of the State Board of Engineering Examiners in Portland July 9. This action brings the total number of licensed engineers in Oregon to 1,161, of which 110 are not residents of the state.

As some of the engineers are qualified to practice more than one branch of the profession they have been granted certificates in each of the branches in which they were found proficient. The following table gives the classifications on the certificates as granted:

Civil engineering	805
Mechanical engineering	178
Hydraulic engineering	157
Electrical engineering	119
Mining engineering	64
Metallurgical engineering	50
Structural engineering	36
Chemical engineering	14
Logging engineering	12
Naval architectural engineering	11
Fire protection engineering	2

An examination will be held at Baker, Ore., Aug. 6, and another at Medford, Ore., Aug. 27.

The members of the State Board of Engineering Examiners are: President, O. Laurgaard; vice-president, F. D. Weber; G. A. Covell, John H. Lewis, Frank S. Baillie, W. B. Dennis, R. R. Bartlett, Fred Hesse, E. G. Hopson.

Indiana Plans Extensive 1921 Road Program

A 1921 state highway program to cost between $26,000,000 and $30,000,000 is contemplated by the Indiana Highway Commission, according to Lorenzo H. Wright, director of the commission. The sum will provide for the paving of approximately 500 mi. of roads, the building of bridges, for the maintenance of approximately 2,500 mi. of roads in the state highway system and for meeting the overhead expense of the department. This year the department has under construction 315 mi. of hard-surface roads.

The commission's bill now being prepared for the special session of the state legislature to be held shortly will ask for a state highway levy of 30c. on each $100 of assessed valuation in the state. Mr. Wright estimates that on the anticipated $6,000,000,000 state total assessed valuation of this year the levy would produce $18,000,000 revenue for the department. He estimated that to the direct tax would be added $5,000,000, the maximum amount the department may obtain from the federal government for road building next year. From the inheritance tax $500,000 is expected and the automobile license department will add at least $2,500,000, according to present estimates.

The total thus available for the department next year would be $26,000,000. This may be increased $2,500,000 by the proposed doubling of the state automobile license fees, but, Mr. Wright said, the state highway commission does not propose to ask the legislature to double the fees, although, he said, such a bill may be introduced at the special session by others.

He estimated that the maintenance department would spend about $3,000,000 or more and that the maintenance and overhead would about consume the combined automobile license receipts and the inheritance tax collections. He figured that this would leave approximately $22,000,000 for road and bridge building.

Dr. Smith Has Longest Term as Director of U. S. G. S.

During the past forty years the U. S. Geological Survey has had but three directors. This period has been almost equally divided among J. W. Powell, C. D. Walcott and George Otis Smith, but on Aug. 14, Dr. Smith exceeded the term of office of Major Powell, who previously had the distinction of having served longer in that position than any of the other directors. Dr. Smith will complete his fourteenth consecutive year as the head of the Survey next May. The Geological Survey was created forty-one years ago. Technically speaking it has had four directors, but Clarence King accepted the first directorship only for the purpose of organizing the bureau and served the new organization for but one year in that capacity.

Railroad Equipment Corporation Formed Under Law

Papers were filed in Baltimore July 29 by S. Davies Warfield, president of the National Association of Owners of Railroad Securities, incorporating the National Railway Service Corporation under the laws of Maryland. The charter gives powers to aid, assist, further and supplement the service of transportation by carriers by railroad subject to Federal regulation; to carry on the business and enterprise of constructing, acquiring by purchase or lease or otherwise, selling, leasing, and otherwise contracting with reference to, maintaining, managing, repairing, disposing of and dealing in locomotives, cars, rolling stock, equipment, appliances, materials and supplies required by carriers by railroad; to receive, administer, invest, lend or otherwise employ or deal with any fund or other assets which may be loaned or made available to the corporation by the Interstate Commerce Commission pursuant to the provisions of the Transportation Act, 1920, as now or hereafter amended, or any other act, or by the United States or by any other party or from any source; to act as an agency of the Interstate Commerce Commission in the matter of loans for the purchase of equipment and to assist or serve the said commission in any other capacity or way now or hereafter authorized by law.

Corporation's Power

The corporation shall have power to act as an agency of the President of the United States in the discharge of any functions relating to Federal control or the relinquishment of all liquidation thereof which may be authorized by the President in conformity with law.

In connection with the incorporation, Mr. Warfield made a statement, which, in part, follows:

"The organization of the National Railway Service Corporation completes as far as is now practicable the plan for the return and regulation of the railroads presented to the Interstate Commerce Committees of Congress in January, 1919, by the National Association of Owners of Railroad Securities. Two of the three fundamental features initiated by the association in that plan are now essential features of the present Transportation Act. One is the mandatory provision that rates are to be made to yield the fixed percentage return named in the act upon railroad property in the aggregate and essential to preserve the transportation system and continue it under private ownership and operation. The second is a division of earnings of a railroad where rates yield to it more than six per cent on its individual property, one half to be retained by such road; the other half establishes a public fund to be expended by the Interstate Commerce Commission for transportation needs.

"The third fundamental of the plan provided for the organization of a national public corporation designed among other things to finance equipment to be leased or otherwise acquired by railroads. We thought we could foresee the necessity for providing the means to relieve the congestion bound to occur upon the return of the roads to their owners and now taking place.

"To accomplish as far as now practicable what was then intended, we are now organizing the public corporation to be called the National Railway Service Corporation, authority for which was obtained under an amendment to the Transportation Act added to the Sundry Civil Appropriation Bill and suggested by our association when that bill was in conference between the two houses of Congress. This amendment was adopted by the conferees and passed by Congress in the closing hours of the last session.

"Accordingly, the Interstate Commerce Commission has recognized the National Railway Service Corporation as an agency to which it will make loans under this amendment and to enable that corporation to provide additional funds to finance much needed equipment for the railroads."

Michigan To Give Graduate Short Courses in Highway Subjects

Graduate short courses in highway engineering and highway transport are to be given at the University of Michigan, Ann Arbor, beginning Dec. 8, 1920. The courses, which will be given by the various civil engineering professors, will be concluded March 25, 1921. Dates on which these short courses are to be given and the subjects included are given herewith:

Dec. 8 to 21: Highway Engineering Theory, Design and Economics. Grading Machinery and Operations.

Dec. 27, 1920 to Jan. 7, 1921: Highway Transport Surveys. Highway Specifications, Contracts, and Jurisprudence.

Jan. 10 to 21: Earth, Sand-Clay, Gravel and Broken Stone Roads. American and English Highway Transport Methods.

Jan. 24 to Feb. 4: Bituminous Surfaces and Bituminous Pavements. Bituminous Materials. Interrelationship of Highway, Railway and Waterway Transport.

Feb. 7 to 18: Mechanism, Operation and Maintenance of Motor Trucks, Tractors and Trailers. Highway Laboratory Research. Highway Structures. American and English Highway Traffic Legislation and Regulations.

Feb. 21 to 25: Seventh Annual Michigan Conference on Highway Engineering.

Feb. 28 to March 11: Brick, Cement-Concrete, Stone Block and Wood Block Pavements. Highway Engineering Seminar. Highway Transport Management, Costs and Record Systems.

March 14 to 25: Highway Engineering Financing, Administration, and Organizations. Highway Transport Seminar.

Notes from Corps of Engineers

Brig.-Gen. Amos A. Fries and Major Earl J. Atkisson have been formally released from the Corps of Engineers, U. S. Army, to become officers in the Chemical Warfare Service. These officers were associated with the Chemical Warfare Service since early in the war, but until now they have retained their status with the Corps of Engineers.

The examinations under the Army Reorganization bill for commissions in the various staff corps of the Army have been completed and all the papers have been forwarded to Washington, where their examination by special board has been begun. The Corps of Engineers, in particular, is suffering from a shortage of officers, but no forecast is ventured as to when the results of the examination will be announced.

Col. Mason M. Patrick, Lt.-Col. Gilbert A. Youngberg and Major F. B. Wilby form the committee on organization of engineer troops. The committee is acting in an advisory capacity to the committee of the General Staff, which has the entire organization of the Army in hand.

Law Would Give Road Contractors Partial Payments Each Mile

A measure that will authorize the director of the Indiana State Highway Commission to allow the contractor 90 per cent of the estimated cost of a mile of road when the mile is completed recently was passed by the senate of the Indiana legislature during a special session. Estimates on completed portions of the road are to be provided by the chief engineer of the state highway commission. The bill is expected to pass the lower house. It was brought up because of a general tightening of credit which made it almost impossible for road contractors to finance contracts.

Development of Oklahoma Asphalt Deposits Undertaken

Considerable development work upon the holdings of the Continental Asphalt & Petroleum Co. in southern Oklahoma is being undertaken by the E. W. Foley Contracting Corp. of New York City. The company's holdings, located in the heart of the Arbuckle Mountains, contain approximately 30,000,000 tons of natural rock asphalt, according to company estimates.

The company is building a railroad connecting the mines with the main line of the Santa Fe Railroad, and it is installing a modern asphalt crushing plant, together with a refinery and asphalt brick plant. It is estimated that the work will necessitate an expenditure of approximately $1,000,000.

Conferences on Water Power Law Enforcement

Conferences are scheduled to be held in Washington Aug. 12 and 13 at which the draft of portions of the regulations to be promulgated in connection with the Waterpower Act will be discussed. A committee of the National Electric Light Association, as well as representatives of various private interests, will attend the conference of Aug. 12.

The regulations dealing with the financial features of the law will be discussed on Aug. 13. A number of large bond companies and banks have signified their intention of sending representatives.

A hearing has been scheduled for Aug. 24 at which officials of the Federal Power Commission will discuss the Great Falls project with the Public Utilities Commissioners of Virginia and of Maryland and the Commissioners of the District of Columbia. Each of the railroads entering Washington has been asked to send representatives to this hearing. The large consumers of power in Washington and throughout the Great Falls area also are to have representatives in attendance.

Hydro-Electric Commission Organized in New Brunswick

A government commission to control water power in the Province of New Brunswick, Canada, similar to the Ontario body, has been organized under the name of the New Brunswick Hydro-Electric Commission. C. O. Foss of St. John has been elected chief engineer of the commission. According to preliminary statements the commission has adopted the policy of proceeding with the development of three water powers—the Shogmoc for St. John Valley, the Letreaux for St. John, and the Tetagouche for the north shore.

City's Engineering Service Threatened, Says Chicago Society

Resolutions passed by the Chicago chapter of the American Association of Engineers charge that the morale of the city's engineering bureaus is threatened with destruction as a result of the dismissal of T. G. Pihlfeldt and H. E. Young, bridge engineers, on the part of the civil service commission two months ago. The chapter calls upon Mayor Thompson to remove from office the three civil service commissioners and C. R. Francis, Commissioner of Public Works.

Examination of the evidence by a committee of engineers having shown the discharge of the two bridge engineers to be unwarranted, the resolution declares that their trial by the commission was a farce and an exhibition of spoils politics. It also urges all members of the engineering profession to refrain from entering the city's service under the present conditions.

Philadelphia Appropriates Money for Bridge Preliminaries

Following a meeting of the joint New Jersey and Pennsylvania interstate bridge commissions two weeks ago, when Mayor Moore of Philadelphia stated that the city's contribution of $250,000 toward the expenses of preliminary study for a Delaware River bridge had not been legally authorized, the city council has enacted an ordinance appropriating the required sum for the bridge investigation. With this action the appropriations of the Pennsylvania and New Jersey state legislatures for the work become available. It is expected that definite organization for the engineering preliminaries will be created by the joint commissions in the near future.

Detroit to Vote on Bond Issue of $37,000,000

Bond issues totalling $37,000,000 will be passed upon by the voters of the city of Detroit on Aug. 31 to provide for waterworks and sewer extensions.

Construction of the proposed new filtration plant and extensions to the city's water system will be financed from a $12,000,000 public utility bond issue, if passed. Of this sum $5,000,000 is to be used for the construction of a filtration plant and the remainder of the $12,000,000 is to be spread over water extensions for the coming five-year period. Plans for the filtration plant have been in preparation for some time, experiments have been conducted and items have been included in the water board budget from time to time looking toward the construction of the plant for which the bond issue will make the money available immediately.

The $25,000,000 issue to be voted for sewers will enable the city to proceed as rapidly as possible with sewer construction, without being held back each year by the 2 per cent limitation placed on the total budget.

The basis of the bond issue is made up from the following program:

Linwood system extension	$150,000
Six Mile Road—Conant to Linwood	1,759,000
Third Street extension	900,000
Michigan Ave	80,000
Small arms	1,200,000
Livernois	1,500,000
Connor's Creek project	13,000,000
Additional Bates Street	2,100,000
Joy Road extension	1,160,000
Six Mile Road—Linwood to Livernois	611,000
Seven Mile Road	2,200,000
Snyder Road	2,000,000
Connor's Creek interceptors	1,035,000
Total	$27,695,000

The Connor's Creek drain will care for the north and northeast sections of the city and the Bates Street project will take care of sewage in the central part of the city as far north as Highland Park.

It is expected that the sum asked for will be adequate to carry out the sewer program proposed by C. W. Hubbell, city engineer, and planned to care for a population of 2,500,000.

Decide on Plan for Detroit Grade Crossing Elimination

The plan to be followed in the separation of grades along the Detroit, Grand Haven and Milwaukee tracks, known as the Grand Trunk-Dequindre project, has been decided upon by the Michigan Public Utilities Commission as the plan proposed by the city which provides for a depression of the railway tracks from the Brush Street station to Milwaukee Junction.

The order just issued by the commission states that the separation of the grades of the Detroit, Grand Haven and Milwaukee Railway Co., and intersecting streets along Dequindre Street is necessary for safety and protection of the public, and that the commission approves and adopts the general plan by the city of Detroit whereby the grade of the railway is lowered all along Dequindre Street from Brush Street to Milwaukee Junction and the streets are to pass over and above the railroad tracks. By this decision a controversy has been settled which has been under discussion since 1913.

The city will now endeavor to arrange with the company as to which sections will be taken up first so that a program will be decided upon and detailed plans worked out immediately. The City Plan Commission has also been consulted with a view to having determined beforehand what streets are to be widened. In event a street is to be widened at a later date provision will be made for the widening at the grade separation crossing by planning a bridge to correspond with the increased width when the bridges are being designed for the grade separation project.

Questions yet to be decided by the commission are date of beginning; apportionment of cost between the city and the company; abuttal damages and their distribution; streets to be closed during the progress of construction work.

The work for the city of Detroit is being directed by John Reid, engineer, Department of Grade Separations.

Ontario to Go Slow on Purchase of Interurban Railways

Premier Drury, of Ontario, has issued a statement defining the policy of the Provincial government in regard to the proposed purchase and construction of hydro-electric radial railways by the Hydro-Electric Power Commission under government guaranties. The commission, in addition to work already inaugurated involving commitments of several million dollars, against which the municipalities interested have issued debentures to an amount approximating $13,500,000, submitted to the government a proposal for the immediate purchase from the Federal Government of the Toronto Eastern Ry., the Toronto Suburban Ry. and the Niagara, St. Catharines & Toronto Ry. at a total cost of $6,873,374. The Gov-

ernment has decided that the proposals of the commission cannot be adopted until the whole subject has been fully and exhaustively examined, the matter being of too great importance to be dealt with hastily. The Government has therefore appointed a commission to study the problem and to hold public hearings. The statement concludes as follows, "In the meantime all action in the direction of further outlays or the assumption of further responsibilities in radial matters by the Hydro-Electric Commission will be stayed."

The principal considerations actuating the government in calling a halt to the projects of the Hydro-Electric Commission are of a financial character. To date it is pointed out the province has advanced approximately $56,750,000 to the Hydro-Electric Commission and in connection with the Central Ontario system. It has also guaranteed bonds bringing its obligations to practically $65,000,000, or 52% of the provincial debt. In addition the province will have to supply in the near future over $32,000,000 in cash to complete the Chippawa, Nipigon and other power works now in process of construction, and in other ways the province is already committed to Hydro expenditures totaling nearly $40,000,000. In all the government estimates the aggregate Hydro expenditures at $104,000,000.

Railroad Construction Budgets Reported Increased

It has been made known that the assurance of improved credit of the railroads, following the announcement of the Interstate Commerce Commission of an increase of from 25 to 40 per cent in rates, has led railroad managements to plan on increases in budgets for construction up to 20 per cent more than amounts previously indicated in reports by 106 railroads made to the commission last April. It is thought also that large increases in maintenance items will be quite general. Out of the 171 class 1 roads, 249 class 2, and 1,000 class 3 roads, the report of last April to the Interstate Commerce Commission included only 106 companies (among which, however, are some of the largest trunk lines in the country) and indicated an item of over $282,000,000 in the 1920 budgets for additions and betterments exclusive of equipment. This item increased by about 20 per cent would become almost $350,000,000, representing only the 106 roads in question.

According to the report made to the commission, the item included the following:

	United States 106 Roads
Additional main tracks	$22,165,000
Additional yard tracks and sidings	41,149,000
Signals and interlocking plants	6,549,000
Shops	43,273,000
Stations and station facilities	15,136,000
Extensions and branches	5,906,000
All other road improvements	148,370,000
Total	$282,548,000

Some of the larger projects are: Double tracking on the Virginian Ry., further extension of the Cedar Hill yards of the New Haven, the Pennsylvania's extension to Detroit, and enlargement of the Detroit terminal of the Ann Arbor R.R., tunnel elimination work on the Delaware & Hudson, line revision and increased trackage of the Evansville, Indianapolis & Terre Haute, new grain and coal piers of the Western Maryland and Pennsylvania in Baltimore, enlargement of terminals at Fort Worth, Tex., line revision on the Norfolk Southern, and a cut-off on the Kanawha & Michigan.

Another East River Subway Tunnel Opened to Traffic

On Aug. 1 train service started through the Whitehall St.-Montague St. rapid-transit tunnel under the East River, New York City. The tunnel consists of two cast-iron tubes, the easterly half of the length driven by shield and the westerly half excavated in rock under normal air. It connects on the Manhattan side with the Brooklyn Rapid Transit subway going through Church St., Vesey St., Broadway, Seventh Ave., 59th St., and through the 60th St. tunnel to Queens Borough. On the Brooklyn side it connects with the Fourth Ave. subway line. The opening of the Montague St. connection virtually completes the downtown rapid-transit systems of Manhattan and Brooklyn. Three pairs of tunnels now constitute the Battery group of rapid-transit lines under the East River: the old Battery tunnels (South Ferry to Joraleman St.), the Montague St. tunnels, and the Old Slip-Clark St. tunnels. The first and third are operating parts of the Interborough Rapid Transit Co. system, being the downtown river crossings of the Lexington Ave. or east-side line and the Seventh Ave. or west-side line.

City Planning Commission for Kansas City, Kan.

A city planning commission with advisory powers, consisting of one member from each of seven districts of the city, has been created at Kansas City, Kan. The members serve without pay, but will have a paid secretary.

Civil Service Examinations

United States

For the United States civil service examinations listed below apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the Civil Service Commission, for Form 1312.

Assistant Director of Statistics, $5,000 to $6,000 a year. File application not later than Aug. 31.

Building Estimator, $1,800 to $2,400 a year. File application not later than Sept. 7.

Instrumentman, $5.20 to $8.40 per diem. File application not later than Sept. 7.

Junior Drainage Engineer, $1,200 to $1,920 a year. File application not later than Sept. 22.

Engineering Draftsman, $1,200 to $3,000 a year. File application not later than Sept. 21.

Topographic Draftsman, $1,200 to $3,000 a year. File application not later than Sept. 21.

Canada

Application forms properly filled in must be filed in the office of the Civil Service Commission not later than Aug. 27. Application forms may be obtained from the office of the Employment Service of Canada, or from the Secretary of the Civil Service Commission, Ottawa.

Junior engineers, $1,680 to $2,040 a year.

Statisticians, $2,400 to $3,120 a year.

Senior draftsmen, $1,680 to $2,040 a year.

Engineering Societies

Calendar

Annual Meetings

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Sept. 13-17.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Valparaiso, Ind.; St. Louis, Oct. 10-15.

The Duluth (Minn.) Engineers' Club, at its annual meeting held Aug. 2, elected the following officers: President, W. S. Heald; first vice-president, O. B. Bjorge; second vice-president, Ray S. Huey; secretary, George C. Olmsted; treasurer, A. U. Shipman; directors, A. M. Frazee, Frank Hutchinson, W. J. Mathews, Col. F. A. Pope; representative on the Minnesota Joint Engineering Board, W. H. Woodbury; delegate to Organization Committee of the Minnesota Federation of Engineers, J. L. Pickles.

The North Carolina Society of Engineers will hold its annual convention at Asheville Aug. 12-14. The most important matter to be taken up at the convention will be the state licensing of engineers and surveyors. It is expected that a committee will be appointed to attempt to secure the passage of a bill for that purpose at the next session of the legislature. The first session will be held on the evening of Aug. 12, at which the charter of the Asheville Chapter of the American Association of Engineers will also be delivered. Three sessions will be held Aug. 13, the morning session to be addressed by Charles E. Waddell, consulting engineer, Asheville, who will speak on state licensing of engineers; W. S. Fallis, state highway engineer, and T. H. Gatlin, assistant vice-president of the Southern Railway. In

the afternoon Edwin W. Myers, hydraulic engineer, will talk on the state's water resources. Addresses will also be made by representatives of the Knoxville and Charlotte Chapters of the A.A.E. A business meeting will be held in the evening. Saturday the members and guests will take an excursion to the Pisgah National Forest.

The Southern California Section, Am. Soc. C. E. held a meeting at Los Angeles July 14, at which a number of committee reports were presented. Upon the reading of the report of the Committee on California Engineering Council, it was agreed that action thereon be deferred and that the chairman of the committee be empowered to confer with the Committee of Joint Technical Societies of Los Angeles. The report of the committee appointed to revise the ordinance relative to the signature of a licensed architect required on plans for concrete buildings was heard and adopted. The revised ordinance provided for signature by a licensed architect or recognized qualified engineer. The committee was made a standing committee to consider present building ordinances and recommend such changes as seemed advisable. The report of the Committee on Jurisdictional Awards was then presented, and the chairman was directed to send a copy of it to the board of directors of the parent society and also copies to the other local sections. The report of the Committee on Terminal Investigation received considerable discussion. It was finally accepted, with the insertion of a clause to the effect that the Sachse report was not conclusive nor satisfactory in regard to the freight terminal situation. The board of directors of the section was instructed to send a letter to Mayor Snyder of Los Angeles giving the conclusions of the committee.

Personal Notes

FRANK SUTTON, of the U. S. Geological Survey, will inspect the topographic work which has been done this year by the Geological Survey in New York, Vermont and Maine.

E. E. MCADAMS, formerly assistant to Dean Nagle of the Engineering Department, A. & M. College of Texas, has been appointed city manager of Bryan, Tex.

W. E. ANDERSON, recently city manager of Brownsville, Tex., has been appointed engineer for the irrigation district at San Benito, Tex. Mr. Anderson was formerly a member of the engineering firm of Maxey & Anderson, of Houston.

HENRY MAETZEL has resigned as city engineer of Columbus, Ohio. His position will not be filled at present, but Robert Simpson, assistant engineer in charge of flood improvement work, will assume charge of the city engineer's office. Mr. Maetzel will become associated with the Rail-Light Co.

C. D. YOUNG, vice-president of the American Society for Testing Materials, has been appointed the representative of that organization on Engineering Council to succeed Albert Ladd Colby. Mr. Young is general supervisor of stores, Pennsylvania System, at Philadelphia.

JULIAN C. SMITH has resigned as general manager of the Shawinigan Water & Power Co. to become vice-president of the new Dominion Engineering Works, Ltd., of Montreal.

THOMAS E. BOND, since 1915 assistant engineer on the International & Great Northern Ry., has been promoted to the position of assistant chief engineer, with headquarters at Palestine, Tex.

MAJOR FRANK P. ADAMS has resigned as city engineer of Chatham, Ont., and has been appointed city engineer of Brantford, Ont., succeeding T. Harry Jones, deceased.

ROMEO MORRISSETTE, until recently with the National Shipbuilding Corporation, Three Rivers, Que., has entered private practice as a consulting engineer in that city. He will give special attention to reports on water powers and timber lands in the St. Maurice district.

DABNEY H. MAURY, of Chicago, has been engaged by the city council of Elgin, Ill., to make a preliminary survey of the local water supply situation.

R. W. BURCHARD, of the U. S. Geological Survey, is completing a survey of the Boulder Canyon Reservoir site on the Colorado River.

WILLIAM B. DAVEY, the newly appointed city engineer of New Orleans, assumed the duties of that office Aug. 1. For the past three years he has been associated with the New Orleans Levee Board, and previous to that for ten years was engaged in looking after the drainage work of the Sewer and Water Board of New Orleans.

LIEUTENANT F. E. WILMOT, civil engineer, of Los Angeles, has been appointed resident engineer for the Republic of Santo Domingo. Previous to the war he had nine years' engineering experience in the Philippine Islands.

DUDLEY ATKINS, JR., formerly engineer of Doniphan County, Kan., has been appointed resident engineer on Federal Aid Project No. 53 in that county, with headquarters at Troy, Kan.

JOHN B. JOHNSON has resigned as bridge designing engineer in the service of the City of Chicago to accept a position as superintendent of bridge construction with the M. & P. Contract Co., Inc., of Rockport, Ind. Mr. Johnson will have charge of the construction of the new concrete arch bridge being built for the State of Illinois across the Kankakee River at Wilmington, Ill.

CHARLES O. LENZ, consulting engineer, New York City, has been appointed one of the consulting engineers for the Foundation Co., of New York City.

A. V. HELMS has been appointed resident engineer on Federal Aid Project No. 41 in Franklin County, with headquarters at Ottawa, Kan.

Obituary

CHARLES W. NEWTON, consulting engineer for the Bartlett Hayward Co., of Baltimore, died Aug. 6 in that city. He was born in Boston in 1834 and was a veteran of the Civil War.

DAVID CHAUNCEY SHEPARD, railroad builder and formerly engineer on the Erie Canal, died recently at St. Paul, Minn. Mr. Shepard was engaged on the construction of much of the Great Northern and Canadian Pacific Railroads. He was a member of the American Society of Civil Engineers.

EDWARD H. HOLDEN, assistant engineer, Topographical Bureau, Borough of the Bronx, New York City, died Aug. 7, at sixty-four years of age. He had been connected with the bureau for twenty-seven years and was also consulting engineer to the City of Yonkers, N. Y.

Business News

THE LEHIGH STRUCTURAL STEEL CO., Allentown, Pa., has established an office in Philadelphia, Pa.

THE EASTON CAR & CONSTRUCTION CO., Easton, Pa., announces the opening of a new office in Chicago to take care of the increasing business in the west and middle-west districts.

THE CONCRETE MIXING & PLACING CO., Chicago, has resumed business on the return from war service of its president, H. B. Kirkland. The company may be addressed at 123 W. Madison St., Chicago.

THE AURORA PUMP & MANUFACTURING CO., of Aurora, Ill., is the name of a new organization which has just completed the erection of an up-to-date factory, equipped with modern machinery, to manufacture a full line of hydraulic pumping machinery. The officers of the company are: President, P. G. Hartz; vice-president, L W. Bodinson; secretary and treasurer W. L. Todd

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E. J. MEHREN
Editor

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Concrete for Rats

THREAT of bubonic plague is leading the health officers of New York, Philadelphia and other cities to make a vigorous campaign against rats. Always a serious economic drain because of their heavy toll on foodstuffs, rats become a cause of alarm when bubonic plague reaches our seaports, as it has done recently. Rat extermination is the order of the day, under such conditions. Concrete rat stops and concrete instead of wood structures along the waterfront are efficient and permanent measures against rats that should be supported by all good citizens and leaders of civic thought and action in rat infested communities.

The Ethics of Promotion

ARE the ethics of promotion like snakes in Ireland—notable by their absence? The discussion may well be limited here to the sort of promotion encountered by engineers in municipal practice and be further confined to those cases where an engineer thoroughly conversant with his field has been engaged to prepare plans for a specific piece of improvement and has submitted the plans for final approval. He has studied every aspect of the case and out of many methods which somewhere have served well to do the work in hand he has selected the one which his experience and his cost estimates indicate will, under local conditions, produce the desired result at the lowest cost, or perchance the best results at a reasonable cost. At this juncture the promoter arrives. He has a single proprietary method or apparatus for doing work which can be done more or less well and expensively by various methods or apparatus. All these possibilities, or the most promising of them, have been canvassed by the engineer, and his choice, as already indicated, has been made. Has the promoter any code of ethics to serve as a guide in such cases and if so, what is it?

City or Contract Work

WEIGHED in the balance by three engineers, the advantages and disadvantages of city cleansing at Philadelphia by municipal as against contract forces show a decided tip of the scales for municipal work, as may be seen by extracts from the report printed on p. 357. This, as the full report shows (see *Journal* of the Engineers' Club of Philadelphia for August) is in line with the conclusions reached and put into practice by other large cities of the country—particularly as regards street cleaning and in lesser degree as to refuse collection. As we pointed out last week, the reform administration at Philadelphia will be judged, both as to good intent and ability, by the way it handles its city cleansing problems of the coming year. Engineers stand ready to see that the work is done honestly and efficiently. The question at issue is, do those who have the decision as to ways and means care most for good work at the lowest possible price or for whether it is done by a contractor of this or that political faction? The answer to this question is more important than whether the work is to be done by contract or by the city direct, although the people of Philadelphia have reason to suppose that direct city work was virtually decided on when the new charter was enacted and made sure when the present administration came into power.

Housing to the Front

THE housing shortage is emphasized anew by the announcement that in the month of July plans for only one apartment house and for one dwelling were filed in Manhattan Borough, New York City, and by the calling by Governor Smith of a special session of the New York legislature to deal with the serious housing shortage in the cities of the entire state. The subject is also to come up again soon in an adjourned session of the New Jersey Senate. It has been given serious attention by the authorities of New York, Jersey City, Newark, Providence and other cities for months past. State and city action on housing is so new in this country, and the housing problem here is so acute and so complex, that attention may well be given to a couple of books on housing reviewed on p. 370. No one responsible for reaching a decision as to how to meet our housing problem should fail to read the British book, since it details years of governmental experience in England, as well as the elaborate Parliamentary acts and the administrative procedure under them. The American book is well worth reading, but its contents are stimulating rather than of direct practical application—or perhaps one should say of immediate general application, along the lines urged by its author. The housing problem comes home to the engineer because of the certain reaction of the demand for so much labor, material, transportation and capital upon construction activities more in his domain and also because the engineer must take no small part in sharing the problem if it is to be adequately and quickly solved.

Railway Rate Reactions

NEXT week the new railway rates go into effect. There is division of opinion as to their reaction on the ultimate consumer, but most people expect that the public will bear not only the increased rates but several accretions of added charges as well. The only argument to the contrary worth considering is that with higher rates the railway will give so much better service that production costs will fall and profits rise, but the past few years have made the average citizen skeptical of the immediate reaction of economic laws. The instinct to get while the getting is good seems farther than ever from being overcome. Consequently, the

skeptics believe that even if the higher rates should decrease production costs the producers will still find a way to pass on to the consumers the whole of the increase of rates—probably with something added, as has already been suggested. Regardless of this, it should be remembered that months and in some cases years will be required to convert the increased rates into better service, even assuming that they do make possible large loans for construction and equipment. It will take time to negotiate loans, get new cars and locomotives, provide better roadbed and track and larger terminals. The rise in rates is immediate. The improvements in service will come slowly and their effect upon general production will be slower yet. The one thing that ought to be improved immediately is the morale of the men and the management, which have been at low ebb. With higher wages and increased rates there should be betterment in both, with consequent better service. The public, certainly, will not be disposed much longer to take excuses which in the past year have sometimes seemed to be only a substitute for effort. Even with a better morale all around, there is danger of a rise in prices for commodities and services due to higher rates that will be not a fraction but a multiple of the rate increases. Public opinion alone can afford protection against that. Unfortunately the public is unorganized and has no agent that can reach out quickly and surely to put down the ubiquitous gargentuan profiteer.

Economy May Mean Spending

NEARLY every proverb has its antithesis. Thus, on the one hand there is the advice to "do the best with what we have" and on the other it is urged that "the best is the cheapest." The conflict between these contrasting lines of policy in engineering work is suggested by discussions at the annual meeting of the mechanical section of the American Railroad Association. It appears that in many cases the policy of utilizing old plant and following old methods is being carried to a point where it results in direct waste and loss. The common reason or excuse assigned is inability to obtain money. But under the conditions noted it should not be difficult to demonstrate conclusively that small immediate expenditure may mean a direct and continual saving. Have the men with the knowledge and responsibility failed to make this demonstration successfully?

In car repair work, for instance, it is still common practice to have gangs of men with jacks raise the car bodies from the trucks, a slow and troublesome job. If this was occasional work the practice might be justified, but it is work that goes on day after day, year in and year out. An overhead crane or gantry would do the work in less time and with fewer men, while the men would put in their time on productive repair work instead of non-productive hoisting. The same conditions may be found in some locomotive repair shops, where small and old machines are strengthened, modified or coaxed to do the necessary work of modern equipment. In some cases this may be true economy. But in many more cases it means loss of time and energy, high cost of work and waste of material spoiled or given ineffective treatment.

These conditions are not peculiar to the railways but occur more or less in all lines of industry. In construction work, for example, there is frequently a tendency to use old or inadequate equipment in order to save expense. But if this results in delaying the work by breakdowns or insufficient capacity, the financial loss may far exceed the cost that would have provided more satisfactory equipment, to say nothing of the worry, friction and possible ill feeling between the contractor and the engineer or owner. In rarer cases there is the unnecessary expense of special employment, the cost of which is not justified by the work or the results. Such excess of plant may prove a losing investment.

What is needed is more careful exercise of judgment as to the relations between the plant and the work, as well as the relative economy of saving and spending, with a wider realization of the fact that direct saving may result from spending and that avoiding expense is not necessarily economy. In other words, a more judicial balancing of the opposing policies of "make it do" and "get something better."

Educate the Concrete Foreman

THERE is probably a wider gap between theory and practice in the making and placing of concrete than in any other field of engineering endeavor. For years past the pages of technical journals and of engineering society proceedings have been full of discussions of the technique of concrete. Quality and grading of material have been studied without end and the results of these studies placed before the profession. Insistence on certain proper methods of manufacture is the commonplace of all concrete literature and the evil effects of neglect of all the well known rules—or rather the increased effectiveness of concrete placed according to these rules—have been hammered home again and again. And yet one hour spent on almost any concrete job will show consistent violation of some of the principles which theoretically are universally accepted.

These violations are not as a rule major mistakes. It is rarely, for instance, that today we find rank skinning of cement which was common some years ago. They are such things as short-time mixing and more particularly careless measuring of material. There is no intention on the part of the foreman of saving money at the expense of the concrete but rather a lack of appreciation of the niceties of concrete manufacture. To him it is not the balanced conglomerate of the laboratory, whose strength rises or falls with small variations of content or procedure, but a mushy material which some days later, when the forms are stripped, appears as a hard stone, which can be porous and pitted if very poorly made but which as a rule is of unknown but sufficient strength. Concrete testing 1,500 lb. at 28 days does not look any different in the structure than that testing 2,500 lb.

In other words, in spite of the investigations and cogitations of engineers, the finished concrete still remains largely the product of the foreman and the inspector. These men need more education into what may truly be called the mysteries of concrete, and furthermore the manufacture of concrete should be made more and more an automatic process, so that the personal vagaries of the workman and his boss cannot affect it. In these days of \$3 to \$4 cement and \$2 to \$3 aggregate, every little saving of material helps. If by constant watching or by automatic control a sufficiently

strong concrete can be consistently produced with less costly material the effort is worth while.

It has been the fashion to disparage the efforts of the so-called "laboratory experts" to produce a better concrete. Those who have done so recognize the conditions under which most concrete is placed. They despair of ever getting a concrete gang to follow the rules other than those established by years of practice. The time has come, though, when engineers ought to consider whether the practice of the concrete gang can not be reformed, whether it is not possible regularly to measure and control the mix to a far closer degree than is now common. Engineers and laboratory men can select proper materials and specify proper methods. Only the man on the job can make sure they are regularly used or followed. And the man on the job needs to be impressed with the fact that concrete strengths vary and vary decidedly with methods and materials. He must be persuaded some way or other that a solid appearance does not necessarily mean a satisfactory strength.

Most concrete that is placed stands up under the service required by it. Long ago it was found that it would take more abuse than any other material. But the price of concrete today is so high that it behooves all who are using it to consider whether by more careful methods—and mainly by more care and knowledge on the part of the man actually placing the concrete—it would not be possible to cut down the factor of safety in design and to insure more nearly than now the adherence to a predetermined strength. Some of the large users of concrete are appreciating this necessity for getting right down to the concrete worker and are being repaid in consistently good concrete. The general user can benefit by their lesson.

Civil Engineers to Have Referendum Vote on Society Federation

DEVELOPMENTS at the annual convention of the American Society of Civil Engineers held in Portland, Ore., last week, as reported in further detail in the news section of this issue, point to an early decision of the question whether or not that organization will join the Federated American Engineering Societies. This is good news. It is now almost three months since the Organizing Conference, at Washington, D. C., laid the foundation for the federation. Since that time there has been ample opportunity for members of the profession to inform themselves as to the basis of organization and general objects of the new body. Nothing is to be gained by delaying, longer, a decision on this important question, particularly in view of the fact that the first meeting of the American Engineering Council, the directing body of the federation, is scheduled for November. As matters now stand two local engineering societies, Dallas and Detroit, and two national bodies, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, have definitely accepted the invitation to become charter members of the federated societies. Action by the electrical engineers took place Aug. 12, when the board of directors passed a resolution accepting membership in the federation and pledging the co-operation of the society to its work. Of the four founder societies, therefore, the civil engineers and the mining engineers still remain to be heard from.

Apparently when the board of direction of the American Society of Civil Engineers met at Portland on the day before the convention opened there was some doubt as to the legal status of the society's joining the federation, and action was taken to defer the referendum vote until the opinion of the organization's legal counsel could be secured. The convention itself, however, by an overwhelming vote, overruled this decision and indicated clearly that the wish of the membership was for the submission of the referendum ballot "at once." Deferring to this expression of opinion the board of direction, in a later resolution, instructed the secretary of the society to send out the ballot without waiting for legal advice.

The decision of the civil engineers, therefore, unlike that of the electrical and mechanical engineers, whose directorates acted for the respective organizations, will be based upon a representative vote of the rank and file. This being the case, it is the duty of every corporate member, as has been emphasized by this journal in past editorials, to familiarize himself with all phases of the federation question in order that he may cast his vote intelligently. The attainment of this object is clearly sought by the board, for with the referendum ballot it is proposed to send to the members carefully prepared arguments for and against the federation, together with a copy of the constitution and by-laws of the new body. A very full report of the Organizing Conference in Washington, D. C., at which the federation was formed, was published in *Engineering News-Record* of June 10. This report contained also a digest of the constitution and by-laws approved unanimously by the delegates. Since that time considerable space has been given to editorials and news articles dealing with this subject. Added to this material will be the American Society of Civil Engineers' arguments pro and con. With this mass of data available, therefore, there is no excuse for the engineer who has not an opinion on what the society's policy should be and who does not express that opinion by sending in his ballot.

The previous referendum ballot of the civil engineers on the question of endorsing the "comprehensive organization" proposed by the Joint Conference Committee produced a total vote of 3,821, or about 45 per cent of the membership entitled to vote. It is hoped that an even more general expression of opinion will be elicited by the vote on the question of joining the federation. Figures from the office of the secretary of the American Society of Civil Engineers indicate that on Aug. 10 there were 8,948 corporate members entitled to vote on the referendum, this number including those in the grade of "Member" and "Associate Member," but excluding "Junior." On the previous referendum ballot on the acceptance of the federation principle, canvassed April 14, the vote was very close, the proposal being defeated by 1,954 to 1,867, or a margin of 87 ballots.

Time and again engineers have been accused of utter indifference to questions involving the public welfare and their own interests. It remains to be seen, therefore, whether the decision as to charter membership in the Federated American Engineering Societies is regarded as of sufficient importance to bring out a vote from more than 45 per cent of those entitled to cast ballots. Unless civil engineers dodge a clear responsibility, a much heavier vote should be polled on the coming referendum than on the past one.

American Contractors and Labor Conditions in France

BY
E. J. Mehren
EDITOR ENGINEERING NEWS-RECORD

WHY have not American contractors participated in the rebuilding of the devastated regions of France? There were predictions at the time of the Armistice of great opportunities for them. Few of these opportunities have been realized. There are a number of reasons:

(1) The French want to rebuild according to French ideas, having regard also for the traditions of the ruined cities. These ideas are incompatible with the mass production proposed by some American contractors.

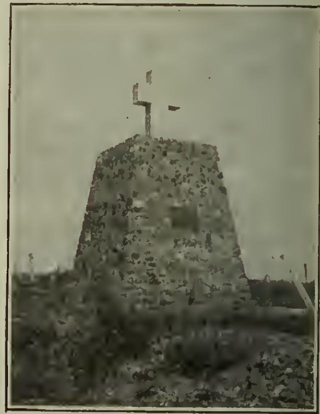
(2) The French have a pride in their ability to carry on construction. They resent the suggestion that they need help. There is, so far as I can learn, only one construction company here that represents American capital—and it is, in reality, a French company manned by French engineers and contractors. There are only three Americans in a responsible force of probably 50.

MILES OF AMERICAN PATENTED CAST-IRON PIPE IN GOVERNMENT BUILDING MATERIAL PARK AT ARRAS

(3) Construction can be taken in hand only so fast as the damages can be determined. This is an enormous task and necessarily can proceed only as rapidly as the relatively limited number of commissions of qualified men, familiar with local conditions, can work. With the fluctuations in wages and material prices, too, these damage credits are subject to frequent change. Under the law, an owner who rebuilds within 50 km. of the original site is paid the reproduction value as of the present date. Necessarily the estimate must be revised if wages and material costs change. A 20 per cent credit is wanted as soon as the damages are determined, and other advances made as the work proceeds. If an owner chooses not to rebuild, or to rebuild at a distant point, he receives damages based on values in 1914.

(4) The French Government wisely decided to concentrate on work in the order of its economic importance: First, the reclamation of the land, and the erection of temporary dwellings, then the restoration of the building-material industry, followed by the reconstruction of factories and the construction of permanent dwellings. The last feature has hardly yet been taken in hand. Therefore, plans for rebuilding whole towns in permanent construction were not in order early in 1919 and are scarcely in order today.

(5) Building materials are scarce and must be distributed so that in all districts and towns progress may be at about the same rate.



CANADIAN MONUMENT AT VIMY RIDGE

There are other reasons, but these are the really important ones.

It is worth noting that the financing of work was not referred to until the question was raised by the visitor. In other words, the various factors above mentioned have always disposed of the American contractor before the question of finance was reached. The traditional position that all flows to the man with money did not hold here. Of course, France would still like to have American credits, but only to allow them to pay for raw material when the exchange has returned to normal or materially improved.

Financing of Contracts

The financing of contracts is, nevertheless, a matter of grave importance, but not due to failure to get estimates promptly, but to the necessity of carrying a large material supply. This applies to the relatively large operations—not to the building of one or two small dwellings, for which material is secured from the Government material depots. The root of the trouble is a combination of inadequate transportation facilities and material shortage. One must wait 3 months for deliveries. Consequently, the larger contractors are following the practice of taking work only in a given locality and carrying there large stocks, which are delivered to the building sites with their own truck fleets. The capital required is about 50 per cent of the amount of work done in a year. Sub-contracting, with the upset conditions, is very unsafe. For that reason most contractors do all the work themselves, and even go so far as to make the window frames, doors and trim in their own shops.

Material, it should be said, is paid for only after it has been built into the job.

Contracts are all on a unit-price basis, the bid price being considered a base price which is adjusted every three months in accordance with the fluctuations in labor and material prices. The contracts are made with individual owners or, for dwellings, with co-operative building societies, the membership of which is composed of those whose damages have been determined by the Government commissions. One may get a contract to build a whole village but, unless one wishes to carry the risk, only if the appraisal work has been finished and the owners have all joined the co-operative society.

TEMPORARY RAILROAD STATION AT LENS

The Government advances go into the treasury of the society, which, in turn, pays the contractor.

There is still much work to be done. In fact, only a beginning has been made, but the work is not likely to be done by American contractors. If they have capital to be employed they may use it in France if they want to lose their identity, and organize as a French company with French officials. Even then they will not get work, or succeed in what they get, unless they are willing to respect French customs and acquire some of that French tact to which we are largely strangers.

The last remark is made advisedly. Many who come here carry a superior air. It is naturally and rightfully resented. "I will bring a hundred Americans over here and show you how to do construction work," was said by the representatives of a strong American company to a French official. What chance would that organization have to get work, no matter how heavily its arms were laden with gold? I could cite other cases of boorish assertion of superiority—but this case will suffice. Our help will be welcome; but we must come here to help only. The French must do the work in their way. That does not mean that American construction methods cannot be used; they can be, if tactfully proposed and where conditions are suitable.

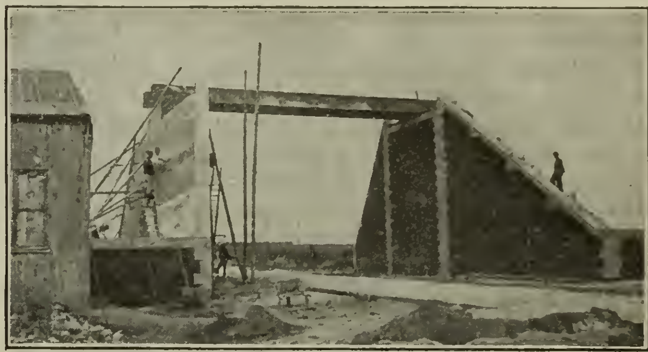
With reference to the reconstruction it is to be noted that it is proceeding much more rapidly than the work in Belgium. There only work in the cities and towns is proceeding. Such is not the case in France. Work of every kind is going forward and the progress is rapid.

Labor Conditions

A previous article also pointed out that labor conditions in the devastated regions are good. Wages are high but the men are working hard.

In the other parts of France conditions are not so favorable, but the recent improvement has been such that a decidedly optimistic tone has developed among the manufacturers, just as it has in Belgium. This optimism has developed largely because of the failure of the May-day strike.

The Confederation Generale du Travail, the French organization corresponding to our American Federation of Labor, had, previous to the war, been quite radical. During the war heavy responsibilities were imposed on the leaders, and, as usual, caused them to modify their program. At the same time, the war was a breeder of radicalism among the younger men. So strong did they become that the leaders were obliged, finally, to condone radicalism (just as Gompers did with us) or lose their jobs. The radical group felt they were ready for the test in May. The plan was nothing short of a social revolution, the establishment of the "Fourth Republic", with the workers in control. The strategy, so the radicals thought, was carefully worked out. There were to be successive "waves" of strikes until the government capitulated—first the railroad men were to strike, then, in succession the steel workers, the stevedores, etc. The strategy got no farther than the third wave, the stevedores. Very shortly it became apparent that the radicals were wrong in their calculations, that they did not have the majority of French workmen with them. Even on the railroads, the critical industry, the strike was not popular, except possibly on the Government railway system, the *Etat*. The proposed steel strike was a flat failure, the stevedores' strike somewhat more successful. For three weeks the losing fight was kept up, and when the C.G.T. called it off it was in hopeless defeat.



REBUILDING BRIDGE NEAR LENS

This it is that has produced the optimistic tone in France. It has been clearly demonstrated that the French worker proposes to stick to a sane economic system, that he will not turn Bolshevistic.

Since the strike, too, efficiency has increased materially. The workers show a better spirit. Evidently they have concluded that their own best interests are served by doing a good day's work.

The French workers, by the way, probably have less cause to complain than those in any other country. Wages have gone up in the same proportion as living costs—about 3½ times. Nevertheless, here as elsewhere, there has been a decrease in efficiency. In fact the 8-hour day is now required by law, though it is by common consent not observed in the devastated regions.

Employers' Attitude

As indicative of the liberalizing of the views of employers, formerly quite conservative, one movement gaining strength here may be noted—a plan whereby married men are paid more for the same work than unmarried men. The plan is administered through associations, each embracing all the industries of one kind in a given district. Each employer pays into the association's treasury weekly a given sum per employee. Out of this fund the married men are paid the extra wage. The amount varies somewhat in different districts, but is approximately 200 francs on the birth of a child and 20 francs per week for each child in the family. The plan is administered through associations not merely to give it greater stability but to insure the payment of the same extra ratio through the given industry in the given district.

Remarking upon the unusual character of the scheme and its negation of the "uniform pay for uniform work" slogan, I was met with the rejoinder, "We apply the differential in income taxation; why not in business? If the differential is sound in taxation, it is so in business."

Incidently the plan does not find favor with the C.G.T., for it tends to make the married man even more steady and unsusceptible to radical propaganda than he is today. What the radicals in the C. G. T. want is a large following of unattached men who will follow wherever the leaders wish to go.

American Construction Plant

Reference to industrial conditions naturally tempts one to inquire as to the prospects for the use here of American construction machinery. The situation is much the same in this respect as it is in Belgium: the present rate of exchange makes the purchase of American equipment prohibitive. Moreover, the attitude of the French contractor is rather less favorable to such equipment than is that of the Belgian; in other words, the French are rather more conservative.

If the labor costs stay up, there may be a change in this attitude. Around Paris common labor received before the war about 0.60 franc per hour (60 centimes or about 11½ cents at normal exchange). Now it receives 2 francs, about 3½ times as much. In the provinces the comparative rates are about 40 centimes and 2.35 francs, respectively. Skilled labor that received 1 franc before the war gets about 3.50 francs now. The French contractor is shrewd and able. He did not use machinery before because hand labor was more economical. If machinery can effect economies he will come to its use, though he will be sure of every step before he proceeds. Conservatism is the rule here.

Paris, June 15.

Influenza Halts Alaska Railway Work

An epidemic of influenza in April disorganized the construction forces on the northern division of the Alaskan Engineering Commission. The following notes are abstracted from the monthly report of Frederick D. Browne, engineer in charge:

On the Chatanika branch, at the steam shovel camp at Bridge No. 5, of fifty-two men at work but eight remained who did not require medical attention. The work was discontinued, with one man only left on the payroll to care for the rolling stock, steam shovel, etc., in addition to a cook and helper who remained. The pile driving crew was also disorganized. There is no doubt that a couple of weeks at least will intervene before we get back into our regular stride.

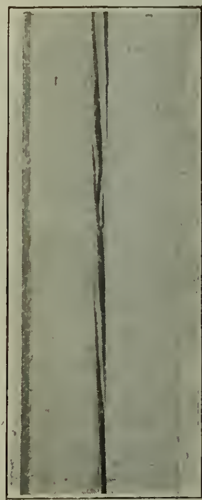
On May 1 there was no communication permitted between Fairbanks and Nenana, as there is a possibility that one of these infected districts will be purged of the scourge before the other district, and by intercommunication there is possibility that reinfection might occur. The epidemic seemed to sweep through all parts of the northern division. Whole contractors' camps have been abandoned, perhaps leaving a single caretaker. The influenza has not confined itself to any one class of men, but has gone through the clerical and engineering forces, as well as the laborers and stationmen. No fatalities have occurred, nor do we anticipate any.

On May 1 the hospital was filled to capacity. The Cooney Hotel and one of the dormitories are nearly full. The native Indian village, including the missionaries has over thirty prostrations.

Test of Timber Posts with Warp and Seasoning Cracks

By Tom W. Greene
Assistant Engineer Physicist, U. S. Bureau of Standards, Washington, D. C.

There has been some question as to the effect of cracking and warping due to the seasoning of timber on the strength of wooden columns. In the hasty construction of the temporary war buildings in Washington, D. C., during the war, it was necessary to use a large number of columns of unseasoned timber. In the process of drying out or seasoning, a large number of these columns developed seasoning cracking and warping. Some inspectors contended that these columns were not safe, so one good column and four columns representing the different conditions that had developed by seasoning were taken from a building and tested at the Bureau of Standards.



4 x 8½ VIRGINIA PINE POST CRACKED IN SEASONING

One of the columns was straight but full of large seasoning cracks; three were bent, the maximum deflection from the perpendicular being $1\frac{3}{16}$ in., $1\frac{1}{16}$ in. and $\frac{7}{8}$ in.; and one was in sound condition with no bending or cracking. The columns, 4 x 8 in. Virginia pine timber about 8½ ft. in length were tested as taken from the building, after the ends had been carefully squared for the flat heads of the testing machine.

The test showed that seasoning cracking alone does not appreciably affect the strength of straight columns. The column tested for this condition was an excellent sample of unusually severe seasoning cracking, one large crack about ½ in. wide extending nearly the whole length of the timber, having practically split the column, as shown in the view. This column showed greater strength than the sound column, which was probably due to the fact that the timber was in better condition, having a lower moisture content and higher specific gravity. It is to be expected that seasoning cracking of this nature would not materially weaken a column where the plane of cleavage is parallel to the plane of least dimension.

4 x 8½ VIRGINIA PINE POST CRACKED IN SEASONING

TESTS OF SEASONING CRACKED WOOD POSTS
4 x 8-In. by 8½-Ft. Virginia Pine

Column No.		Average Moisture Content, per Cent	Average Specific Gravity	Ultimate Strength, Lb.	Condition of Columns Taken from Building
1	97	11.0	0.61	116,300	Sound condition, no cracking or bending.
2	100	10.0	0.64	137,000	Straight but full of large seasoning cracks.
3	100	9.8	0.58	36,000	Warped maximum, deflection at center $1\frac{3}{16}$ in. from straight axis.
4	85	10.2	0.62	57,500	Warped, maximum deflection $1\frac{1}{16}$ in. at one-third the distance from end.
5	97	9.4	0.50	72,000	Warped and twisted, maximum deflection $\frac{7}{8}$ in. at center.

Any bending or warping produced by seasoning, however, considerably weakens a column. Two of the three bent columns which were tested showed about

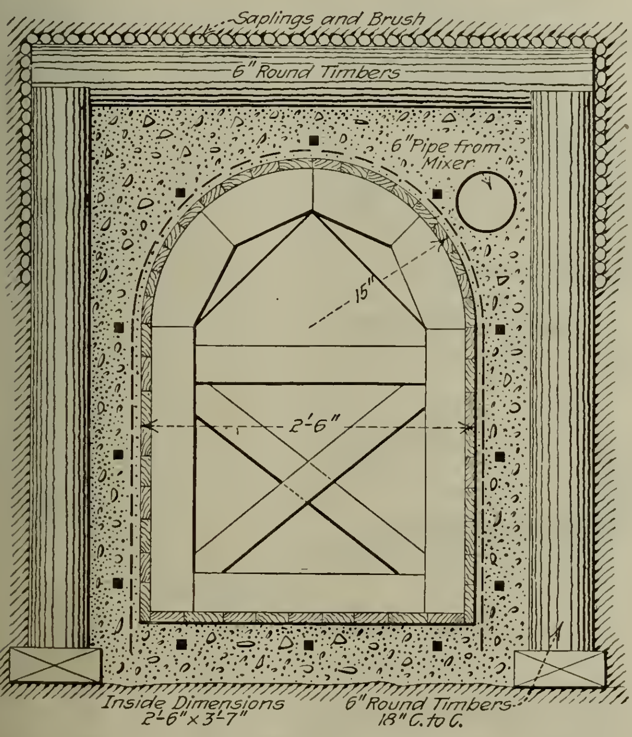
one-half the strength of a straight column and one had less than one-third the strength, which would render it unsafe for use. The weakest column and the maximum bend, the camber at the center in the plane of least dimension being 1$\frac{3}{16}$ in. A small increase in the deflection from the perpendicular due to warping materially reduces the strength of a column as shown in the accompanying table. The table contains the data for the ratio of length to least radius of gyration, average moisture content, average specific gravity, ultimate strength, and condition of the column tested.

Small Tunnel Lined By Pneumatic Method

By H. B. Kirkland

President, Concrete Mixing & Placing Co., Chicago

PNEUMATIC concreting of a small tunnel only 30 x 43 in. in net section and with a 6-in. lining was accomplished recently under difficult conditions at La Salle, Ill. This was a sewer tunnel about 280 ft. long for the Marquette Cement Manufacturing Co., and was in soft clay ground, with about 10 ft. cover and passing under mill buildings where heavy machinery was in operation.



SMALL TUNNEL CONCRETED WITH PNEUMATIC MIXER

The rectangular excavation was lined with square sets of 6-in. round rough timbers spaced about 18 in. c. to c., the roof and sides being covered with saplings and brush.

When the tunnel was completed and timbered, the forms for the lining were erected for a length of 30 ft. at one end and steel reinforcing bars were laid as shown, being supported on blocks in the sides and floor. With these bars in place there was very little room for inserting the delivery pipe for concreting. In fact the only point available was over the haunch on one side of the arch. As this 30-ft. length of 6-in. steel pipe weighed about 400 lb. and had bolted flange joints it was highly desirable to concrete the entire section at one setting of the pipe.

The pneumatic mixer was somewhat at a disadvantage under these conditions, partly because the pipe was below the highest point of the concrete to be placed and also because the opposite side of the form had to be filled from this one position of the pipe. Under the momentum of its discharge, however, with a pressure of 80 to 100 lb. in the delivery pipe, the concrete was forced over the crown of the arch, after the floor, wall and haunch on the pipe side had been filled, the weight of fluid concrete on the opposite side being sufficient to make it flow under the bottom form and so complete the floor lining.

In operation, the rear 15-ft. length of the form was filled first, the delivery pipe being then shortened and the concreting completed up to the forward bulkhead. It took about two hours to fill one 30-ft. length, with one man at the delivery pipe, one operator at the mixer, and five men to charge the mixer. A 1: 2½: 5 mix was used, with gravel aggregate of 1½-in. size. The men worked one 8-hr. shift each day and could place concrete at the rate of one ½-yd. batch per minute. When one section was completed, another 30-ft. length of form was erected, the end bulkhead of the first form removed and the concrete placed, these operations being repeated until the portal was reached. Each form was left in place for 24 hours. Progress was delayed by flood water backing up into the tunnel.

This work was done by day labor under the supervision of Richard Moyle, superintendent for the cement company. An experienced man of the Concrete Mixing & Placing Co., Chicago, makers of the pneumatic mixer, supervised the operations.

Co-ordination of Activities of State Health Engineers

AT THE recent conference of State and Territorial Health Officers with the U. S. Public Health Service at Washington, D. C., sanitary engineers from 23 states were in attendance, or from more than half of the 42 states represented. Besides attending the general conference, the sanitary engineers met in a separate section, together with representatives of the Public Health Service. After reviewing briefly the proceedings at the section meeting, *Public Health Report* (U. S. Public Health Service, Washington, D. C.) for June 4, 1920, says:

The topic, however, of greatest interest and concern to everyone of the group of state engineers was the means for co-ordinating the engineering activities of the various states. The need for standardization of policies and exchange of experiences among the sanitary engineers in official administrative positions was considered of paramount importance for increasing the efficiency of work in this field. It was the opinion of the state engineers that very much toward the co-ordination and standardization of the activities of state sanitary engineering divisions could be effected and properly accomplished by the U. S. Public Health Service. The specific request was made to the chief of the division of domestic quarantine for the full-time detail of an engineer to collect, analyze, and report to all state engineering divisions, data on the prevailing and proposed activities in this field. For this same purpose permanent standing committees were appointed as follows: Water Supply (including laboratory procedure), W. H. Dittoe, chairman; Sewage and Steam Pollution, V. M. Ehlers, chairman; Laws, Organization, Policy, and Procedure of State Sanitary Engineering Divisions, H. A. Whittaker, chairman; Milk Problems, Theodore Horton, chairman; Mosquito Control, R. Messer, chairman; Swimming Pool Sanitation, S. De M. Gage, chairman.

The Design of Cleveland's Sewage-Treatment Works

Three Plants to Protect Bathing Beaches and Prevent Nuisances in Cuyahoga River — Gratings, Grit Chambers and Two-Story Tanks with Disinfection for Two Lake-Front Plants—Final Design of River Plant Deferred

BY GEORGE B. GASCOIGNE
Sanitary Engineer, in charge Sub-Division of Sewage Disposal, City of Cleveland, Ohio

THE TWO large sewage-works now under construction for the City of Cleveland have several features of design which should be of interest. In discussing these, it is important, and also of interest, that the program for improving sewerage and water facilities be outlined briefly.

General Policy—For a number of years the problem of safeguarding the health of this community by purifying the water and treating the sewage, has been discussed, investigated and reported upon. A plan of procedure was eventually adopted, and is now being carried out. It provides for the construction of two large water filtration plants and three sewage treatment plants. The water plants will provide a definite control of the purity of the water supply, while the chief object of treating the sewage is, first, to protect the bathers who use the lake beaches, thereby safeguarding the public's health, and second, to correct the foul condition of the Cuyahoga River. It can be claimed, therefore, that the sewage-works are mainly necessary as a health measure on account of the existing bathing beaches, and that remedying the foul conditions of the Cuyahoga River is a matter largely of sentiment and public comfort. The present program is representative of the progressive spirit of the community and establishes a high standard of municipal sanitation.

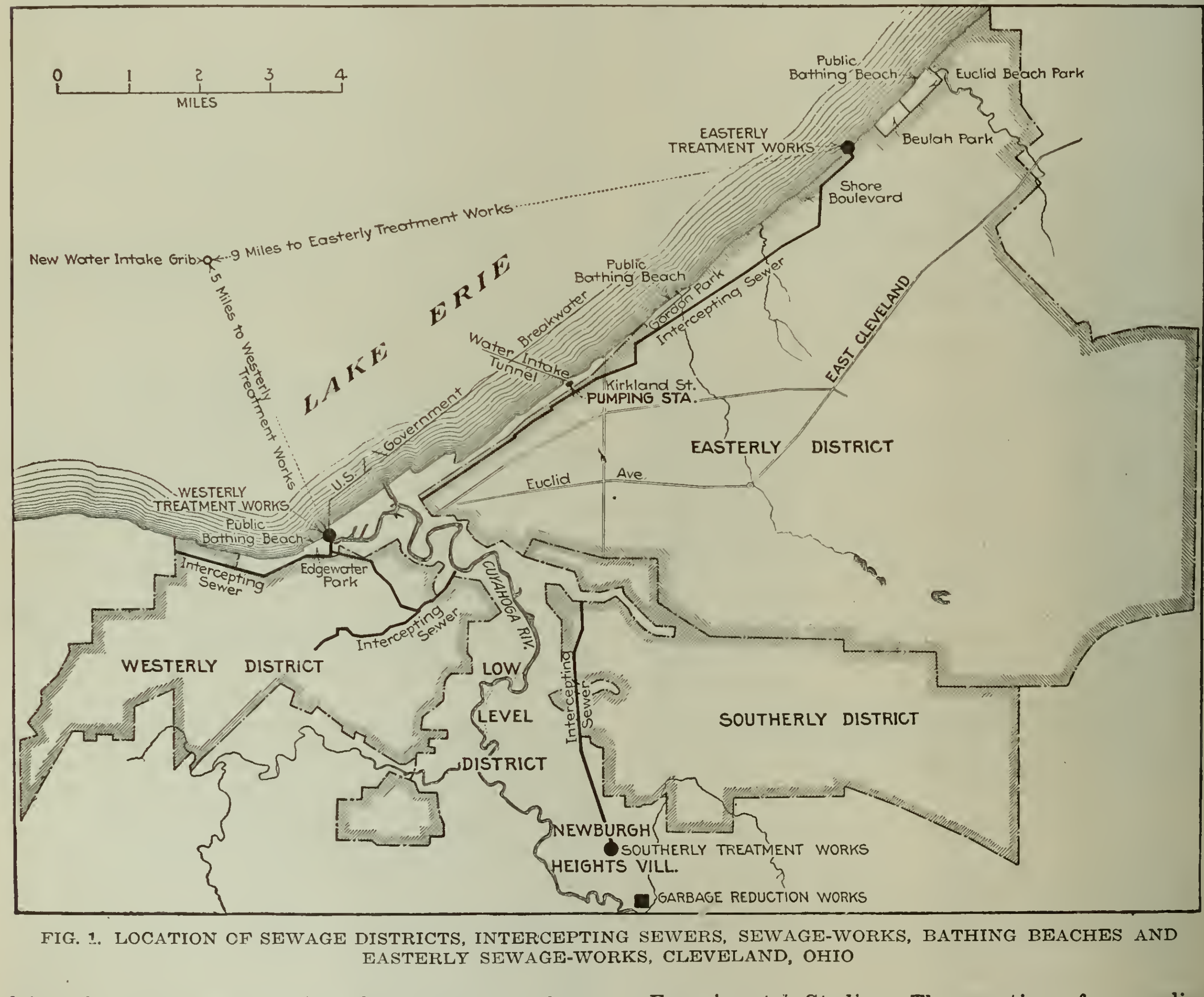


FIG. 1. LOCATION OF SEWAGE DISTRICTS, INTERCEPTING SEWERS, SEWAGE-WORKS, BATHING BEACHES AND EASTERLY SEWAGE-WORKS, CLEVELAND, OHIO

Experimental Studies.—The question of proceeding slowly with the completion of Cleveland's sewage disposal project has received considerable attention. It has seemed advisable to have a unanimity of opinion upon any steps taken and at the same time to take advantage of the latest developments of the art in order that the plants may represent the best in modern sewage disposal practice. While the idea of proceeding cautiously has existed, a determined attempt has been made to avoid unreasonable delay.

TABLE I. SHOWING SALIENT POINTS IN DESIGN OF CLEVELAND SEWAGE-WORKS

Sewerage Districts Name	Estimated as of 1930 Area Acres	Estimated as of 1930 Population	Location of Plants	Type of Plant	Estimated Population Design	Estimated Population Served in 1920	Sewage flows as of 1930 Gallons Per Capita Daily	Normal Dry Weather M. G. Daily	Maximum Wet Weather M. G. Daily	Estimated Cost Works Complete	Estimated Cost Already Done
Westerly	9,280	311,000	W. 58th St. at Lake Front	Sedimentation in grit chambers and 2-story settling tanks; chlorination and dispersion	288,000	194,000	125	36	159	$1,100,000	$400,000
Easterly	20,620	575,300	E. 140th St. at Lake Front.	Same as Westerly	575,000	422,000	160	92	1,055	$1,250,000	$825,000
Southerly	7,200	226,000	Willow, Ohio.	Sedimentation in grit chambers and 2-story settling tanks; oxidation in sprinkling filters	200,000		110	22	131		$300,000
Low Level	7,900	23,700	Undecided	Undecided							
TOTAL	45,000	1,136,000						*128		$2,350,000	

*Flow for Southerly plant omitted.

Although the art of sewage disposal is still developing, certain fundamental principles have been settled fairly definitely. In order to study these principles in their application to local conditions, it was necessary to conduct comprehensive investigations along experimental lines upon the treatment of the sewage at Cleveland. These studies have covered a wide field, in that they pertain to tests with various structures for settling sewage, for oxidizing by filtration and by dilution, for screening sewage and for its treatment by the newer activated-sludge process. Experiments were started in 1913, and to date have cost about $150,000.

Program of Procedure—Funds for constructing the treatment plants were provided on the basis of pre-war estimates but, since the work was not placed under contract until 1919, it was necessary to restrict the immediate program to the more important parts of the work, that is, treating the sewage discharged at the two lake front plants, the Westerly and Easterly, which together represent about 75 per cent of the total. At the Westerly plant the treatment will be relatively complete, while at the Easterly plant it will be partial. It is hoped by a comparison of results to establish the future necessity of providing additional treatment at the partial plant.

The City (Fig. 1) was divided into four sewerage districts, the Westerly, Easterly, Southerly and Low Level, and each district excepting the Low Level, has a main intercepting sewer to deliver sewage to the treatment site. The sewage of the Westerly and Easterly districts will be treated at two lake-front plants, while the sewage from the remainder of the city will be treated at a plant located on the Cuyahoga River, about seven miles from its mouth. Since lake water is not available at this site, it appears that ultimately structures which provide a higher degree of treatment will be necessary. Since contemplated river and harbor improvements along the Cuyahoga River involve an extensive plan for straightening the river channel, the problem of sewage disposal for the Low Level district, which bounds the river, is rendered especially uncertain at this time. As this district is occupied largely by manufacturing establishments, such as steel mills, oil refineries, lumber mills and similar industries, and contains less than two per cent of the city's population, it is considered advisable to delay the sanitary improvements until some time in the future.

Sewage Treatment Sites.—The location of the lake-front sewage disposal sites in reference to bathing beaches, parks, residences and boulevards, together with the districts which they serve, is shown in Fig. 1. Cleveland's main sewer outlets were so located in 1912 that without any additional expense it was possible to collect the sewage at three points instead of one, thereby extending considerably the useful life of the intercepting sewers. The treatment plants were therefore located at these outlets, creating a condition which emphasizes the importance of operating them without nuisances. The fact that the lake front plant sites are not well isolated has a distinct bearing upon many of the features used in the design.

Type of Plants.—In order to present in a concise form the salient points of the various sewage plants, Table I. is presented. It will be noticed that the types proposed are the same except at the Southerly site where sedimentation in grit chambers and two-story tanks is followed by oxidation in sprinkling filters. At the present time funds are not available to construct this plant, therefore a definite decision upon the type which will be used is a question for the future.

Both the Westerly and Easterly sewage plants are practically identical in respect to the types of structures, and the basis of design. The sewage as it flows into the Westerly plant will first be rough screened by means of two sets of gratings. It will then pass into the grit chambers where, by brief sedimentation, the

TABLE II. SHOWING MAXIMUM CAPACITY AND OPERATION RANGE OF VARIOUS DEVICES AT CLEVELAND SEWAGE-WORKS

Easterly Sewage Treatment Works

Treatment Devices	Flows in M.G.D. Operating Range	Flows in M.G.D. Maximum Capacity
Main intercepting sewer	......	400
Collinwood sewers	......	655
Main interceptor by-pass	0–190	260
Collinwood overflow channel	0–600	710
Overflow channel	0–825	1,055
By-pass channels (150% of dry-weather flow)	0–140	140
Flow tributary to plant: Main interceptor	40–210	....
Flow tributary to plant: Collinwood pumps	3–20	...
Bar gratings: 6-in. screens at overflows	0–790	1,100
Bar gratings: 1½-in. and ¾-in. screens	43–230	288
Grit chambers	43–230	240
Venturi meters	43–145	...
Disinfection equipment (liquid chlorine)	43–230	...
Submerged outlets: 84-in. concrete multiple	43–145	...
Submerged outlets: 63-in. steel	0–85	...

Westerly Sewage-Works

Treatment Devices	Flows in M.G.D. Operating Range	Flows in M.G.D. Maximum Capacity
Westerly intercepting sewer	......	859
Walworth run diversion sewer	......	...
Inlet by-pass	0–19	...
Overflow conduit	0–55	106
Open overflow channel	0–859	859
By-pass channels (150% of dry-weather flow)	0–44	...
Flow tributary to plant	0–159	...
Bar gratings: ¾-in. screens, 1½-in. screens	0–140	...
Grit chambers and two-story settling tanks	0–96	96
	0–90	...
Venturi meters	0–90	117
Disinfection equipment (liquid chlorline hypochlorite)	0–90	...
	0–85	...
Outfall conduit	0–90	240
Submerged multiple outlet	0–85	...

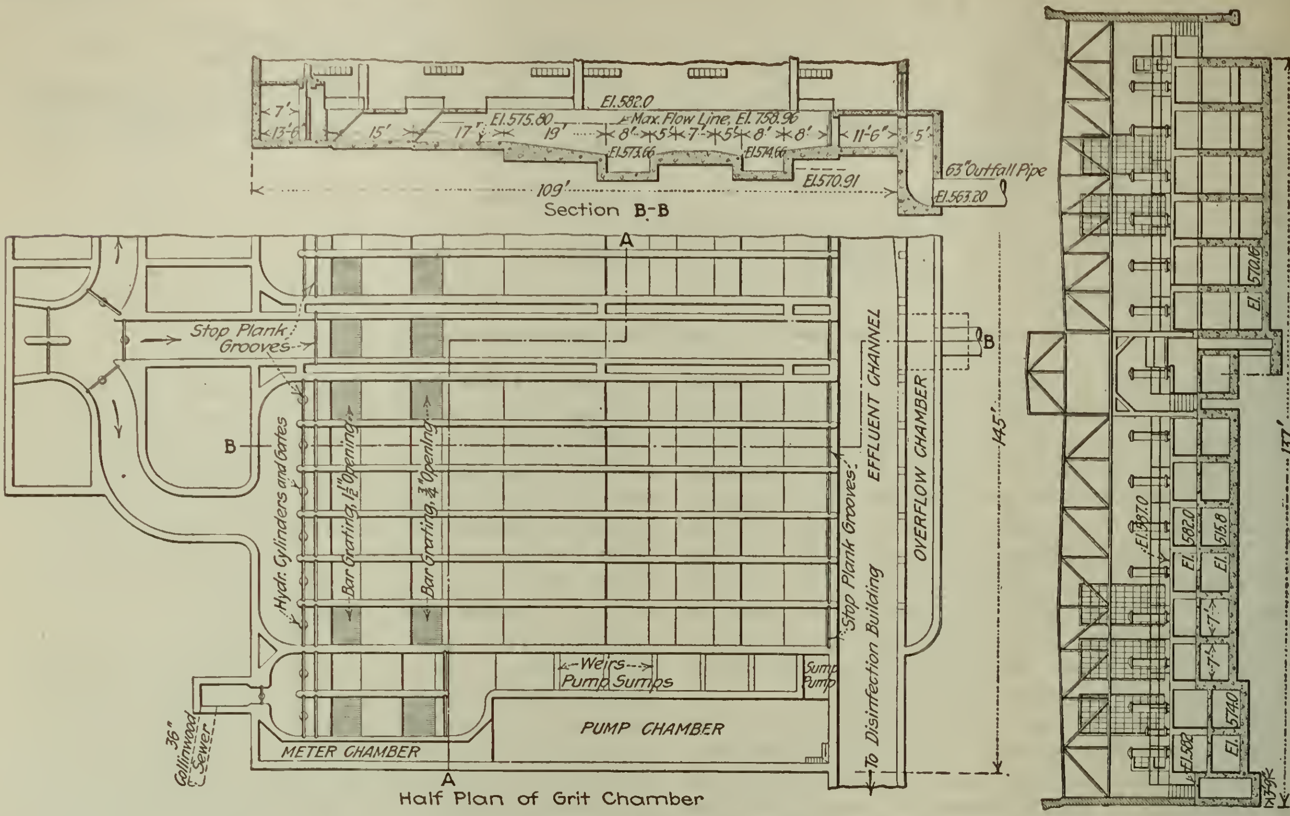


FIG. 2. PLAN AND SECTIONS OF GRIT CHAMBERS FOR EASTERLY SEWAGE-WORKS CLEVELAND, OHIO

heavy mineral matter or grit will be removed. There will follow prolonged sedimentation in two-story settling tanks, after which the sewage will pass through a venturi meter. Just beyond the meter, in a manhole, the settled sewage will be disinfected. The sewage will then pass into a submerged outfall of the multiple outlet type and be dispersed on the lake bottom in approximately 30 ft. of water about one-half mile off shore. At the Easterly plant it is proposed for the present to defer the construction of treatment devices which provide for the more complete removal of suspended matter. Table II. gives the maximum capacity of the various structures and their range of operation.

Quality of Sewage.—The City of Cleveland is sewered upon the combined plan with many overflows of the long weir type in use along the ravines and the lake front. The sewage is a typical American city sewage with the proportion of industrial wastes to domestic sewage small. Of the industrial wastes pickling liquors predominate, and at the Westerly plant these wastes become a matter of importance, especially in connection with disinfection. In 1919 the city began a special industrial waste survey with the end in view of establishing a future policy as to the discharge of these wastes into city sewers. It is desired to prevent, if possible, the objectionable conditions which these wastes cause in the sewers and at the sewage plants.

Pumping Station.—At the Easterly plant it will be necessary to pump the sewage from the Collinwood area of the Easterly district, in which it is estimated there will be about 35,000 persons in 1920. There will be three vertical centrifugal pumps driven by electric motors, operated automatically, their total capacity being 20 m.g.d. The sewage from the Collinwood area as it reaches the plant will be pumped into the flow channels just ahead of the grit chambers.

Bar Gratings.—Sewage-treatment plants can usually be built in units with additions made later as required. However, such structures as inlet sewers, flow channels, force mains and pumping station buildings, which cannot be economically enlarged to meet the increased demand, have been designed in the Cleveland plants for conditions estimated to occur considerably in the future. The inlet channels to the grit chambers are designed with velocities ranging from 3 to 2 sec.-ft. when the chambers are operating at their maximum capacity.

To provide effective rough screening it is thought that two sets of gratings, even with the same size of openings, produce better results than a single set, but their operation will involve slightly more labor. Also, a provision for two sets of gratings permits the installation of one set of finer gratings, if at any time in the future such a change seems desirable. For the present it is planned to hand-rake the gratings, but space is available for the installation of power-driven raking machinery, should it be deemed advisable. The gratings are set at an angle of 45 degrees with the vertical and are made of flat bars, bent at the top so that the screenings may be raked off without obstruction.

At the Westerly plant it is proposed to pass the sewage successively through two sets of gratings having 3-in. and 1½-in. clear openings, while at the Easterly plant the gratings will have 1½-in. and ¾-in. clear openings, respectively. It is desired at the Easterly plant to demonstrate on a large scale the practicability of disinfecting bar-screened sewage.

It is appreciated that screenings are offensive and almost as bad as sludge. For this reason, the screen chambers at each plant have been covered with buildings to increase the efficiency of their operation and to prevent the escape of odors from the sewage as it

falls through the gratings. At the Easterly plant the screenings will be shoveled into small dump cars in which they will be transported to the incinerator room while at both plants they will be pressed in large presses of the cider type and their moisture content reduced to about 65 per cent. The residue will then be burned in the especially constructed furnaces located in the screen building. The quantity of wet screenings which will be handled during the year 1925 at the Westerly and Easterly plants is estimated at 350 and 2,500 tons respectively.

Grit Chambers.—The grit chambers, which are practically identical at both plants, are to the writer's knowledge the first installations of their kind. They were designed with the intent of producing a non-odorous grit which may be used for filling-in purposes about the disposal area sites. It was found from the experimental studies that a non-odorous grit should have an organic matter content of not more than 15 per cent. As a rule, present-day grit chambers do not produce a grit with an organic matter content as low as this. In securing this kind of grit some of the finer grit may be carried past the chambers and into the two-story settling tanks. Should this occur the tank design provides for the removal of the accumulation of grit by pumping. To assist in securing the proper kind of grit, a dry-weather flow channel has been provided so that, if desirable, the grit-chamber treatment can be omitted during periods when the amount of grit carried in the sewage is practically negligible.

It will be noticed in Fig. 2 that each grit chamber has an individual set of bar gratings near its inlet end, a feature which tends to distribute the sewage flow evenly across the chamber. Further, it is expected that this type of chamber will provide uniform velocity throughout its entire length and that practically all grit will be deposited in the sumps, there then being no interruptions to the flowing sewage by uneven banks or deposits of grit on the bottoms. Grit deposited upon the sloping floors leading to the sumps will be cleansed of organic matter as it rolls along on these floors.

The number of grit-chamber units at each plant depends upon the maximum rate of dry-weather flow, together with the first flush from storms reaching the plant. The operating capacity of each unit will vary from 12 to 24 m.g.d., with working velocities of from ½ to 1 ft. per second, respectively. The over-all length of each grit chamber is 60 ft.; consequently, the maximum detention period is two minutes. Valves and drains are provided for removing the supernatant liquid without its passage through the grit, while the moisture in the grit will be collected at a sump from which it will be pumped into the outlet channel.

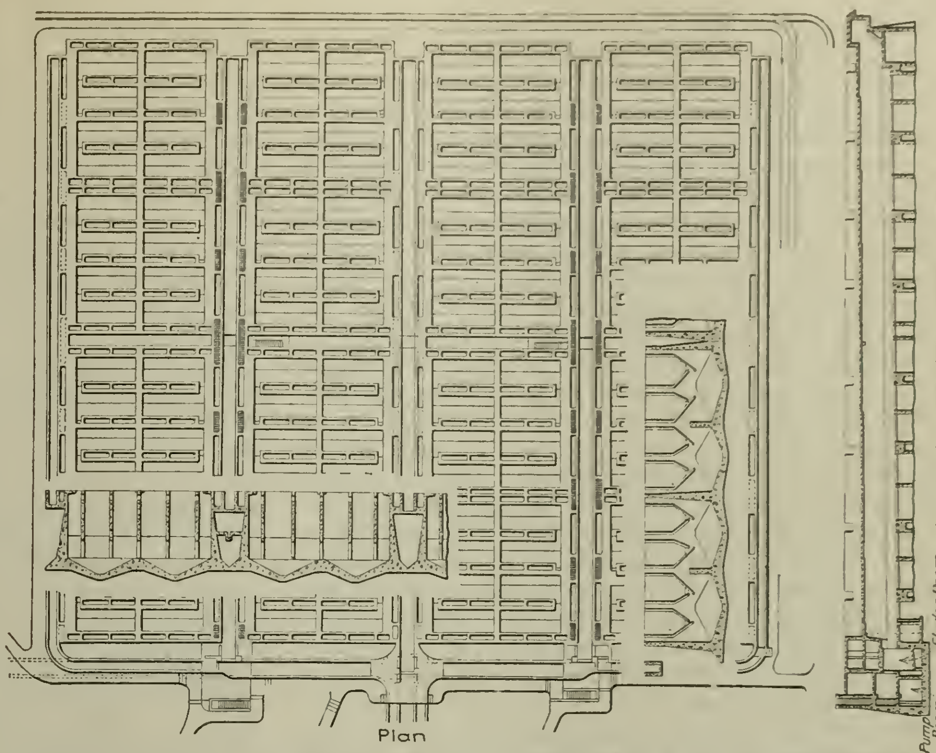


FIG. 3. GENERAL SCHEME OF TWO-STORY SETTLING TANKS FOR WESTERLY SEWAGE-WORKS, CLEVELAND, OHIO

In the grit-chamber design particular emphasis has been placed upon the importance of efficient operation. In order to place a grit chamber in operation and control the sewage flow to it, large hydraulically-operated sluice gates have been provided. While this type of gate is relatively expensive, it reduces to a mimimum the attention required of an operator to place a grit chamber in proper operation and to keep it so. Also, the sluice gates will be so installed that their operation can be controlled from a central switchboard, should this be desired in the future.

At the Easterly plant a building with ventilating equipment will permit cleaning the chambers irrespective of weather conditions, and a large number of small chambers will require a small operating crew to be engaged constantly in removing the grit. In all chambers there are provided two hoppers, thereby reducing the area over which the removal equipment must operate. The crane equipment, with clam-shell, bucket will need to operate only over the hoppers, although at this time it has not been decided definitely just what type of grit-removal equipment will be used. The capacity of the removal equipment must be sufficient to handle 8 cu. yd. of material per hour, while the deposit expected under the most adverse conditions is estimated at a rate of 2 cu. yd. per million gallons of sewage flow.

Flow Channels.—At the Westerly plant the sewage as it leaves the grit chambers will pass into an equalizing chamber by means of which the sewage flow will be divided. This chamber has inside partition walls through which are openings for equalizing the head upon the individual flow channels leading to gates which control the direction of flow. Stop-plank gates will be used for the present, but provision is made for the installation of mechanically operated gates, if desirable in the future. The sewage will then pass into open distributing channels and, prior to its entering a tank,

will flow into a small entrance chamber. There its velocity will be reduced considerably since its exit is through an orifice at the bottom of the chamber and about 3 ft. below the water surface in the tank. It is expected to collect in this trap a considerable quantity of the greasy and soapy substances which form as films upon the water surface in settling tanks. In order to control accurately the sewage flow to any tank and, further, to be able to determine promptly the amount of flow, adjustable weirs have been installed in the inlet openings to the entrance or trap chamber. By changing the stop-plank gates the direction of flow in the distributing channels is reversed, thereby reversing the flow in the settling tanks; the entrance chambers being the same at either end of a tank.

Settling Tanks.—At the Westerly site there will be 32 two-story settling tanks (Fig. 3) 50 feet in length, 25 feet in width and with two hoppers in each. The water depth in the tanks will be about 27 ft. and a free-board of 2 ft. is provided. The tanks are designed to give a detention period of 100 minutes, which means that this period will be about 2½ hours when the plant is first placed in operation. The width of the slot has been made 8 in. in the clear and the slope of the flow partition floors 1.5 on 1. The flow partition walls and floors are 3 in. thick below the water line, and are to be constructed by using the cement gun.

A scum capacity of 0.6 cu. ft., and a sludge capacity of 1.2 cu. ft. have been provided for each person. The sludge storage period amounts to 5.7 months but this period will be increased to about 8.5 months during the first year of operation.

Sludge will be withdrawn from the tanks through 8-in. pipes operating under 7½ ft. head, one independent vertical riser in each hopper discharging into the main which leads to the sludge gallery between the tanks. The sludge will discharge from the main into an open channel located below the floor in the center of the sludge gallery. There are two sludge galleries, the channel in each leading to a sludge well which has a storage capacity of about 500 cu. ft. Here a vertical centrifugal pump and an ejector will be provided for delivering the sludge from the sump to either sludge-drying beds or to barges. Each pumping device is capable of handling all the sludge. A special drain pipe located beneath the sludge gallery floor is connected to the inlet end of the pumps for the purpose of removing any fine silt which may deposit in the hoppers and cannot be removed hydraulically.

In order to minimize odor difficulties all gas vents will have wooden covers of the hinged type and, should it be found necessary, the tanks have been so designed that a building may be placed over them.

Measuring and Disinfecting Sewage.—At each plant the sewage will pass through a large venturi meter with the necessary recording equipment for measuring the sewage flow and connections for automatically controlling the quantity of disinfectant which is to be added. It is proposed to install standard-size liquid chlorine machines of the solution-feed type and to disinfect the sewage at a manhole just beyond the venturi tube. Since very large quantities of chlorine will be used, it will probably be supplied to the sewage through injectors, such as have been used by the New York Department of Water Supply at Kensico. The injectors mix the chlorine with water, yet the control apparatus is of the direct-feed type, since the absorption chambers and water connections at the control panel are omitted. Table II. shows the capacity of the disinfection equipment.

Submerged Outfall.—There are now in operation at the two sewage-works three submerged outfalls; two at the Easterly plant, one being new, and a new outfall at the Westerly site. The old outfall pipe at the Easterly plant is of steel, 63 in. in diameter, and has its end turned up in about 30 ft. of water approximately one-half mile off shore. The capacity of this outfall is estimated at 85 m.g.d. when operating under 6.5 ft. of static head.

The outfall at the Westerly plant is of concrete and steel, while at the Easterly plant the new outfall is of reinforced concrete throughout. In each case the sewage is discharged in about 30 ft. of water at least one-half mile off shore, through openings in a 1,000-ft. tapered section. Along the tapered section are about 140 holes, 7½ in. in diameter 6½ ft. c. to c., staggered in two rows each 45 degrees off the vertical axis. The capacity of the Easterly outfall is estimated at 145 m.g.d. when operating under 5 ft. of static head, while the capacity of the Westerly outfall is estimated at 85 m.g.d. when operating under 11 ft. of static head.

Sludge Disposal.—During the earlier years of operation it is proposed to remove small quantities of thoroughly digested sludge from the two-story tanks at the Westerly plant from time to time, the winter season excepted, and load it into barges. These barges will then be towed out into the lake about three miles and discharged on the Government dumping ground where the yearly dredgings from the Cuyahoga River are deposited. It is expected that this small quantity of well digested and innocuous sludge will at once become thoroughly dissipated in the lake water and will prove to be entirely unobjectionable. Nevertheless, the city has acquired sufficient land at that site to provide for the draining and drying on sand beds of all the sludge from this plant in the event that disposal in the lake should eventually become undesirable. The sludge beds when built will be enclosed by suitable buildings, presumably of a type similar to those used for greenhouses, thus protecting the sludge from rains, facilitating drying, and preventing the escape of odors, should any arise. The area of covered sludge-drying beds required is based on the assumption that 5.3 persons will be cared for on each square foot. The quantity of sludge produced by each person every day was estimated at 0.007 cu. ft., which means that about 27,500 cu. yd. of wet sludge (moisture content 88 per cent) must be removed by the barges each year. Upon this basis a barge with a capacity of 300 cu. yd. must be towed to the dumping ground once every two days during the summer season of the year when the maximum rate of disposal occurs.

General.—A laboratory and office building have been provided at each treatment plant, and a separate building for housing the disinfection equipment and storing supplies used in connection therewith. At the Westerly plant an additional building is provided for housing the locomotive which hauls the dump cars used in the disposal of grit, and for a repair shop and garage. All buildings are harmonious in architectural appearance, are of substantial construction, and are designed for a minimum maintenance expense. The grounds surrounding the plants will be parked and the general appearance made as attractive as possible. The ventila-

tion of the buildings will be taken care of by tall chimneys, a feature made necessary by the locations of the plants and their lack of isolation.

The construction of both plants should proceed rapidly during the year and it is expected that they will be ready for operation by the first of next year. Robert Hoffman is chief engineer and commissioner of the Division of Engineering and Construction, of which the Sub-division of Sewage Disposal is a part. The work of design and construction herein described is under the supervision of the writer. J. M. Heffelfinger and A. A. Burger are the resident engineers in immediate charge of the construction, and the Masters & Mullen Co. and the American Construction Co., both of Cleveland, are the contractors for the Westerly and Easterly plants respectively.

New Contract Drafted To Cover Detroit Sewer Work

IN ORDER to induce contractors to bid upon portions of Detroit's $50,000,000 sewer construction program a special commission, appointed late in 1919 by the Common Council of Detroit, has incorporated in its report recently submitted a contract form containing clauses which materially minimize the risk incident to bidding with materials and labor at present uncertain levels. The new contract form, prepared after several months' investigation of local conditions and after various conferences between the commission and city officials, was recently adopted as the form of contract to apply to future sewer contracts in Detroit by the Common Council sitting as a committee of the whole. Its early acceptance by the Common Council is predicted.

Salient changes in the new contract form include a sliding scale for compensating contractors who are forced to expend considerably more for labor and materials than prices upon which they base their bids. The contractor is safeguarded through a clause which states that the city will stand 75 per cent of the additional cost of labor and certain materials above prices specified in the contract. Such prices of materials and wages for labor will be the prevailing rates at the time the contract begins of execution. This so-called sliding scale compensation becomes inoperative after the expiration of the contract time limit.

In the event that increased compensation is sought by the contractor owing to higher wages being paid than the schedule named in the contract the contractor must present to the Commissioner of Public Works individual time slips and daily records indicating the excess wages paid. Any failure to submit such evidence, or a failure to notify 48 hours in advance that a wage increase is to be paid, will act as a waiver upon the right of the contractor to receive any additional compensation.

Another new feature of the contract pertains to the inclusion in monthly estimates of a certain amount of materials. In the event it is found necessary to store on the job large quantities of materials in order to prosecute construction these materials up to 80 per cent may be included in the monthly estimate. What allowance will be made the contractor in such a case rests with the Commissioner of Public Works.

While the special sewer commission found it necessary to make some provision in the new contract to safeguard the contractor against rising material and labor prices, it was deemed inadvisable to include any clause which should allow the city to benefit directly from any decrease of cost of labor and materials. Reasons for omitting such a clause were enumerated as follows: (1) Because the prices named in the contract do not establish the exact prices and rates that the contractor must pay; (2) if possible a contractor will pay less than the established rates for materials and labor; (3) if lower costs are assured the contractor they will be reflected in his bid; (4) so far as there is any possibility of such an asurance to the contractor the advantage will accrue to the city.

Several conferences were held in which not only public officials participated but contractors already engaged upon sewer construction for the city of Detroit. Various alleged defects in existing contracts were pointed out by these contractors and the new contract form submitted by the commission include minor improvements over the old established lump sum form. For instance, certain contractors complained of not receiving their partial payments in time to take advantage of cash discounts when purchasing minor materials and accessories. The new contract, therefore, specifies a date not later than which monthly estimates shall be paid, thereby allowing the contractor to take advantage of cash discounts. Then again, any compensations due the contractor from his payment of excess labor and material prices are to be included in monthly estimates, and the 10 per cent retention is not to apply.

Details Clarified

Various details which in the past have led to litigation are clarified in the Detroit contract. It is specifically stated that in encountering subsurface, surface and overhead structures the contractor is to secure them in the interests of public safety at his own expense, in case they are not to be moved. When subsurface, surface, or overhead structures require to be moved they must be moved not at the contractor's expense. When subsurface structures not shown on plans are encountered the contractor is entitled to reimbursement, and delays due to encountering structures necessitating changes in alignment or grade will not be counted within the time limit.

Before adopting the above outlined form of contract the special sewer commission considered several forms, including a cost-plus-percentage and the cost-plus-a-fixed fee contract. Owing to the fact that a cost-plus-a-percentage type precludes competitive bidding, which the city charter insists upon in municipal work, that type was little thought of. In a cost-plus-fixed-fee contract the lowest bidder is selected by comparing the estimated field costs plus a fixed fee. As such a selection does not guarantee that the lowest bidder will do the work at the lowest total cost to the city, coupled with the fact that that form of contract would not be adapted to city work of such magnitude because of the large organization needed to keep complete cost records, the cost-plus-a-fixed-fee type was also discarded.

The special sewer commission, which prepared the contract above outlined, is composed of Wilson S. Kinnear, consulting engineer, New York City, chairman; William C. Hoad, professor of sanitary engineering, University of Michigan; Edward D. Rich, state sanitary engineer, Michigan; John A. Mercier, contractor, Detroit, and George R. Cooke, contracting engineer De-

troit. The commission was first appointed as a consultant, being given by the Common Council authority to perfect its own organization, and its entire freedom of action as to the scope of its work. At the first meeting of the commission in January, 1920, the city engineer of Detroit gave an historical review of the study and development of the proposed sewerage system and explained to the commission difficulties connected with contract work in the city of Detroit. It was disclosed that the progress of sewer construction work for the year 1919 had been disappointing. The city engineer explained that it would be necessary to complete about $1,000,000 worth of work monthly to carry out satisfactorily his sewer construction program, whereas the maximum month's work during 1919 amounted to approximately one-quarter of that amount.

Trainshed Roof of Steel Arches Instead of Columns

Spacious Appearance Given to Indianapolis Union Station by Novel Design—Monitors for Light and Ventilation

With the purpose of obtaining a low-roof trainshed having an exceptionally well-lighted and attractive appearance the steel trainshed of the new union station at Indianapolis, Ind., was designed with arches instead of columns to support the roof framing, and with monitors extending above the level of the main roof. As the arches rise to the top of the monitor framing the interior effect of height is increased materially. This distinctive and unusual construction was adopted as an element of architectural design, it being considered that a more lofty effect and a more decided appearance of spaciousness would be given to the trainshed by the rows of tall arches than by the usual arrangement of relatively short columns in trainsheds of the low-roof type, and that the light and ventilation would be improved materially by the high monitors. This roof is 930 ft. long and 238½ ft. wide, covering six platforms. A portion of the completed framing is shown in Fig. 1.

The monitors are located over the platforms, at the low points of the main roof, above which they extend to a height of about 7½ ft., as indicated in Fig. 2. Being open at the bottom they give an actually increased height over the platforms, where ordinarily the roof is at its lowest level. The purpose of this arrangement is to provide ample light and ventilation at the platforms, the side of each monitor being covered mainly with wire glass and leaving a continuous open ventilating space at the top. This opening is covered by a narrow umbrella roof of red tile, carried by light steel framing, as shown. Details of the main and monitor roof framing are given in Fig. 3.

Amber-colored ribbed wire-glass is used for the monitor skylights, the effect of this glass being to deflect or absorb the heat rays of the sun. Recent experiments are stated to have shown that this glass will keep the interior temperature lower by 2 to 6 deg. F. than when ordinary clear glass is used. As a precaution against breakage of glass by movement of the roof due to vibration and temperature changes the panes will not be set tight in the frames but will be sufficiently loose to permit considerable movement in the steelwork without breaking the glass.

Another modification is introduced in the design of the longitudinal smoke ducts or roof openings which extend over the center lines of the tracks, Fig. 3. The slabs which form the sides of these ducts are inclined inward at the top instead of being vertical for their full height, the narrower top opening giving less opportunity for snow and rain to drift upon the platform. At the same time the width is sufficient for free passage of smoke and steam without any tendency to choke the exhaust of the engines. In this case the slabs are 63½ in. deep, and the space between them is 36½ in. wide, at the bottom and 19½ in. at the top. A 3-in. concrete slab covers the sections of the main roof between the monitors, and the monitor side between the skylights. Inside the monitor the roof framing is open. A waterproof roofing is laid over the concrete.

In the crutches formed at the haunches of the longitudinal arches are seated transverse curved girders

FIG. 1. LONGITUDINAL STEEL ARCHES CARRY ROOF OF INDIANAPOLIS TRAINSHED

upon which rest the inclined beams of the monitors. Between the transverse girders there are two intermediate transverse beams or rafters suspended from a longitudinal girder resting on the crowns of the arches. Each of these rafters is a rib of I-section, with inclined ends forming beams for the monitors and a curved middle portion spanning the tracks. Light rafters over the platforms are attached to the corners of these rafters, as shown. This arrangement makes a four-point connection between the main rafter, platform rafter, monitor beam and longitudinal strut. Four lines of trussed purlins are framed between

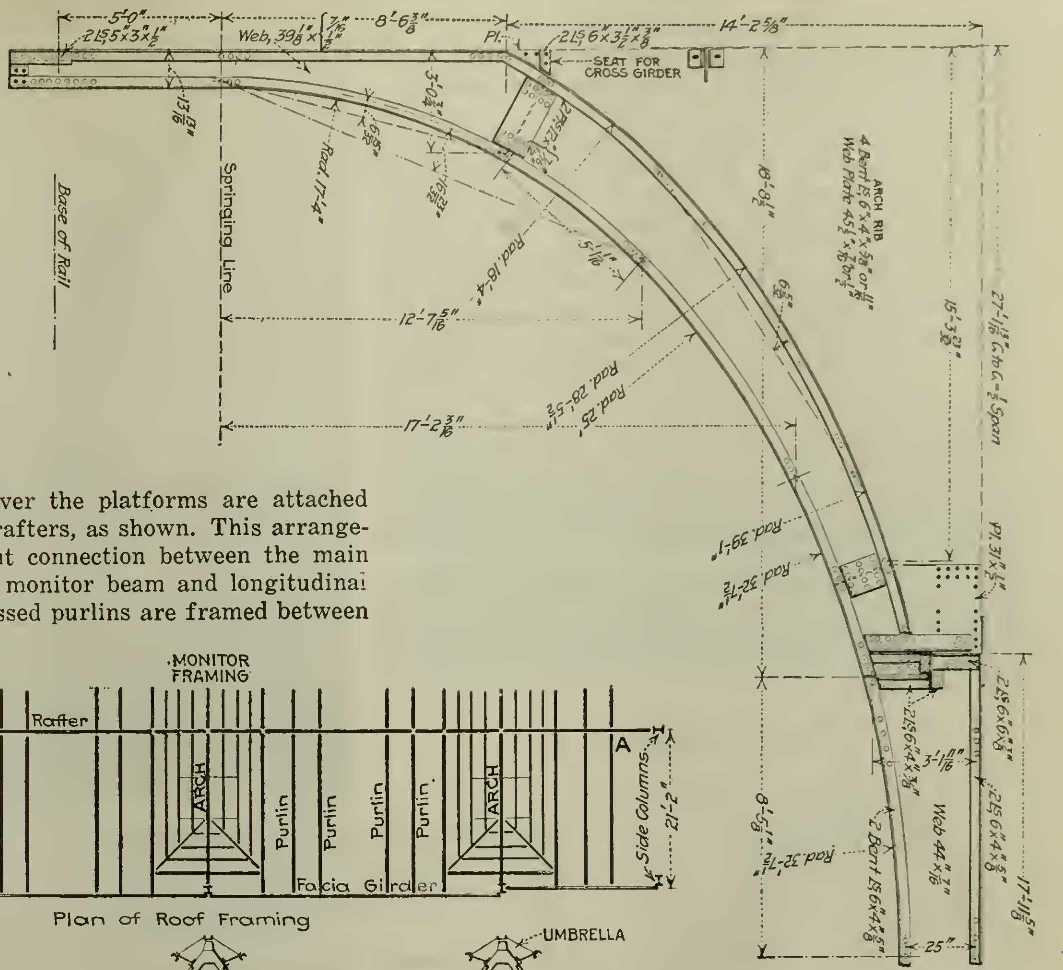


FIG. 4. ARCH RIB SUPPORTS ROOF

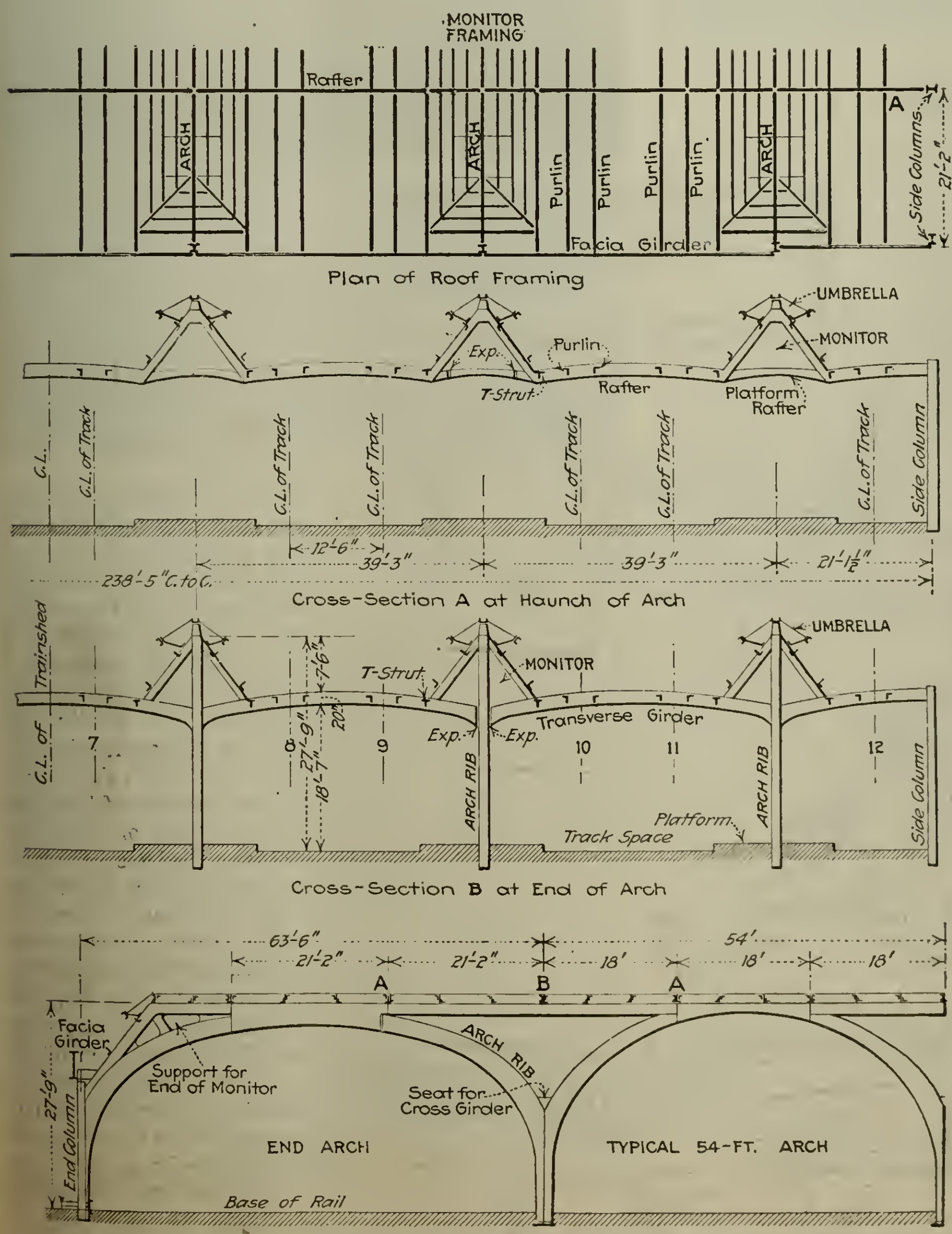


FIG. 2. ARCH SUPPORTS AND ROOF FRAMING

the rafters in each bay, these purlins being embedded in the concrete slabs which form the sides of the open smoke ducts already described.

Arches of 54 ft. span c. to c. are used generally in the longitudinal rows. They have a rise of 27 ft. 9 in. above base of rail, this being the height inside the platform monitors, but the maximum interior height of the main roof is 18 ft. 7 in. above base of rail. The span is governed largely by the design of the steel framing which supports the platforms and track deck and upon which the feet of the arches rest. Arches of 63 ft. span are required at the center of the trainshed, where a subway carries Illinois St. under the tracks, and also at the east end, where a driveway extends under the tracks to the baggage delivery platform. With springing line 5 ft. above base of rail (or 4½ ft. above the platform) there

is ample headroom at the ends of the arches. As baggage is handled below the track deck there is little trucking on the platforms to take into consideration.

Each arch is a plate-girder rib, built in three sections for erection, as shown by Figs. 2 and 4. At the crown the extrados is flattened to carry the 18½-in. plate girder forming the crest of the monitor roof framing. The monitor roof beams and the main and intermediate rafters are built-up members of I-section, while the platform rafters are of T-section. No diagonal bracing is required as the concrete slab ties the framing together effectively. At each end of the trainshed the last arch is framed against a column supporting a transverse fascia girder from which are suspended curved angles carrying the end of the concrete slab and the portal arches over the tracks. Roof drainage is carried off by drain pipes laid along the rafters and down the ends of the arches to pass through the platforms. This roof was designed for a live load or snow load of 40 lb. per sq. ft.

For the main part of the erection a traveling stiff-leg derrick was used, moving on rollers and having a steel box-latticed boom 95 ft. long, as shown in Fig. 5. The heaviest parts handled weigh 10.8 tons each. Traffic did not interfere with the erection, as this was done from the new elevated track-level while traffic was being operated on the old tracks at the street level.

The roof design, with its arch supports and monitors, was worked out by Price & McLanahan, Philadelphia, architects for the station, under the supervision of T. R. Ratcliff, engineer of maintenance of way, Indianapolis Union R.R. Mr. Ratcliff also superintended the erection of the trainshed and the construction of the track-elevation work on which the new trainshed has been built. Contracts were let to the Mount Vernon Bridge Co., Mount Vernon, Ohio, for the steelwork of the roof, and to the Powers & Addy Co., Inc., Indianapolis, for the erection. The completion of the trainshed is one of the last steps in the construction of the new Union Station with elevated tracks, as described in *Engineering News-Record*, July 10 and Aug. 7, 1919, pages 84 and 265.

FIG. 5. DERRICK ERECTING TRAINSHED ROOF

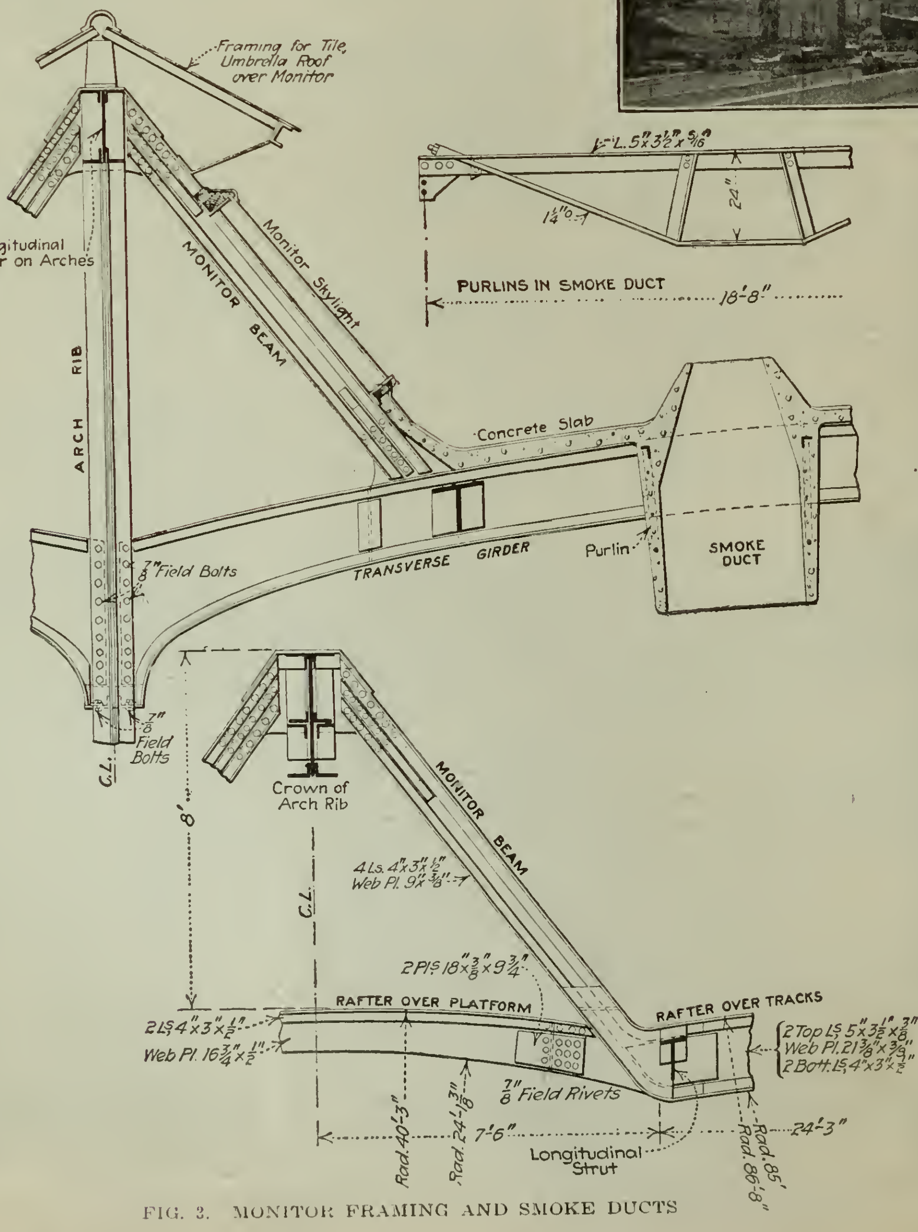


FIG. 3. MONITOR FRAMING AND SMOKE DUCTS

Irrigation in Mendoza, Argentina

Melting Snow from Andes Furnishes Ample Water Supply — Engineer Opportunity Contingent Upon American Financing

By S. T. Henry
Vice-President, Allied Machinery Co. of America, and Formerly Associate Editor of *Engineering Record*

MORE than 100,000 acres of land are under intensive irrigation and cultivation in a single project in the immediate vicinity of the city of Mendoza, Argentina. This is only one of a number of large irrigation projects in the semi-arid sections of that country. Some of these projects have been under irrigation for many years; others are of more recent development. Additional works are being built, and many new projects are contemplated. There is apparently ample water to serve great new areas of fertile land on which the rainfall is insufficient.

Favorable topography, soil and climatic conditions combine to render irrigation most profitable in the provinces of the Argentine close to the eastern slopes of the Andes Mountains. In fact, the products raised vary from sugar cane, in the Tucuman district in the

RIO BLANCO MASONRY DIVERTING DAM

north, to wheat and other colder country products in the south. Irrigation, therefore, should have a great future in the Argentine.

The irrigated section in the vicinity of Mendoza lies at the foot of the Andes Mountains. It is in about the same latitude as Los Angeles, Cal., and the climates of the two places are very similar. The mountains directly to the west rise to heights of from 12,000 to 19,000 ft. above the sea. Many peaks in the vicinity are covered with perpetual snow. The snowfall is heavy in the winter down to elevations as low as 8,000 ft. The water used for irrigation in this and most other Argentine projects comes from this source.

Irrigation is known to have been practiced in Mendoza and vicinity for more than 800 years. Authentic records show that the Eighth Inca of Peru sent an irrigation engineer to Mendoza to assist the natives resident there then in laying out and constructing their works. When the Spaniards arrived about 1550 they found extensive irrigation works on which they made comparatively little improvement. These conditions continued until the existing works were built in the late 80's and early 90's of the last century.

Water for irrigation in the vicinity of Mendoza is diverted from the Rio Blanco a few miles above the city. This stream has a relatively large minimum flow. When the snow in the mountains is melting the river carries tremendous volumes of water. At rare intervals cloudbursts in the watershed also cause freshets.

CANAL INTAKE AT END OF DAM

Geologists consider that the land around Mendoza was formed by wash from the high mountains to the west. The Rio Blanco in the vicinity of the intake runs through this alluvial deposit. The bed of the stream is of great width in most places, and consists of boulders and coarse gravel containing very little sand. On account of the steep gradient of the stream and the great volumes of water carried by it when in flood, the channel shifts frequently. Indications are that the entire stream formerly changed its course from place to place over a wide area.

The water is diverted from the Rio Blanco by a low dam of stone masonry, which was finished in 1889. Details of the construction of this dam were not available at the time these notes were made. One of the accompanying photographs shows a view of the dam taken from the intake of a canal at one end.

According to local engineers there is no bed rock at the site. A foundation was secured simply by removing the boulders and coarse gravel and replacing them by large boulders carefully placed and grouted in position. The fact that the dam has stood all these years in such a violent stream is probably attributable to several simple fundamental conditions.

In the first place, the structure is low. The total net head against it is evidently always small.

A second favorable factor is the relatively great width of the dam section as compared with the height. This can be seen from the photograph. This view also shows the broad apron which reduces tendency to scour at the toe.

The stream carries great quantities of sand and gravel when in flood. This detrius is deposited behind the dam so as further to reduce the tendency to undercut the structure.

A canal leads from an intake at each end of the dam. One of these intakes is shown in an accompanying photo-

graph. Both intakes are built integral with the adjacent end of the dam. In the dam are five groups of gates through which the sand and gravel that accumulate back of the dam are flushed through the latter. The distribution and arrangement of these gates are such that they can be manipulated so that comparatively little sand and gravel gets into the canals. The deposits back of the dam also can be flushed through the gates without resort to excavators or to hand labor.

Prevention of scour at the ends of the dam also has contributed to its stability on an apparently uncertain foundation. The tendency of the stream to shift its channel, and at times its entire course, was recognized from the beginning. Well-protected levees were built along the course of the stream above the dam. These were planted closely with Lombardy poplars. The area back of the levees to a width of several hundred yards also was planted with a dense setting of these trees, which have grown to good size. The closely matted roots of these thick clumps of artificial woods evidently have served their purpose well.

The main canal leading from the left-hand end of the dam, looking downstream, serves a greater area than the one on the opposite side. This canal and its main branches are more than 75 miles long. One of the photographs gives an idea of the size of this canal and the volume of water carried by it. This picture also shows how Lombardy poplars and other planted vegetation is used to prevent bank erosion by the relatively high velocity in the canal.

About a mile from the intake of the left bank canal advantage has been taken of the topography to develop hydro-electric power in a low head plant. One of the photographs shows the section of concrete-lined canal directly above the power house. Another picture shows the power house from the downstream side.

No outstanding features are evident in the construction of the main and secondary laterals. The gate structures are either of brick or concrete, with steel gates of modern design. None of the laterals or ditches is lined.

Some of the main laterals and practically all the secondary laterals are built along the sides of the highways which network the irrigated district. This arrangement permits the ditches to be maintained by the forces which keep up the roads. It also provides water for sprinkling the latter, which are mainly surfaced with gravel.

The roads are divided into sections for maintenance. Each section is assigned to one man. The length of the sections varies according to the amount of work required to maintain the road surface and the irrigation ditches along both sides of the latter. One of the photographs shows a road-section man and the results of his work on the irrigating ditch. Another shows one of these men drawing water from the irrigation ditch with a bucket to wet down the road surface. The numbered targets shown in these two pictures are placed by the men near the point where they are at work in order to facilitate the location of them by inspectors, and for several other reasons.

Most of the land under irrigation is devoted to growing grapes. Wine is made from the bulk of the grapes, although some grapes are grown for table use. The land appears to the eye to be almost absolutely level, but there is ample slope to permit of very satisfactory irrigation of the vineyards. The latter are owned and cultivated largely by Argentines of Italian and French extraction. Their methods of culture are as advanced as may be found anywhere. Wines made in this section are shipped all over the world. The great wealth and the high state of development of the district are good evidences of the permanent success of irrigation as it is practiced here.

UNLINED CANAL WITH POPLARS ON BANK TO PREVENT EROSION

SECTION OF LINED CANAL DIRECTLY ABOVE POWER HOUSE

POWER HOUSE FROM DOWNSTREAM SIDE

Local landowners seem to be convinced that there is little opportunity to increase the area under irrigation in the vicinity of Mendoza. Well-informed local engineers differ with this viewpoint. It is true that there is a shortage of water during a part of some seasons. There also is no opportunity to build impounding reservoirs on the watershed above the intakes, but everywhere there is evidence that the duty of the available water could be greatly increased. The situation is similar to that which exists on several irrigation projects in the United States.

Lack of lining in the canals, laterals and ditches through dry, porous soil must result in very large losses. Since there is practically no frost in this locality, and the banks of cuts stand well, very thin linings should be sufficient. Even though the cost of lining might be high, the additional land which could be brought under cultivation would certainly justify the necessary investment. Good vineyards sell locally at from $1,500 to $2,500 per acre. They evidently produce good rates of return at these valuations.

Another opportunity to increase the duty of the available water is through better methods of application to the land. Too much water is said generally to be used. This difficulty presents more than a physical problem. It has been solved in very few places in the United States. There apparently are few projects where the water users are under sufficient control to permit much progress in this direction.

American irrigation engineers would find much of

IRRIGATION DITCH ALONG ROAD SPRINKLED BY HAND

interest in the design and operation of the works of the projects in the vicinity of Mendoza. Other projects in the Argentine also offer valuable ideas. Whether there is an opportunity for American engineers in future irrigation works in the Argentine depends largely on how such works are financed. If money is furnished by American capitalists then American engineers may be employed in the more important positions. In case the financing is done elsewhere American engineers are likely to secure only secondary positions. Engineers thoroughly experienced in irrigation work would do well, however, to study closely the possibilities for them in the Argentine. This can be done properly only by a visit to the country, and for such a trip a knowledge of the language is very desirable.

Floods Wash Out Part of Apron of Granite Reef Dam

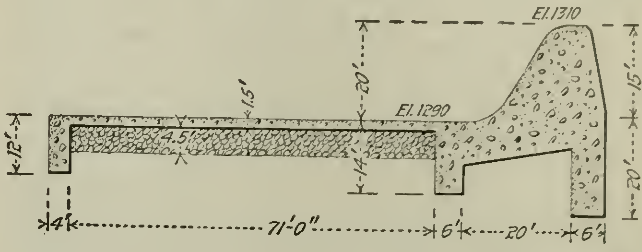
Damage Downstream Pavement of Porous Foundation Diversion Dam on Salt River Project of Reclamation Service

UNUSUAL flood conditions on the Salt River project of the U. S. Reclamation Service during the last part of 1919 resulted in some damage to the downstream apron of the Granite Reef diversion dam, which is of interest because it is the second time that this structure has been in similar trouble. Furthermore, a somewhat similar dam in another location on the project was damaged in like manner in an earlier flood.

The Granite Reef diversion dam is located about 45 miles below the Roosevelt dam and forms the main storage for the Salt River project. The diversion dam is built at a point where bedrock is so deep as to make it impracticable to extend foundations to it. A section is shown in the accompanying drawing. As given there, it has three curtain walls, one at the upstream and one at the downstream side of the main dam section, and one at the downstream end of the downstream apron; the two upstream walls are 6 ft. in thickness and the downstream one 4 ft. The one under the upper toe is carried down to a depth of about 18 ft. below the elevation of the apron below the dam, and under the lower toe is carried to a depth of 14 ft. below the surface of the apron. Through the lower toe wall there were left openings 6 in. square, 5 ft. apart, and about 6 ft. above the bottom of the wall. These openings permit the water that would collect under the dam to drain out under the apron.

The apron itself was made on a foundation of placed boulders having a thickness of 4½ ft. The thickness of the apron itself is 1½ ft. and it is laid in squares of about 10 ft. on a side, with a space of about 3 in. between the squares.

During 1919 there was a long wet period in the whole Salt River district. This started with unusual rainfall on the watershed during the last half of July and the



MIDRIVER SECTION OF GRANITE REEF DIVERSION DAM

first half of August, causing a gain in the reservoir within a period of twenty days of over 230,000 acre-ft., which exceeds any former summer gain six times. Little or no damage to the works of the project, however, resulted from this flood. A second floor occurred in November, 1919, reaching its peak at the Granite Reef dam on Nov. 27. The average depth overflowing the entire length of the 1,000-ft. dam was 7.65 ft., equivalent to approximately 100,000 sec.ft. The result of this flood was the loss of the protective apron of the diversion dam 75 ft. wide by 540 ft. long, and a portion of the concrete cut-off wall located 75 ft. downstream from the toe wall of the dam. A former flood in 1916 partly washed away this apron and it had been replaced on the gravel backfill in the form of slabs about 10 ft. square and 14 to 16 in. thick, tied together with steel cable and other reinforcing material.

When the flood went down it was found that repairs would have to be made including replacing the damaged cut-off wall and the construction of a strip of the apron 75 x 540 ft. with an average thickness of 6 ft. including the boulder bottom. Repairing was started Dec. 19, 1919, and completed Feb. 7, 1920. It required 7,666 cu.yd. of concrete at a cost of about $11.26 per cu.yd.

Another flood took place culminating on Feb. 17-23, 1920. This flood topped the Granite Reef dam with a maximum overflow of 8 ft. carrying approximately 107,000 sec.ft. of water. The repairs to the apron, however, had been completed and the dam withstood the second flood with no damage.

A somewhat similar dam on the Salt River above Roosevelt dam was described in *Engineering News*, May 25, 1916, p. 974. A large part of this dam was washed out by a flood in January of that year.

The present damage to the Granite Reef dam is described in the *Reclamation Record*, July, 1920, by W. R. Elliott, formerly general superintendent and chief engineer of the Salt River project. This project has been operated by the water users themselves since Nov. 1, 1917.

Terre Haute May Have City Manager

The city-manager form of government is under consideration at Terre Haute, Ind. The local chapter of the American Association of Engineers has been asked to co-operate in the movement and has referred the request to its Civics Committee.

Wet Haulage to Road Excels Dry Haulage to Mixer

Comparison of Two Methods Determine Adoption of Central Mixing Plant and Wet Batch Haulage on New Contracts

WITH light motor trucks carrying one-batch loads, over 30 per cent greater yardage has been obtained on a 13½-mi. concrete road job in Illinois when the wet batch is hauled to the road, than when the dry batch is hauled to the mixer. Oversize pneumatic tires on the trucks and a truck turntable have reduced cutting of the subgrade to unimportant proportions. A fleet of twenty-six trucks hauling an average distance of 2½ mi., has served two mixers whose average rates of output have been 560 ft. and 420 ft., of 16- and 18-ft. pavement per day.

In planning the work, the road, which is a portion

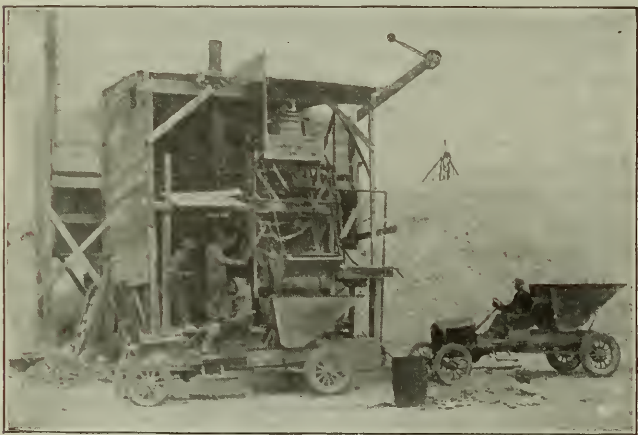


FIG. 1. CENTRAL UNLOADING AND MIXING PLANT

of the National Trails Highway in Fayette County, was divided into a section 5.27 mi. long to be constructed by dry batch haulage to a paving mixer and a section 8.2 mi. long to be constructed by wet batch haulage to the road. Construction proceeded on both sections at once, the 26 trucks being divided between the two according to the relative lengths of haul. A separate statement of the outfit and operations for each section simplifies comparison.

Wet Batch Method.—The location of the central mixing plant was at about the middle of the 8.2-mi. section. Fig. 1 is a view of the installation. It is to be noted particularly that the mixer is a two-bag batch machine. The materials were unloaded from cars by a derrick operating a clamshell bucket and whenever materials were received in such quantities as permitted them to be placed in reserve storage, this was done. Otherwise the materials were unloaded from the cars directly into the storage bins, which had a capacity of about three carloads. From the bins the materials were measured directly into the mixer hopper. With direct discharge of the mixed batch into the truck, the aggregates therefore did not touch the ground from the cars or stockpile to the pavement slab. Fig. 2 shows the wet batch being dumped ahead of the finishing machine.

Eleven men were required for the wet batch method: Two men feeding cement to the mixer; one man on the rock and sand bins; one mixer engineer; one mixer

FIG. 2. WET BATCH DISCHARGED AT FINISHER

fireman, one man discharging the mixer; two men spreading concrete; one man dumping the trucks; one man operating the finishing machine and one man assisting in finishing the slab.

Dry Batch Method.—On the section constructed by dry batch haulage the unloading and proportioning plant was located at one end. The materials were unloaded and stored in the same manner as at the central mixing plant. The bins were arranged, however, so that the trucks drove under them and received their loads through bottom doors. A truck was loaded in 15 sec.

The operating crew consisted of sixteen men as follows: Four men dumping cement into the trucks; two men on the rock and sand bins; one man dumping trucks into the mixer skip (Fig. 3); two men keeping the subgrade in shape around the mixer; one mixer operator; one mixer fireman; one discharge man; two concrete spreaders; one finishing machine operator and one man helping to finish.

Comparison and Discussion.—The crews compared, include only the force which varied with the method;

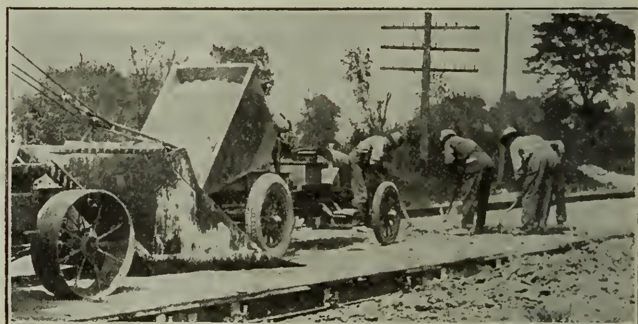


FIG. 3. DRY BATCH DISCHARGED INTO MIXER

the truck drivers, sub-grade men and turntable men remained the same whichever method was employed. Operating a four-bag batch paver and dry haulage the maximum rate of construction was 608 ft. in 10 hours and the average rate was 560 ft. With wet batch haulage and a two-bag batch mixer the average rate of construction was 420 ft. in 10 hours. Commenting on the records made by the two methods the contractors say:

The contractors feel that the wet batch method has advantages over the dry batch method, as in running 608 lin.ft., it is necessary to move the mixer at least thirty times the length of the boom during the day, the average

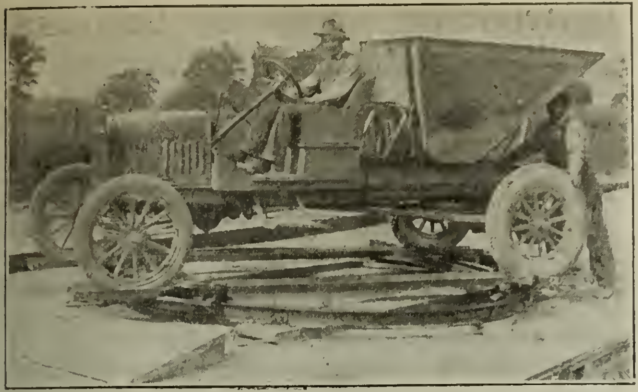


FIG. 4. ONE MAN OPERATES TRUCK TURNTABLE

time for a move being close to one minute. This one minute lost in moving thirty times totals a half-hour loss each day, under the most favorable conditions, and the labor required upon the road and at the bins is more than is required on the wet batch method. The contractors have been able to lay about one-third more yardage per day by the wet batch method than by the dry batch method, and have installed central mixing plants on their Clear Lake, Ia., paving contract, and are also placing the same type of plant on their contract at Cedar Rapids, Ia.

In operating the motor trucks on these two sections, the total fleet of twenty-six was split up according to the relative lengths of haul. To keep both jobs moving evenly the work was planned so that when the haul was long on one job it was short on the other job. The average haul for both jobs was $2\frac{1}{2}$ mi. On the wet batch section a maximum haul of 3.4 mi. was entirely successful, but the conclusion from experience is that the ideal haul for wet mix over ordinary roads is $2\frac{1}{2}$ mi.

Generally the grading on each section was kept about 2,000 ft. ahead of the concreting. This distance gave ample leeway for grading, subgrade preparation and form setting; kept the haul over grade and subgrade within moderate lengths, and, consequently, left the greatest possible length of haul over the original road. Using solid tires the subgrade was considerably cut and rutted by the hauling, but this was nearly all eliminated when the trucks had been equipped with oversize pneumatic tires. Another aid of importance in keeping the subgrade unmarred, and, also, a help to speed and a saving in wear and tear on the trucks in reversing to back up to dumping position, was a turntable arranged as shown by Fig. 4. One man operated this turntable.

Truck haulage required close attention to schedules. Schedule maintenance consisted largely in training the drivers, but certain checks were found helpful. Each truck was supposed to report at the loading station within a certain period of time after departure with a load. Its arrival at destination was also checked. The rule that whenever the track was standing idle the motor must be shut off also discouraged bunching the trucks, since each stop meant that to start again the driver had to dismount and crank his motor and as he disliked to do this he endeavored to keep to schedule.

On the work described F. J. Colosey is in charge for the contractors, with C. G. McHugh as field engineer, and Harry H. Toothacher and A. B. Snow in charge of inspection for the State Highway Department under E. J. Finnell, resident engineer. The contractor was the Henry W. Horst Co., Rock Island, Ill.

Advantages and Disadvantages of Municipal Street Cleaning

SOME of the advantages and disadvantages of street cleaning and refuse collection by contract and also by the city direct are summarized in the report on street cleaning and allied matters at Philadelphia, noted on p. 236 of our issue of July 29. Extracts from the report, which was made by E. B. Morden, chief of the Bureau of Street Cleaning, James W. Follin, engineer, Philadelphia Bureau of Municipal Research, and J. H. Neeson, principal assistant engineer, Bureau of Highways, follow:

It is perfectly clear that no contract is on a sound basis unless, (1) the work to be performed is definitely specified so that the bidder can determine the cost of performance and bid intelligently, and (2) unless it is possible for the party paying for the work to determine if the work specified has been performed.

Disadvantages of Philadelphia Contract

The existing contract for street cleaning is disadvantageous for the following reasons:

1. It is humanly impossible completely and definitely to specify the work to be performed, for although the frequency of cleaning can be given, standards of cleanliness are not possible of definition, and the results of the street cleaning must be judged without definite specifications, and therefore,

2. It is necessary for the bidder to pad the contract price to provide against possible unfriendly attitude on the part of the bureau chief who is the judge of the work performed, and of other officials.

3. The contractor is sometimes forced by unfavorable circumstances to attempt to control the city inspection forces, and there is an ever present temptation to influence their reports for a consideration.

4. Undue authority is given to the bureau chief to judge the results of the work performed, and he is in a position either to make or to break the contractor as he wills.

5. It is difficult to determine whether the streets are properly cleaned because of the intangible results, and the fact that the streets do not stay clean very long after the cleaners have been over them.

6. It is difficult to obtain practical and dependable inspectors.

7. The city is unwilling to pay salaries to the street cleaning inspectors commensurate with the responsibilities involved in work of such an intangible nature, thereby putting a premium upon inefficiency and dishonesty.

8. It is impossible to guarantee to the contractor that the public as a whole will obey existing ordinances, thereby throwing the burden of their disobedience on the contractor, who has this indeterminate factor to take into consideration in making his bid.

9. The contractor is tempted to slight the work by racing his equipment and speeding up his gangs, thereby covering the streets with the specified frequency, but only imperfectly.

10. It is impossible to obtain flexibility under any form of specifications to permit extensive modifications of performance such as are required by seasonal variations or emergency shifting of forces from one district to another.

11. It is necessary for the bidder either to amortize his plant and equipment during the life of the contract, thus adding an excessive amount to the bid, or to insure by some other means that the contract will be renewed and new competition discouraged.

12. It is necessary for the contractor to add a high contingent cost to his bid to cover the greatest conceivable advances in the labor and material markets.

13. The cost is increased by dual supervision by contractor and the city.

Municipal operation of street cleaning work overcomes the majority of the objections to the existing contract performance listed above, but naturally has certain inherent disadvantages of its own. The advantages of municipal operation are as follows:

1. Flexibility of organization, with ability to concentrate the force in emergencies and to revise methods and schedules to meet changing conditions that cannot be foreseen when contracts are let.
2. The placing of the city bureau organization on a business-like basis, actually performing the work, and abolishing the rewardless task of attempting to keep the contractor's work under control.
3. The substitution for the underpaid and unsatisfactory city street cleaning inspection force with superintendents and foremen who actually direct the work and get results, with actual economy from the abolition of costly dual inspection essential to contract work.
4. Actual saving of money to the city by eliminating the contingent fund included by the contractor in the bid price to guard against unfriendly or unreasonable action by the bureau chief in enforcing the specifications.
5. Actual saving of money to the city in carrying its own insurance against advances in the labor and material markets for which the bidder may make more than the necessary provision.
6. Accomplishment of the maximum possible amount of work for the money appropriated by Council, since municipal work is at cost.
7. Avoidance of nonequitable contracts and possible expensive controversies in the courts.
8. Possible securing of better co-operation from the public in their care of the highways because of the sympathetic attitude of the public toward municipal work.
9. Opportunity for continuous study of conditions and for making beneficial changes in equipment and methods.
10. Direct and absolute control of the working forces.

Municipal operation is subject to certain disadvantages which can be successfully overcome:

1. The present inability to obtain experienced and properly qualified employees with dispatch through the Civil Service Commission.
2. The possible failure of the proper authorities to appreciate the need of sufficient funds to carry on the work and maintain the equipment, which might cause the service rendered to the public to be unsatisfactory.
3. Possible decreased efficiency of the labor because the foremen-supervisors are not actuated by the incentive of increased profits which exists in contract performance.

Contract work has certain inherent advantages:

The contractor is able to purchase equipment and materials directly on the basis of practical judgment and without the competitive bidding in force in the city, thus saving delays and securing the most desirable equipment and materials.

2. The contractor is able to compensate supervising employees properly and to increase their salaries immediately to keep them from accepting more lucrative positions and, besides, can offer them special inducements.
3. The contractor can regulate wages and salaries without the complicated procedure required in municipal work.
4. The contractor can hire and discharge employees without restriction or regulation, such as civil service control.

In the case of street-cleaning work, the disadvantages of contract performances are so numerous and so overwhelming that the argument of possible increased labor efficiency under contract work is relatively unimportant. Municipal operation is the only proper method, and every effort must be made to overcome any disadvantages inherent to it. Civil service control should be reasonable and not arbitrary; the city purchasing agent should co-operate to secure the most desirable equipment and materials and not merely the cheapest in price, and the salaries of supervisors and foremen must be fixed equal to those prevalent in outside employment.

Determining Limits of Legitimate Capital Expenditure

By J. R. Wade
New York City

In determining the limits of useful capital expenditure for any engineering work or program of industrial expansion the principle, that operating expenses plus interest charges should be a minimum, may produce the very faults which the rule is intended to prevent unless used with well balanced judgment and the consideration of other factors. For instance, it will be found on examination of the misfortunes of certain railroad corporations that disastrous results were due in part to the fallacy of continuing an endless chain of expansion and improvement on borrowed money as long as the net returns were sufficient merely to pay interest on the debt, without profit to the borrower and a proper factor of safety, so that the damage to the credit of the borrower outweighed the advantages gained.

The usual method of calculating the point of maximum economy in the determination of capital expenditures may lead a management bent on a policy of expansion to unjustified expenditure. It is the purpose of the following mathematical analysis to show that such errors may be due largely to disregarding the rate of increase of the interest rate on borrowed money, as the amount borrowed increases over a wide range. Fundamentally the rate of interest is a variable function of the amount borrowed affected by the following factors: More bonds may be offered for sale at a given interest rate than the market can absorb, forcing the price down and raising the interest rate on the proceeds; impaired credit of the borrower through increasing the ratio of the amount of money required to pay interest on the debt to the net earnings and decreased ratio of the value of the property to the amount of outstanding bonds will tend to raise the interest rate as the amount of borrowed capital increases; again, the interest rate to which increasing amounts of borrowed capital are subject is dependent on general financial conditions.

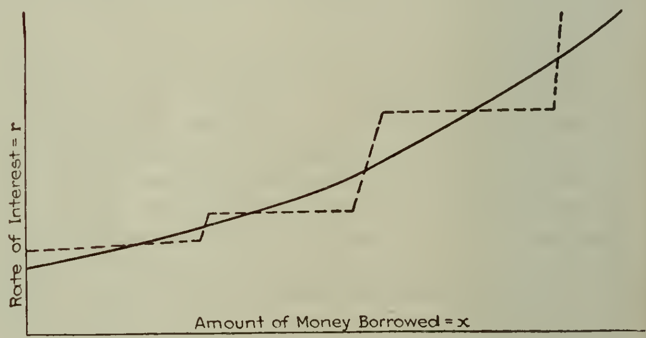


FIG. 1. INTEREST RATE IS VARIABLE OF AMOUNT BORROWED

With consideration of the above factors it should be possible to draw an approximate curve representing the rate of interest as a variable of the amount borrowed, as in Fig. 1, in which the heavy line represents the theoretical variation and the dotted line the probable actual variation as borrowing and expenditure increase.

Let, r = rate of interest
a = total annual interest charges
x = total amount borrowed for capital expenditure
e = estimated operating expenses.

Then the condition of maximum economy is described by the differential equation:

$$\frac{da}{dx} + \frac{de}{dx} = o,$$

as represented in Fig. 2. The curve for e can be approximately established by estimating the operating expenses for several programs of expansion or construction representing different amounts of capital expenditure, and the curve for a can be readily developed as a function of x from Fig. 1.

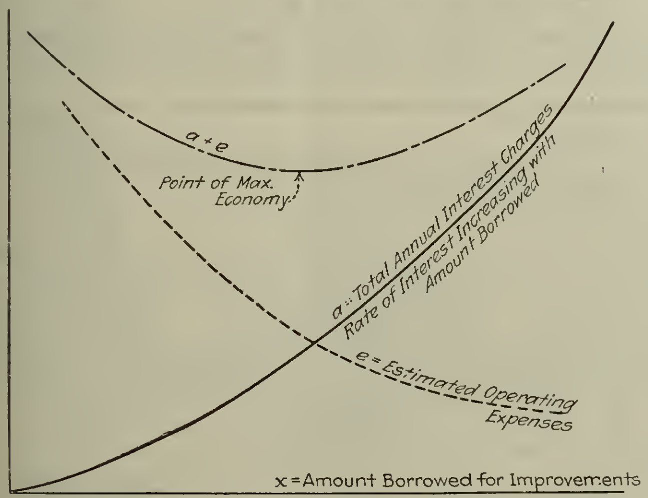


FIG. 2. RELATION OF VARIABLE INTEREST CHARGES AND OPERATING EXPENSES TO MAXIMUM ECONOMY

Since, $a = rx$,

$$\frac{da}{dx} = r + x\left(\frac{dr}{dx}\right).$$

Substituting this value of $\frac{da}{dx}$ in the above equation we arrive at the fundamental equation:

$$r + x\left(\frac{dr}{dx}\right) + \frac{de}{dx} = o.$$

While this equation will be readily conceded to represent the condition of greatest economy, the assumption is too often made that the term $x\left(\frac{dr}{dx}\right)$ may be neglected though this is true only when the amount of money to be borrowed is infinitely small or when the rate of interest on variable amounts is constant. A careful forecast of the curve represented by Fig. 1 will almost invariably indicate that the interest rate will be a variable where the amounts of expenditure under consideration are large, and an approximate value of $\frac{dr}{dx}$ can be determined. Now a constant based on the value of $x\left(\frac{dr}{dx}\right)$ may be developed so that an approximation of the fundamental equation may be represented thus:

$$Sr + \frac{de}{dx} = o,$$

where S may be considered a factor of safety. Such an approximate empirical equation may be found useful where it is difficult to solve the fundamental differential equation.

However, the development of the fundamental equation,

$$r + x\left(\frac{dr}{dx}\right) + \frac{de}{dx} = o,$$

indicates that the term $x\left(\frac{dr}{dx}\right)$ should not usually be neglected and the equation should not be written,

$$r + \frac{de}{dx} = o,$$

without the use of some such factor as S, to serve as an approximation of the true equation. Although the value of this factor may in many cases be in doubt, it would appear that as long as the ratio of net earnings to interest on debt remains constant the credit of the company should remain unimpaired, so that the ratio may, under certain circumstances, be the correct factor of safety, though in the case of a strong company of large earning power there would appear to be no necessity for the use of a factor nearly as large as the ratio of net earnings to the interest on debt.

Objection to this rule may be raised on the score that it is too conservative in that while the last dollar spent earns no more than enough to keep the ratio of interest to net earnings constant, some of the earlier expenditure is likely to be much more profitable and the credit of the company will be thereby improved, yet on the other hand it is well to recall that the increased supply of bonds is likely to depress the price, unless it can be shown that the nature of the security is improving, hence the use of a factor of safety as here suggested is probably not far wrong.

Record Traffic Through Panama Canal

During the fiscal year ending June 30, 1920, the volume of traffic passing through the Panama Canal exceeded that in any previous 12-month period. A total of 2,478 commercial ships made the transit, as compared with 2,025 in the fiscal year 1918-19, 2,130 in the fiscal year 1917-18, and 2,134 in the calendar year 1919. The aggregate net tonnage of the commercial ships passing through the canal in the fiscal year 1920 was 8,545,653 tons, according to the Panama Canal rules of measurement. In the fiscal year 1918-19, the aggregate was 6,131,575 net tons. In addition to the traffic of commercial ships, 266 vessels passed through the canal in the service of the United States Government, without the payment of tolls. In revenues and in earnings in excess of expenses of operation and maintenance, new records were, likewise, established during the fiscal year. The summation of charges has not been completed in detail, but the figures indicate aggregate revenues approximating $8,800,000 during the year. Expenses of operation and maintenance total about $6,650,000. No profit has been made in a commercial sense, since there is no consideration here of interest charges on the investment or of the depreciation of the plant. The previous record for a year for revenues was made in the fiscal year 1918, in an amount of $6,411,843.28. In that year the excess of revenues over expenses amounted to $491,500.34, being greater than that in any fiscal year prior to the fiscal year 1920.

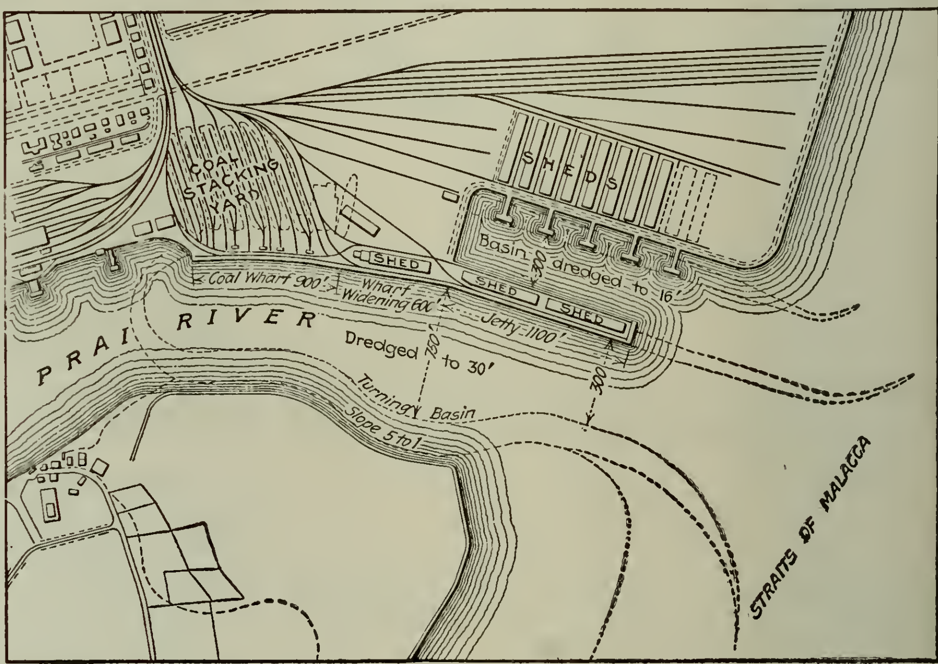
Precast Concrete Pieces Make Up Cylinder Piers For Wharf

Novel Type of Marine Structure Being Built in New Port Development in the Federated Malay States

CONCRETE cylinder piers made up of short precast sections are being used for the support of a reinforced-concrete wharf, or as it is locally called "jetty," in the new Prai River port development in the Province of Wellesley, the Federated Malay States. This port, which is at the mouth of the Prai River where it empties into the Strait of Malacca, has been growing in importance for a number of years. Just before the outbreak of the war a plan for enlargement was submitted to the government but its initiation was postponed until 1918. The work is well under way.

The entire project comprises deepening of the river channel, reclamation of swamp and foreshore, construction of quarters, building of a new dry dock, and, the main piece of work at present, the construction of a wharf which is in the form of a quay for a distance of about 1,500 ft. and which extends further a distance of 1,100 ft. out into the river which widens at this point. Inasmuch as the main channel of the river is to be dredged to a depth of 30 ft. and the marginal basin on the other side of the wharf to a depth of 16 ft., the structure here is in somewhat anomalous type. It is called at the project itself a "jetty," although it has none of the properties of the jetty as understood in this country. The upstream end of the structure is a coal wharf and is approached by tracks from an adjacent railway coal yard. The 600 ft. of shore wharf and 1,100 ft. of "jetty" have on them three two-story transit sheds, each 475 ft. long and 65 ft. wide, which are also approached by tracks from the adjacent railway yard and which will be used in the transshipment of freight to vessels. The whole project is described in *The Engineer*, April 30, 1920.

Borings made in 1914 showed that under the river mud at the site of the wharf and at an average depth of about 50 ft. below low water there is an extensive layer of quartz sand going down to a great depth. Later borings made in search of water penetrated continuous layers of sand and gravel of varying degrees of coarseness to a depth of 320 ft. below low water when a hard, igneous rock was encountered. It was decided, therefore, to make the foundations for the wharf in the layer of sand and concrete cylinders were chosen in preference to screw piles on account of the rapid deterioration of steelwork in these waters. The wharf, therefore, is built on rows of concrete cylinders, seven in each row, spaced 25 ft. apart longitudinally and 22 ft. transversely. It has a total width of 142 ft., the coping level being 4 ft. above high water.



LOCATION OF NEW PIER IN THE PORT OF PRAI, FEDERATED MALAY STATES

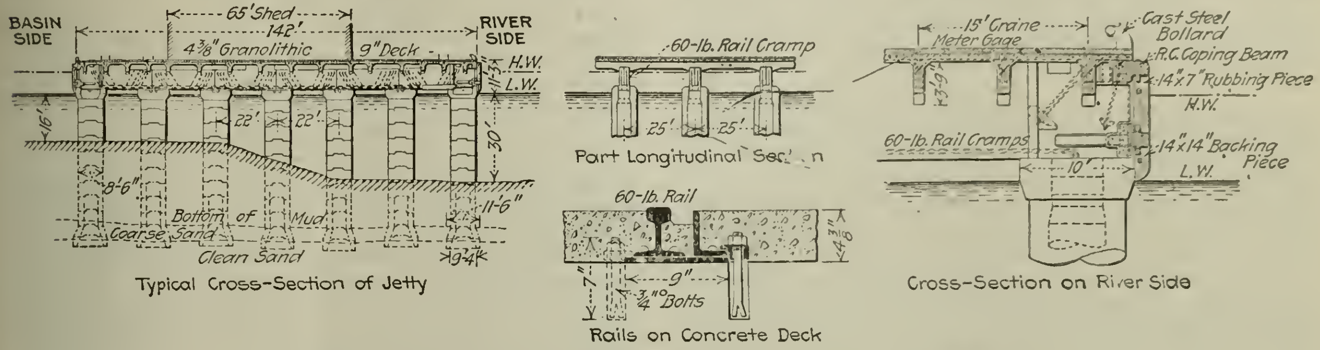
The cylinders for the supporting piers are built up in rings in a block yard and allowed to set for three months before being used in the work. Each ring weighs from 10 to 14 tons. For each cylinder there is a cutting edge ring 3 ft. 6 in. deep, 11 ft. 6 in. outside, and 9 ft. 4 in. inside diameter. On top of this ring is placed a ring tapering from 11 ft. 6 in. to 8 ft. 6 in. outside, and to 5 ft. inside, and the latter dimensions are maintained for the ordinary rings forming the cylinder up to 1 ft. 6 in. below low water, these rings being 5 ft. in depth. A compensation ring made from measured dimensions brings the top to the required level. Special caps capable of a slight adjustment in alignment complete each cylinder at a height of 2 ft. above low water level. On these caps the reinforced-concrete superstructure is built.

The cylinders are sunk in steel guide sleeves fixed for the temporary stages by inside clam-shell excavation and by loading with cast-iron billets. The bottom cylinder is sunk until the cutting edge has penetrated 2 ft. into the layer of sand. A test load of 100 tons, in addition to the weight of the cylinder, is then applied and no cylinder is passed as satisfactory until it has stood 48 hr. without settlement under total load. This is equivalent to five tons per square foot or greater than the ultimate load that will come on the foundations. After each cylinder has been tested the cast-iron loading is removed, the bottom cleaned out by divers, and the core filled solid with 1:6 concrete to within 18 in. of the top of the cap.

When several rows of cylinders have been completed the superstructure is then proceeded with. The lower fender railings, also precast concrete, are placed in position on top of the front caps, forms for the mass concrete columns on top of the cylinders and the cap beams which brace the structure are placed in position, the steel reinforcement assembled, and the whole concreted with 1:6 concrete. The cap beams are 3 ft. 6 in. wide by 6 ft. 9 in. deep and extend from center to center of each cylinder with an expansion joint at each

end. They are reinforced with 1¼-in. diameter steel bars and stirrups, and at the bottom of each beam there are laid two 60 lb. British standard flat-bottom rails, bent downward at each end into collars fixed in the recesses left in the top of the cylinders.

The fender rails are braced by diagonal struts, the tail ends of which are housed in the cap beams and are grooved on the face to receive the lower horizontal fender. The main floorbeams are set and grouted in recesses left in the top of the cap beams. They are 3



DETAILS OF REINFORCED-CONCRETE PIER AT PRAI RIVER MOUTH

ft. 9 in. deep at the ends and 2 ft. 9 in. deep at the central part and 12 in. wide. The reinforcement is made up of 1¼-in. diameter bars. A special coping beam is fixed on the sides and ends of the wharf and grooved to receive the upper horizontal fender.

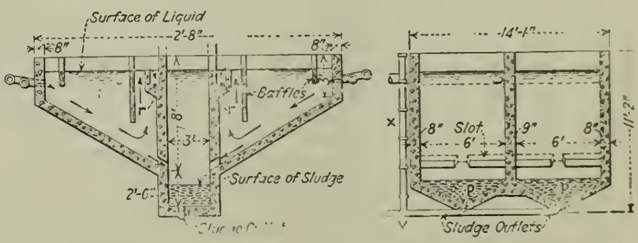
The floor over the whole wharf is 9 in. thick, with top and bottom longitudinal bars ¼ in. in diameter spaced 12 in. c. to c. Transverse bars are ⅝ in. diameter spaced 9 in. c. to c. with intermediate ⅝-in. bars under the track. Under the area to be occupied by the warehouses the spacing of the transverse bars is 6 in. c. to c. The top of the reinforced-concrete floor is finished off with a layer of 1:4 concrete 3⅝ in. thick on which is laid 1 in. of 1:2 granolithic concrete of fine granite screening, screeded off to the required level, the top layer being laid immediately after the lower one.

The concrete of the cutting ring of the cylinders is 1:3 mix and all the other rings 1:5 concrete. All reinforced concrete is made in the proportions of 90 lb. of cement to 1⅓ cu.ft. of sand and 2⅔ cu.ft. of crushed granite, the stone broken to assorted sizes not less than ⅛ in. and more than ⅝ in.

Three meter-gage tracks are laid on the river side and two on the basin side of the wharf, with frequent crossovers. Turntables are also fixed in wells specially formed in the reinforced-concrete superstructure on the cross-track between the warehouses, and at the end of the wharf for the transfer of single cars from one track to any other. The track rails and the rails for the 15-ft. gage electric cranes are laid at the same time as they were before mass concrete and granolithic surface. They are 60-lb. rails riveted to a ⅝-in. steel bed plate carrying also an angle guard rail, as shown in the accompanying detail. The development of the Prai River project was prepared by P. A. Anthony, general manager and chief engineer of the Federated Malay States Railways, and approved by Coode, Matthews, Fitzmaurice and Wilson, consulting engineers for the Straits Settlement and the Federated Malay States governments. Construction is going on under contract to Topham, Jones & Railton, Ltd.

Sewage Treatment at the Miami Conservancy Camps

THE application of a system of sewage treatment to the needs of the Miami Conservancy camps naturally required special adaptation. The camps are small, the two largest built to accommodate a total maximum camp population of about 500. For Conservancy use they would be operated about four years, after which the whole camp plant would have to be disposed of. The sites are all several miles from the nearest town or city, but in all cases except one are near railway or electric railway lines. Under such circumstances it was considered best to so design the camps that they could become permanent villages after the Conservancy work was done. The buildings are inexpensive one- or two-story structures of the summer cottage type, with water, electric and sewage facilities. The sewers are of the separate type.



IMHOFF TANKS MADE SHALLOW FOR ECONOMY GIVE RESULT

For sewage treatment a standard pattern of Imhoff tank would cost too much, largely on account of the depth necessary, approximating 30 ft., requiring expensive excavation, since the tanks must be below street sewer level, in order to receive the sewage by gravity flow. It was for this reason that the design indicated was adopted. By locating the greater part of the sludge chamber between the two sedimentation chambers, instead of below them, a great saving in depth was obtained, while at the same time the sludge decomposition was completely separated from the fresh liquid sewage.

The Conservancy tanks show a depth below the surface of the liquid of 9½ ft., and after being in use more than a year create no perceptible odor even in the near neighborhood.

The maximum number of men to be provided for at Englewood and Taylorsville, the two largest camps, may be 300. With their families, most of them not being married, this might make a total camp population in each of these cases, of 500. At 7 cu.ft. per second per thousand people, the Stillwater River at Englewood (below West Milton), would take care of a population of 3,500, seven times the maximum camp population, without sewage treatment. Similarly at Taylorsville, the Miami would take care of 10,000 people; Mad River at Huffman, of 28,000 people, Loramie Creek of 1,268, and Twin Creek of 1,428. With the known conditions, the danger of creating a nuisance is remote.—*Miami Conservancy Bulletin.*

A View on British Registration of Engineers

IN A communication in the July 23 issue of *The Surveyor* (London) Percy Griffith, member of the Institution of Civil Engineers and other national organizations and recently secretary of the Institution of Water Engineers, discusses the present status of British engineer registration. He emphasizes particularly the opportunity which is believed to exist for an effective co-ordination of the work now being carried on by a large number of engineering institutions. His letter follows:

Now that the Institution of Civil Engineers has accepted the principle of registration as the proper, if not the only, means of securing general compliance with a standard of qualifications adequate to safeguard the interests of the public on the one hand, and to maintain the prestige of the profession on the other, it seems to me that a golden opportunity offers for an effective co-ordination of the work now being carried on by a large number of engineering institutions. At the moment each of these bodies is struggling to secure for its members special advantages which may not only justify the payment of the annual subscription, but also attract new members, and the resulting disadvantages are sufficiently obvious to require no elaborate statement. Briefly, however, they include the following: (*a*) Multiplication of subscriptions; (*b*) overlapping in subjects discussed; and (*c*) distribution of literary matter, models, specimens and other data required by engineers from time to time among a vast number of centers, located without any consideration of general accessibility.

The difficulty of geographical distribution is being partly met by the formation of "local branches" in various provincial towns, but the attempt of the London institutions to establish local branches in the Colonies has been finally checked by the establishment of independent institutions in India, Canada and Australia, representing all branches of the profession, and each providing schemes of registration which ensure to the members not only public recognition, but security against unfair competition by unqualified men.

These facts will suffice to emphasize the feeling, which has been growing rapidly in recent years, and especially during and since the war, that something should be done to co-ordinate the labors of English engineers practicing at home, but the difficulties which have arisen in connection with the Civil Engineers (Registration) Bill, promoted this session, but definitely held over for the present, have clearly revealed the impossibility of attaining the object in view so long as the initiative is retained in the hands of one institution. We all recognize the seniority and prestige of the Institution of Civil Engineers, but, unfortunately, we do not quite understand what is meant by the term "civil engineer;" moreover, we all (or nearly all) belong to some other (sectional) institution or society which specializes in the particular branch we are engaged in, and whatever value may attach to our Institution of Civil Engineers' certificate, we still prize our certificates proving us to be specialists in our own branch as highly. Registration under the Civil Engineers' scheme would therefore give us little more prestige than we gain from our present certificates as "members" or "associate-members," and the only advantage left would be the elimination of the unqualified competitor. It is, however, not certain that we should even secure this, as anyone could practice as an electrical, gas, water, or sanitary engineer so long as he did not call himself a civil engineer as well.

It is no doubt under consideration to provide some means of recognizing the specialist in the registration scheme, but, unfortunately, we have another large and influential institution, whose title is almost as vague and ill-defined as that of the senior institution—namely, the Institution of Mechanical Engineers. Moreover, the interests of these two institutions are so similar that their very existence side by side entails an element of competition and rivalry which the best intentions of their respective councils cannot entirely eliminate or overcome. As regards registration, their claims to dominate the situation are nearly equal, and many no doubt would, on personal grounds, prefer to trust their fate to the "mechanicals" rather than to the "civils." We should, I think, most of us agree in attributing this feeling to the fact that the junior institution is more "human" than the senior, and possibly, in many cases, the term "up to date" would be accepted as nearer the truth than the term "human."

Assuming, however, that the two senior institutions can find some means of acting together in this important matter, we shall be in a position to consider "registration of engineers" on broad, comprehensive lines, and then we can face the problem involved by the claims of the admittedly sectional institutions. With this in view, it is worth while to realize their specific functions more clearly than has been generally done. For many years past the Society of Engineers, which was established in the year 1854, and therefore follows the Institution of Mechanical Engineers as regards seniority, has been working in the direction of registration for all classes of engineers; but, owing to its relatively small membership and the want of prominent "personalities," its labors have been unfruitful. Meantime it has, by a praiseworthy act of self-abnegation, induced the Institution of Municipal and County Engineers and the Institution of Water Engineers to initiate schemes for testing and vouching for the qualifications of their members.

To this extent, at least, we have the materials at hand for framing a comprehensive scheme of registration. The two leading institutions should undoubtedly together form the permanent nucleus of the governing body, and become the registering council or authority, but their certificates of competency should be restricted to (*a*) general engineering knowledge, and (*b*) special experience in branches not at present represented by any sectional institution. In the the case of certificates for general engineering knowledge only, registration should not be conceded except in a separate class, and the registration certificate should be clearly differentiated, but it would be certainly preferable that registration should be restricted to those obtaining certificate (*b*), and then the nature of the experience obtained should be stated quite specifically. In all cases where the candidates had qualified in some branch represented by an existing institution, the scheme could provide for registration being granted to anyone holding a certificate issued by the sectional institution in question, subject only to the examination or other test on the strength of which the certificate was granted—being approved by the governing body. To secure the necessary supervision and control, it might easily be arranged that the governing body should have power to nominate representatives on the sectional board of examiners in each case.

Registration certificates would then be issued to all classes of engineers with the particular section or sections in which qualifying certificates had been obtained stated as a supplementary classifying title. The mention of two or even three sections on the certificate would be no serious difficulty. Needless to say, the vague terms "civil engineer" and "mechanical engineer" would disappear into the "limbo of a forgotten past."

So much for registration. But I would point out, with all the emphasis at my command, that in negotiating such a scheme as this, the foundation would be laid for a comprehensive co-ordination of the whole profession, the superstructure of which would be comparatively easy of design and erection owing to its manifest advantages. I cannot enlarge upon this without unduly encroaching upon your space; but it will suffice to indicate summarily some of the possibilities:

1. A central building with a central engineering library (both "lending" and "reference") in Westminster.
2. Provincial engineering centers in the chief cities outside London with smaller libraries (for "reference" only).
3. Engineering clubs attached to the building in each case, with social functions arranged from time to time.
4. Central meeting halls available for all sections and possibly sectional headquarters (secretariat) in the same block.

5. Sectional employment bureaus, with sections for juniors or assistants having only general experience.

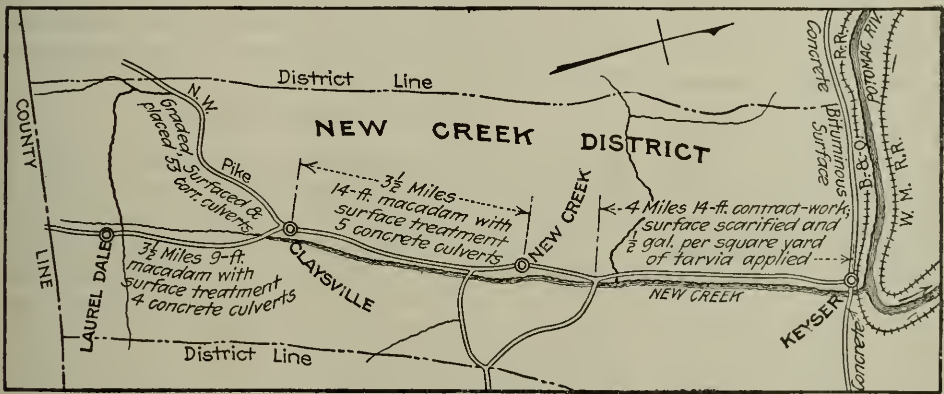
These, are, however, but feeble illustrations of the advantages of co-ordination among professional engineers, and I venture to hope that some of our leading men will seize this opportunity of initiating a movement worthy of our prestige, our ability, and our destiny.

County Roads Constructed Cheaply by Day Labor

Farm Boys and Old Men Unfit for Military Service Make Fairly Efficient Macadam Road Builders

By Samuel H. Lea
County Engineer, Keyser, W. Va.

SUCCESSFUL highway improvement by force account, with local labor under the unpaid direction of a local business man, has been accomplished during the three seasons prior to 1920 in Mineral County, W. Va. While the construction performed was not notable in magnitude it was of a kind with which many communities are concerned. Incidentally, one part of the construction was by contract, so that a cost comparison with the force account work is possible. The sketch map indicates the roads improved, the town of Keyser being the headquarters for the direction of the work. There were altogether 13½ mi. of road divided as follows: 5 mi. graded and macadamized to a width of 14 ft. with a surface treatment of ½-gal. of refined tar per square yard; 3½ mi. graded and macadamized to a width of 9 ft. with a surface treatment of ½-gal. of refined tar per square yard; and 5 mi. of mountain road (Northwestern Pike) graded and surfaced. In addition, the road south from Keyser for a distance of 4 mi. was resurfaced to a width of 14 ft. with a surface treatment of ½-gal. of refined tar per square yard. This latter work was done under contract at cost-plus 10 per cent. The total cost was $11,387.59, or $0.346 per square yard.



MINERAL COUNTY, WEST VIRGINIA, FORCE ACCOUNT ROAD SYSTEM

The county owned considerable road machinery; good stone was obtainable locally and a comparatively small portion of the construction material required railroad shipment.

The equipment employed consisted of a portable rock crusher, with screens and bins; one 4-ton motor truck, with dump body; one light runabout for the timekeeper; one 10-ton steam roller; four dump wagons and two carts; two 18-hp. boilers; two steam drills, and wheelbarrows, hand tools, etc.

Three foremen were employed at a flat rate of $100 per month each. One foreman supervised the quarry operations; one had charge of grading and preparing subgrade, and one looked after the construction of the macadam roadway. The engineering was done by a private firm at the rate of 4½ per cent of the cost of the completed work. A timekeeper was employed at $100 per month. He was given a light runabout and, in addition to keeping the time of workmen, he made out payrolls and monthly statements, attended to local purchases of supplies and carried orders and messages to different parts of the work.

Laborers were obtained mostly from adjacent farms. On account of war conditions old men and boys and men who were unfitted for military service comprised the working force. They were paid wages of $2.25 to $2.50 per day and the efficiency obtained was at least equal to that of some of the higher-priced laborers at the war construction camps.

The macadam was placed upon a rolled subgrade and compacted by rolling to a depth of 8 in. Shoulders of earth and broken stone were made about 3 ft. wide. Upon the macadam roadway a surface treatment was applied, consisting of ½-gal. of refined tar and about 20 lb. of stone chips per square yard of surface. The chips were in sizes from ½ in. to 1 in. The lump sum costs are given in the table which is reproduced below.

The unit costs, allowing interest and depreciation, were as follows: waterbound macadam, $0.793 per square yard; surface treatment with ½-gal. refined tar and 20 lb. chips, $0.187 per square yard; corrugated metal culverts, 15 in. to 30 in. diameter, furnished and installed, $3.37 per linear foot; concrete culverts $15.60 per cubic yard of concrete.

LUMP SUM COSTS OF ROAD CONSTRUCTION BY FORCE ACCOUNT IN MINERAL COUNTY, W. VA.

Five miles waterbound macadam, 14 ft. wide, 8 in. thick..	$36,757.91
Three and a half miles waterbound macadam, 9 ft. wide, 8 in. thick	14,360.62
Five miles grading and surfacing (Northwestern Pike)	4,629.35
Fifty-three corrugated metal culverts furnished and installed	3,235.20
Nine concrete culverts	6,893.40
Surface treatment with refined tar to waterbound macadam	12,101.41
Engineering supervision, 4½ per cent	3,509.00
Interest and depreciation on plant, 20 per cent on $6,000	1,200.00
Total cost	$82,686.89

The funds were obtained by the sale of district road bonds.

The work was under the direction of a local advisory committee whose chairman, J. C. Watson, a business man of Keyser, supervised all expenditures and directed operations. This service, rendered without compensation, resulted in a successful and economical consummation of highway improvement work of considerable magnitude.

Japan's Railway Progress Under State Ownership

Private Lines with Majority of Mileage Acquired in One Year—Extension and Improvement to Form Unified System

TEN years of railway development in Japan under the law for nationalization of the railways have shown results distinctly favorable to government ownership as compared with the previous combination of government and private ownership. This is the general substance of a comprehensive report issued by the Imperial Government Railways of Japan. The law in question was passed in March, 1906, and the acquisition of the leading private lines had been completed by October, 1917. This naturalization was not a revolutionary change in the government's policy of railway administration, but was rather an expansion of the existing state railway system by incorporating into it the separate private lines.

First Railways Built by State

In Japan the first railways were built by the state and it was not until 1881 that owing to difficulties in raising capital the Government decided to depart from its policy and grant concessions to private companies for the construction of railways. At that time the Government had built 115 miles. In 1891 the private companies had built 1,165 miles, while the state system did not exceed 557 miles, but the former had been assisted by government guarantees of interest and by cash subsidies. The first concessions were for 99 years, with provision for purchase by the state after 50 years, but in the year 1887 the purchase period was reduced to 25 years and guarantee of interest was withdrawn for all the new projects.

It was considered in 1891 that a network of 3,600 miles was necessary to complete a railway system adequately serving the whole country, but the existing mileage was only about 1,600 miles. Most of the contemplated extensions were in remote districts, giving little prospect of immediate profit, and therefore they did not appeal to private capital. This condition, combined with financial failure of some of the private companies, led to the initiation of a movement in favor of government ownership of the entire system.

Meanwhile construction was continued by both the government and the companies, so that at the beginning of 1906 the former had 1,536 miles and the latter 3,248 miles. During this period the consolidation of the lines was considered at various times, but although there was a strong majority opinion in favor of government ownership there was division of opinion as to whether government or private operation was preferable. In the business depression of 1898-99 several companies were dissolved, but thirty-eight existed in 1906 and their 3,248 miles of railway were made up largely of short and disconnected lines. Some of the more important routes, therefore, included parts of the government lines and parts of different private lines throughout the country.

The railway nationalization law passed in 1906 provided for government ownership of all except local lines and for the purchase of the seventeen main private railways by 1915, but within a few months this purchase period was reduced to one year. These railways aggregated 2,824 miles.

The present organization of the Imperial Government Railways is headed by a minister of railways, a vice-minister and an engineer in chief. Under this administration are the six departments of finance, engineering, mechanical engineering, traffic, private railways and business affairs. The operating organization is on the divisional system. The financial program, covering the period up to 1928, provides for annual expenditures of from $5,000,000 to $12,000,000,000 for construction and from $2,500,000 to $18,000,000 for improvements. These figures are based on a 50c. value in the rate of exchange for the "yen."

In 1917 Japan had 5,857 miles of state railways with 9,029 miles of track, while the private local lines brought the railway total to 7,621 miles. This total is equivalent to 13.80 miles per 100,000 inhabitants and 5.16 per 100 square miles of area. All main lines are of 3½-ft. gage and the heaviest rails weigh 70 lb. per yd. The equipment included 2,725 locomotives (12 electric), 6,867 passenger cars (125 electric and 22 steam motor cars), and 196,419 freight cars. With reference to the sudden demands upon the transportation system consequent upon the European war the report states that "but for the unity of management under a single authority the railways might have experienced serious embarrassment, if not utter collapse, owing to the phenomenal flood of traffic forced upon them."

Recent Improvements

Engineering difficulties have been numerous in carrying out the extensions planned under the new law to link up the lines of 1906 into a comprehensive and interconnected system. Owing to the mountainous character of the country grades of 1 to 3 per cent are frequent, with heavy curvature, heavy earthwork and numerous tunnels and bridges. New stations, city terminals, freight yards, car ferries, shops and extensive signal equipment are among the many works included in the development of the railway system from 1906 to 1918, and similar works are still in progress. Electrification has been applied at several points for suburban and main line traffic. It includes the rack-rail section of the Usui Pass, with grades of 6.7 per cent, where steam operation in the numerous long tunnels was a serious trial to enginemen and passengers owing to the inadequate ventilation.

Extensive improvements have been carried out also on existing lines, including grade reduction and double tracking. Two important grade reduction works of heavy character are now in progress; one will eliminate a mountain crossing with grades of 1.4 to 2.30 per cent and provide a low-level line with grades of 0.3 to 0.7 per cent, but this work involves a 5-mile tunnel. The other work is of a similar character, substituting a tunnel line with 1 per cent grades for an open-pass line with grades of 2.5 per cent.

Scientific railway engineering has received a large share of attention in the scheme of railway development. This work is under the direction of the Research Office, which has laboratories for chemical, electrical and timber study, a locomotive testing plant and a fuel testing plant. This office is in turn included in the business department and has charge of all the local laboratories.

Seepage and Waste Water Losses on Wapato Irrigation Project

Drainage Ditches to Relieve Alkalied and Swamped Lands Give Measured Flow of 60 Per Cent of Applied Irrigation Water

By L. W. Holt
Supervising Engineer, U. S. Indian Service, Yakima, Wash.

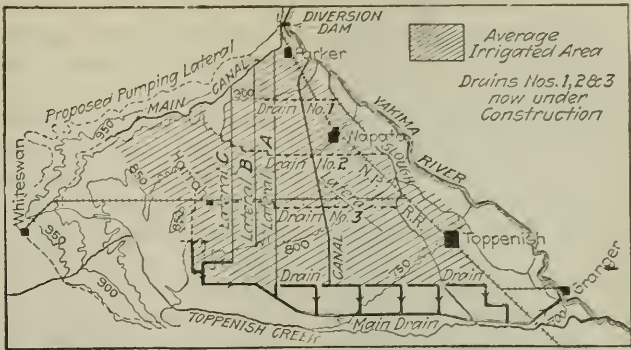
MEASUREMENTS of the flow from the drainage system of the Wapato Irrigation Project, Washington, show that as an average for the six years, 1913-19, about 60 per cent of the applied water reached the main drainage ditch.

The Wapato Project diverts water from the Yakima River six miles south of the city of Yakima, and is within the boundaries of the Yakima Indian Reservation. The first irrigation canal on that project was constructed by the U. S. Indian Service in 1896. It had a capacity of 300 sec. ft. In 1903 a canal with a capacity of approximately 1,000 sec.-ft. was constructed, diverting from the Yakima River at Union Gap near the northern boundary of the Reservation.

The soil is locally called volcanic ash, 2 to 5 ft. deep, underlaid with a stratum of loose gravel 25 to 50 ft. deep. The slope of the land is toward the south and averages 14 ft. to the mile. Toppenish Creek runs east at the extreme southern boundary of the project. The land immediately north of this creek has less fall and the soil generally speaking is somewhat deeper than the average on the project above. The annual rainfall is 7 inches.

In 1910 the alkalied and swamped lands had increased to such an extent and were so rapidly taking additional land to the north, that Congress appropriated $250,000 for draining the area thus swamped, which approximated 40,000 acres, some of which, however, had never been irrigated.

Until that time it was believed that this land could be drained by dredging out Toppenish Creek. The Board of Engineers investigating this matter (W. H. Code, chief engineer, U. S. Indian Service; C. G. Elliott, chief drainage engineer, U. S. Department of Agriculture, C. H. Swigart, supervising engineer, U. S. Reclamation Service, and J. W. Martin, superintendent of irrigation, U. S. Indian Service) was of the opinion that owing to the many bends in the creek and the fact that the land had less fall adjacent to the creek than at a distance that it would be better to locate the main



IRRIGATION AND DRAINAGE SYSTEM, WAPATO PROJECT

drain approximately one-half mile north of and paralleling Toppenish Creek, with lateral drains constructed 1½ miles north of the main drain and emptying into the main drain at intervals of about two miles.

A dredge with a 1-yd. bucket and a dragline excavator with a 1½-yd. bucket were purchased and the work was begun during the summer of 1910. Later a dragline machine with 1-yd. bucket was leased. The work was practically finished by the middle of the summer of 1912. However, so much water was encountered in the drain that it was deemed wise to enlarge the main drain from the outlet at Yakima River back three miles to the first main lateral and two miles of this lateral. This work was completed in December, 1912. In all, 42 miles of drains were constructed.

As soon as the construction work was completed a gage was established near the outlet of the drain. It has been read daily, with slight interruption since that time, and weekly current meter measurements have been made. The discharge from this drain was so large and so uniform that I believe the record given in the table will be of interest to irrigation and drainage engineers.

In preparing the table in the form given it was necessary to make certain assumptions and estimate corrections. One of these was that the irrigation water found its way to the drains on May 1 of each year, or one month after irrigation water was turned into the irrigation ditches, as May was the first month to show any increase over previous months most years. On two or three different occasions flood water from the overflow of Toppenish Creek and the Yakima River found its way into the drain and corrections have been made for those months. Also certain deductions have

MONTHLY DISCHARGE FROM MAIN DRAINAGE DITCH, WAPATO IRRIGATION PROJECT, WASHINGTON

Year	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Total	Acres Irrigated	Acre-Ft. Applied	Discharge Through Drains: Depth, Acre-Ft.	Depth in Feet per Acre Irrigated	% of Water Applied
1913	12,558	12,048	11,080	10,709	11,082	13,518	12,361	12,105	13,343	11,647	12,345	12,024	144,820	35,868	234,880	6.6	4.0	60
1914	13,591	12,246	12,119	10,925	12,418	14,194	12,881	12,254	11,679	11,284	12,274	10,678	146,543	36,000	234,424	6.5	4.0	61
1915	11,140	10,108	9,733	9,298	8,844	10,126	10,572	10,493	12,000	10,080	11,000	13,000	126,394	37,424	187,600c	5.0	3.4	68
1916	20,000a	19,632	18,616	14,121	15,314	13,672	12,278	12,005	11,488	10,119	10,526	10,182	167,953	44,712	279,849	6.2	3.7	61
1917	17,061	19,547	17,025	16,438	17,677	15,199	15,971	21,274a	25,555a	16,037	14,746	14,875	211,405a	53,790d	350,892	6.5	3.8	58
1918	15,974	18,421	17,143	18,949	18,919	17,732	14,770	12,666	12,600b	12,600b	12,600b	14,080	196,974	60,223d	363,137	6.0	3.4	57
															Average,	6.1	3.7	60

a Includes some flood waters in drains.
b Discharge estimated.
c Does not include November irrigation.
d 2,500 acres should be deducted from area irrigated in 1917 and 4,500 acres deducted from area irrigated in 1918.

been made in the irrigated area draining into other outlets. The table mentioned above is attached hereto.

It will be noted that the percent of the water applied to the land irrigated that was discharged through the drains averaged 60% and was very uniform with the exception of 1915. That year was the driest on record in the valley and the greater percent of runoff that season can be accounted for only by assuming that no record was kept of the diversion for irrigation after Oct. 31, as there was thereafter sufficient water for all purposes. Water was used, however, for irrigation throughout the month of November and at least 10,000 acre-feet used on the land of which no record was kept.

The table shows that on an average 3.7 acre-ft. of the 6.1 acre-ft. applied to each acre was lost by deep percolation and through waste-water ditches, and that at least 90% of the total loss was by deep percolation. This shows that nearly 30 in. of irrigation water was used on each acre irrigated and lost by evaporation. This is what might be expected, for, if we had a 30-in. rainfall distributed uniformly over the irrigated area from April 1 until Oct. 31—the length of the irrigation season—irrigation would not be required.

The writer has continually tried to increase the duty of irrigation water, but owing to the fact that 40,000 acres of the land irrigated are leased from the Indians, and the average lessee tries to get as much out of the land as possible at the least expense, consequently neglecting to properly prepare the land for irrigation, increasing the duty is a very difficult thing to do.

The 42 miles of drainage canals were measured at one-mile intervals one winter, and at that time the average increase in the flow was 5 sec.-ft. per mile, being slightly more on the east and west drains than on those running north and south.

The project is very productive, and even though an excessive amount of water was used, the 60,000 acres of land irrigated produced a crop in 1918 valued at $6,000,000 and estimated at $10,000,000 for 1919.

The irrigation system is being rebuilt and increased to irrigate 120,000 acres as fast as funds are provided by Congress, and an adequate drainage system is now being constructed along with the irrigation work. Much of the land formerly alkalied has been reclaimed and is now very productive.

Congress has recently appropriated sufficient funds to enable the Indian Irrigation Service to proceed with the development of the project on a larger scale than heretofore. At this time five dragline excavating machines are at work on irrigation and drainage canals. The work when completed will, no doubt, affect the flow of the drains heretofore described.

Previous to beginning the drainage work now under construction the ground water rose dangerously near to the surface of the ground in many places during the latter part of the irrigation season, which if allowed to go unchecked from year to year would gradually alkali and swamp a considerable area. It is believed that the proposed drains will prevent the ground water from rising to more than 8 ft. from the ground surface and will intercept some of the water which now reaches the drains described in this article.

Drainage canals are being constructed at approximately 2½-mile intervals, running east across the project, emptying at present into a large slough where the drainage water is used for irrigating land in the vicinity of Toppenish. Some of the drains now under construction intercepted a flow of 20 sec.-ft. per mile of drain during the past summer.

When the larger project is completed the maintenance and operation charges will be fixed according to the number of acre feet used by each water user. This method will result in an increasing duty of water, as the farmer will know that he is saving money.

A Tribute to the Engineer

The following editorial from the Cedar Rapids *Evening Gazette* has been brought to our attention by H. R. Green, an engineer of that city, who thinks the editorial, entitled "The Engineer" should be read by a wider circle of engineers than will see it in the *Gazette*:

Outside of the professor and the captain of industry few persons realize the evolution that has come in engineering. Plain humans have evolved but slowly in a half century, but today you find the engineer everywhere.

In all walks of production and industry except, perhaps, the industry of farming, the engineer is called in first. Few capitalists will risk their money and time on a project until competent engineers have gone over the ground thoroughly and indorsed it. Indeed, it is now a large practice for engineers of ability to seek out independently opportunities for the investment of capital or for the utilization of natural resources. Herbert Hoover himself is one of the successful examples of this latter class who are sure to grow in numbers and influence every year.

The engineer is becoming so important, as a matter of fact, that the day may not be long distant when he will take first place in industry and progress, the place occupied for centuries by the capitalist.

And will not the world be a better place for humans when that happens? The capitalist sits in his office by day, the lord of all he surveys, and at night associates with his own class. His chief affair in life is how to make money and how to spend it. In most cases he is totally materialistic—not entirely because he wants to be but because his environment and habits of life restrict him. He is cold spiritually because he doesn't mingle personally with the world's throngs. Thus when a problem comes to him involving masses of people he naturally trends to the materialistic side.

But the engineer! The very nature of his life's work carries him daily among the people, where he sees their problems, where he is often compelled to live as they live, work as they work and take risks that they take.

It is easy to recognize which man should have first place in this worldful of human beings—the capitalistic captain of industry or the engineer.

Mr. Green suggests that this tribute to the engineer, which he says is "unsolicited publicity," is due in part to the increased activities of the engineer in public affairs and probably to the organization of many local and state engineering societies.

Large Lumber Consumption During War

Approximately 6,500,000,000 ft., b.m. of lumber was used by the Government during the war, as shown by figures compiled by R. D. Bryant, industrial examiner of the United States Forest Service. Of this amount of lumber purchased directly by the various Government departments, the Army consumption was nearly 5,500,000,000 ft., the Navy consuming more than 120,000,000. During 1918 the Emergency Fleet Corporation consumed for ship construction approximately 800,000,000 ft. Lumber needed for boxes and crates alone required approximately 2,000,000,000 ft. Structures for cantonments, hospitals, warehouses, etc., used approximately 3,000,000,000 feet.

Notes from Foreign Fields

FROM GLASGOW TO LONDON

BY
E. J. Mehren
EDITOR ENGINEERING NEWS-RECORD

COMING down from Glasgow toward Liverpool I was treated to an experience that is rare in England—an all-night journey due to a washout. England experienced on the night of May 29 a severe storm. At Brock, below Lancaster, a small river crosses the right-of-way of the London & North-Western Railway. Normally a brook but five or six yards wide, it became a torrent and carried against the abutments and girders of the L. & N. W. bridge large trees, which dammed the waterway. A few hundred feet to the south is a highway undercrossing. Though well above usual high water the damming of the stream forced the water through this opening and the structure was washed out.

Though the failure occurred at 11 p.m. on Saturday, passengers for the south were blithely allowed to leave Glasgow on the 5 p.m. train Sunday, without being told that they would be subject to delay. On reaching Carlisle the news of the break got about. Though due in Preston at 10:30 p.m. we did not reach there until 3:40 a.m. Monday, and then only when the train was routed over the Midland Railway.

The amount of rainfall on the River Brock watershed I was unable to ascertain, but the gage at Preston, a few miles to the south, showed 2.82 in. between Saturday at 9 a.m. and Sunday at the same hour. Most of this fall occurred Saturday evening.

It was during the same night that the South disaster, in which 22 people lost their lives, occurred. The rainfall on that watershed was given at the coroner's inquest as 4.59 in. at one station and 4.70 in. at another in a 2½-hour period. A rivulet normally a yard wide and a foot deep was swollen to a width of 150 and a depth of 50 ft.

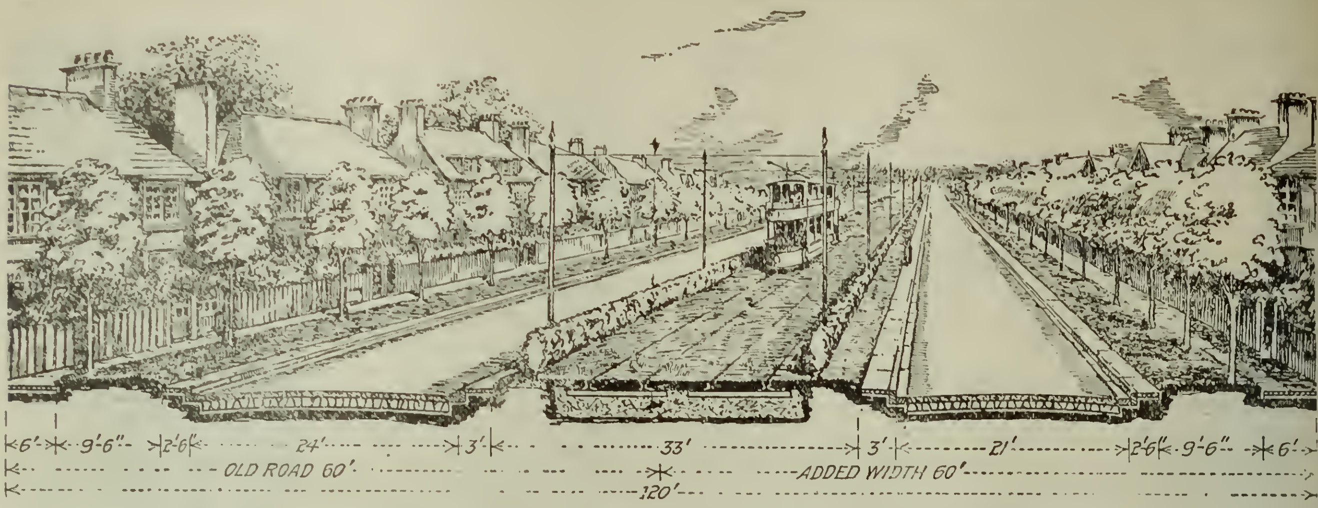
JOHN A. BRODIE

Liverpool—At Liverpool, the city engineer, Mr. John A. Brodie, who has recently been elected president of the Institution of Civil Engineers, showed me his plans for providing for the traffic of the future. Under his guidance Liverpool is taking time by the forelock and by providing liberal arterial ways and a ring-street in what is now sparsely built territory will save itself many millions in the future. In other words, Liverpool is benefiting by the experience of London and Paris.

For main arterial ways Mr. Brodie recommends a minimum width of 120 ft. This permits the laying out of two carriageways each 24 to 27 ft. wide, and a street-railway right-of-way of 30 to 33 ft., with the remainder in grassplots and footwalks. A cross-section of a street actually widened from 60 to 120 ft. is shown herewith.

AN ARTERIAL WAY 120 FT. WIDE, OF TYPE ADVOCATED BY MR. BRODIE

Mr. Brodie places much emphasis on the economies of putting the street railway on a right-of-way of its own. When this is done a cheaper form of track construction can be employed: rails on ties bedded in stone ballast, instead of the usual English construction of rails on steel ties on a concrete base. He has shown that with property values in Liverpool, even for land with buildings, it is cheaper to take an extra strip for the street railway than to lay the track in the carriageway. In other words, with the saving accruing from the cheaper form of track construction and the lower maintenance cost of the pavement due to the absence of rails, it is possible to buy the extra land for the railway right-of-way. Of course, the argument here appeals directly to

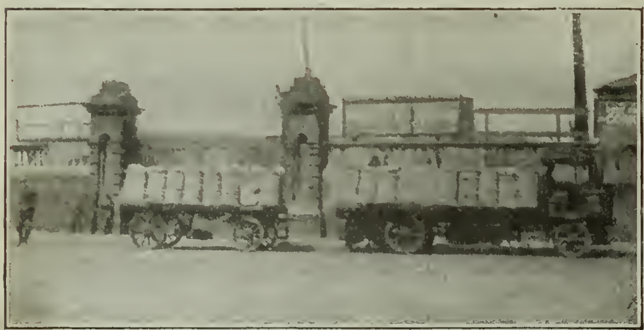


CROSS SECTION, SHOWING STREET WIDENED FROM 60 TO 120 FT. AT LIVERPOOL

the Corporation of Liverpool, for it owns the tramways, but the thought is worth passing on to our municipal officials and electric-railway operators.

The Queen's Drive, a ring road constructed under Mr. Brodie's direction, has already proved its value. Heavy commercial traffic uses it to avoid running through the heavily congested business district, formerly necessary to get from one side of the city to the other. Like the arterial ways, it has a minimum width of 120 ft.

In Liverpool I saw the heaviest traffic, taking weight



STEAM LORRY AND TRAILER, LIVERPOOL

and density into consideration, that I have seen in the United Kingdom. I think it equals that of any of our American cities. The steam lorry, in good favor everywhere in England, is here seen at its best. Invariably it hauls a trailer. Ten-ton loads on both lorry and trailer are common; in other words, the gross weight of the train will be about 30 long tons. The length of lorry and trailer is about 45 ft. Gasoline-driven trucks are used to a less extent than the steam vehicle, though this is merely a street observation, and is not based on records. In London, on the other hand, there are more gasoline than steam trucks.

Birmingham—At Birmingham, my last stop between Glasgow and London, the sewage disposal works and the refuse and garbage disposal system are of special interest. The sewage disposal plant is under the direction of John D. Watson, well known in the United States.

The main refuse-disposal plant, where refuse is picked over and incinerated and garbage reduced, is in a thickly settled part of the city, and while the odors within the plant are not pleasing the plant apparently is not a nuisance to its neighbors. Electrically driven carts are largely used for collection and are found economical as compared with horse-drawn traffic because of the larger district covered and the use for charging of the current generated by the incinerating plant. Among the products sold are rags of a number of classes, paper in three classifications, baled twine and rope, recovered solder and tin, detinned iron, glue, four kinds of fertilizer, destructor clinker, prepared mortar in which finely crushed clinker is used instead of sand, cement brick, sidewalk slabs and lawn rollers made with clinker aggregate. The demand for clinker is so heavy for use in filling and for concrete that a plant is being installed by which the entire handling from the furnaces, through the crushers, screens and bins into the carts, will be mechanical. Another improvement is the installation, now under way, of an electric detinning plant. Even with the sale of these by-products the plant does not pay all the expenses of operation, taking into consideration collection charges, the maintenance of collecting carts, plant, etc. The impression one gains is that everything possible is being done to get the values out of the material collected and that the operation is businesslike and efficient.

London, June 4, 1920.

No Relation Between Pellagra and Sanitation

Studies made by the U. S. Public Health Service show no relation between pellagra and sanitation. Among these studies was one of pellagra incidence in seven South Carolina mill villages, conducted by Joseph Goldberger, Surgeon U. S. Public Health Service and associates, the latter including R. E. Tarbett, sanitary engineer, who contributed sanitary ratings in tabular and graphic form. This study is presented in *Public Health Reports*, July 16, 1920, with the following conclusion:

> This study of the relation of factors of sanitary importance to the incidence of pellagra in seven representative mill villages has failed to reveal any consistent correlation between them. Although based on a rather small mass of data and, in itself, not warranting any conclusions, it may, nevertheless, be noted as not without significance that this result, at any rate, affords no support for the view until recently, at least, quite widely entertained in this country, that pellagra is "an intestinal infection transmitted in much the same way as typhoid fever;" nor does the evidence adduced in favor of this view by other workers, when rightly considered, afford it any real support.

ENGINEERING LITERATURE

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

The Makeup of Technical Books

By R. Fleming

American Bridge Co., New York City

Readers of technical books are of two classes—those who are pursuing courses of study and those who use them mainly as works of reference. This article is written with the latter class in mind. Information for the busy engineer should be so arranged that it can be found with the least expenditure of time and effort. This is an important consideration in the makeup of a technical book.

A book by a well-known engineer was reviewed a few years ago by another noted in the same profession. The review was exhaustive and of uncommon interest. The portion relating to the makeup of the book reviewed reads:

> Its use for reference would have been facilitated also by sub-dividing the chapters into numbered articles or paragraphs with their particular titles printed in heavier type. These headings might also be placed at the top of the page instead of the senseless repetition of the general title of the book on every other page. This is a defect of makeup which is quite general in technical books and for which the printers are largely to blame. In the present work there are whole chapters without a single sub-head, so that the finding of any desired subject is made unnecessarily troublesome and time-consuming. This is further aggravated by the manner of reference to articles published elsewhere, by number of volume or periodical or journal instead of by date of publication, a sort of pedantry found also in the transactions and journals of engineering and other scientific societies.

The present writer has been particularly annoyed by the omission of the date of issue in references to periodicals. With only the volume number and page given the reader is at a loss to know until he looks it up whether the periodical referred to is sufficiently recent for the information contained to be of any value. Why can not references be given as follows?

Transactions Am. Soc. C. E., Vol. 32, Aug., 1894, p. 99.

Engineering News, Vol. 76, Dec. 21, 1916, p. 1171.

Engineering and Contracting, Vol. 47, Jan. 24, 1917, p. 89.

The importance of a good index can hardly be overrated, especially if the work is of any considerable magnitude. Thomas Fuller, the seventeenth century divine and historian, as quoted by Isaac Disraeli, observes: "An Index is a necessary implement and no impediment of a book except in the same sense wherein the carriages of an army are termed *Impedimenta*. Without this a large author is but a labyrinth without a clue to direct the reader therein." (It is too bad that Fuller did not have this more in mind in putting forth his own voluminous writings.)

Some sentences from "A Manual for Writers," by Manly and Powell, are so pertinent that they will be quoted here.

> The making of a good index is far more technical and difficult than many authors suppose. The success of a book may be said often to depend upon its index; certainly the proper use of the book does. Unless the author is familiar with the elementary requirements of a good index it is often desirable, if the book is technical or complicated, to have the index compiled by one who makes a business of this sort of work. . . . . Superficial indexing may cause a failure to use the book in the belief that it does not cover the subject, though all the while information may be there, though undisclosed by the index.

An English writer, W. C. Cocking, in his book "Steel Frame Structures," designates formulas by giving to each the number of the page on which it first occurs together with a distinctive letter. Thus any reference throughout the book to Formula (36B) indicates that it may be found for the first time on page 36, the second formula on that page. Bishop in his "Structural Drafting and the Design of Details" gives to each figure the same number as the page upon which it may be found. When more than one figure is found upon the same page they are lettered, thus: Fig. 268 (a) and Fig. 268 (b) are both on page 268.

Molitor, in his "Kinetic Theory of Engineering Structures," uses the number of the chapter instead of that of the page. Thus, Equation (15M) is found for the first time in Chapter 15. Whether these unique ways are to be preferred to numbering the formulas consecutively is not assured, but they make for easy reference.

A table at the beginning of a book of the notation and symbols used therein is always a help to the busy reader. Many textbooks have such a table.

It would be a great convenience if technical writers could agree on a standard notation for engineering symbols. Efforts to this end have been made but with only partial success. A committee of the Society for the Promotion of Engineering Education presented in 1917 a list of proposed symbols for mechanics and hydraulics. Their list has accomplished but little as yet in remedying the present chaotic condition that exists regarding the use of symbols. The present writer suggests that the compilers of the Bethlehem, Cambria, Carnegie, Jones & Laughlin, Lackawanna and Phoenix handbooks come to an agreement as to what engineering symbols they shall use in their respective publications. This would be a big step toward a uniform notation.

In conclusion, a technical book can be brought out in so attractive a makeup in the way of binding, good paper and typographical excellence that a dull or difficult subject may appear inviting. If in addition to a good external appearance the subject matter is worth presenting, the author's style is clear, the topical arrangement easy to follow, and the book well indexed, we have the requisites of an ideal book.

International Journal of Public Health

Among the original papers in the first number of the *International Journal of Public Health* (League of Red Cross Societies, Geneva, Switzerland) is one by Prof. George C. Whipple, Harvard University, on "World Sanitation: A Twentieth Century Possibility." Many

abstracts of articles already published are given. The *Journal* will appear every two months in English, French, Italian and Spanish and doubtless will contribute largely to health and sanitation throughout the world. The League also publishes a *Bulletin*, designed for laymen, the *Journal* being for professional workers. The first three numbers of the *Journal* will be sent gratis to any organization or person interested, but beginning with January, 1921, a subscription will be charged—20s.; $5; 25 francs; 25 lire, per year.

British and American Housing Problems

THE HOUSING PROBLEM: Its History, Growth, Legislation and Procedure—By John J. Clarke, M.A., F.S.S., Accountant of the University of Liverpool; Lundie Medallist for Citizenship, etc.; with an Introduction by Brig.-General G. Kyffin-Taylor, C.B.E., V.D. New York and London: Sir Isaac Pitman & Sons, Ltd. Cloth; 6 x 9 in.; pp. 544. 21/-net.

THE JOKE ABOUT HOUSING—By Charles Harris Whitaker. Boston, Mass.: Marshall Jones Co. Cloth; 6 x 9 in.; pp. 233. $2.

Mr. Clarke has produced a monograph on municipal and state housing in England. Mr. Whitaker has written a propagandist essay in which he urges that there is a housing crisis in the United States, ascribes a cause and prescribes and urges a remedy.

Of the English treatise it need only be said further that it is an exhaustive analytical and critical review of the history and present status of the British housing problem, both urban and rural, including Parliamentary Acts well into 1919, and their administration; various municipal housing enterprises, and the manifold sociological and economic aspects of the subject, with much stress on the inability of wage earners, even with recent increases in wages, to pay economic rent. The financial aspects of the subject, and rural as well as urban housing, are considered.

The joke in "The Joke About Housing," according to the publishers' statement on the jacket of the book, is that the more houses we have built in this country the smaller both they and their rooms have become, while all the time costs and rents have increased. Why? Because of land speculation, the author repeatedly asserts. One suspects him of being a single taxer, but the term "single tax" is not once used, although taxing or taking the unearned increment for the benefit of the community instead of letting it go to "non-producers" is urged again and again. The author does point his finger more than once to what he considers another large factor in the American housing problem —too small wages to pay the rent demanded for such homes as wage earners should have.

Appended to Mr. Whitaker's book are two prize essays resulting from a competition held in 1917 by the Journal of the American Institute of Architects and the Ladies' Home Journal. The prize winners were Milo Hastings and Robert Anderson Pope.

Mr. Clarke's book will repay study by the many earnest men and women who are now devoting themselves to the housing problem in America. Mr. Whitaker's volume promises to awaken many to the fact that we have a housing problem this side of the Atlantic that demands immediate and careful attention, but it has the weaknesses of books that attack many-sided problems from one side only. Nevertheless, its diagnosis of our own housing problem and the remedy it urges deserve thoughtful attention, especially by those who are engaged in establishing new industrial towns, where the unearned increment created by the community may be conserved for the creators.

Principles and Practice of Land Drainage

DRAINAGE ENGINEERING—By Daniel William Murphy, A.B., A.M., Ph.D., Consulting Engineer, M. Am. Soc. C. E., Former Drainage Engineer, United States Reclamation Service. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in. pp. 178; illustrated. $2.50.

In remarkably small space the author has presented the fundamental principles of agricultural land drainage and outlined the design and construction of drainage works. Economic and administrative phases of the subject are also summarized. Throughout the book the special problems of drainage associated with irrigation are given careful consideration. This is fitting because of the magnitude of recent and future drainage operations in connection with irrigated lands and also because the author is particularly well qualified to deal with drainage in relation to irrigation through having been drainage engineer to the United States Reclamation Service.

The author first takes up soils and plant growth, and soil, ground and surface waters. The fundamental factors in drainage and the benefits of drainage are next presented. Then comes a chapter on drainage investigations, after which the location, depth and capacity of drains are considered. Some forty-five pages are given to drainage surveys, plans, construction and maintenance. The final chapter deals with the economics of the subject, with brief consideration of drainage organization and the apportionment of drainage costs.

Most of the book is well within the understanding of any one of average intelligence, but there is enough in the way of formulas, tables and logarithmic diagrams to satisfy those who wish such things to be represented but are willing to go to treatises on hydraulics and to handbooks for detailed material of the sort. As a fresh review of an old field the volume is highly commendable.

A Highway Handbook

HIGHWAYS GREEN BOOK, 1920—Washington, D. C.: American Automobile Association. Cloth; 6 x 9 in.; pp. 525; illustrated. $3.

A veritable handbook for highway engineers, commissioners, or any one either mildly or intensely interested in road construction and the use of the automobile, is the Highways Green Book for 1920, published by the American Automobile Association. This volume divides into three parts, the first containing information relative to road improvement under Federal, state and local control. A preface to Part I supplies information upon highway legislation in the United States, and historical sketches of different bureaus for the administration of Federal funds for highway construction. Most of Part I is taken up with a detailed account of highway management and financing in the various states, each state in the United States, and also the Canadian provincial highway departments, receiving separate attention.

Part II has to do with highway construction and maintenance. Some excellent articles are reproduced explaining standard methods used in the construction of not only the so-called durable types of pavement, but also earth and sand-clay roads, gravel roads, and water-bound macadam roads.

Miscellaneous information is given in Part III, including tables of highway expenditures and mileage in the United States during the last few years, production and value of road materials, weights and measures of stone, gravel, and sand, and other valuable informa-

tion. The use of convict labor for road work has a chapter, and another is devoted to state good roads associations. Highway engineering education is taken up at length and a syllabus indicates to what extent the various colleges, universities and technical schools of the country have gone in the matter of highway engineering education. Also included in this miscellaneous information is a valuable bibliography of roads and allied subjects, and the names and addresses of highway contractors of various states. The book is issued as an annual by the Good Roads Board of the American Automobile Association, of which George C. Diehl, Buffalo, N. Y., is the chairman. It was edited by M. O. Eldridge, of Washington, D. C., the director of roads, A. A. A., who for 25 years was connected with the good roads activities of the Federal Government. The book has not only a wide popular appeal, but also a technical one.

New England Toll Roads Described

THE TURNPIKES OF NEW ENGLAND: Evolution of the Same Through England, Virginia, and Maryland—By Frederic J. Wood, M. Am. Soc. C. E., etc. Boston, Mass.: Marshall Jones Co. Cloth; 8 x 11 in.; pp. 461; illustrated. $10.

After ten years of painstaking research Mr. Wood has produced a notable volume describing in considerable detail the numerous turnpikes or toll roads of the six New England states. The volume is prefaced by an interesting and informing review of turnpikes in England, Virginia, Maryland and Pennsylvania, as well as an account of some of the roadbuilding efforts of the Federal government in the early part of the 19th century. This review also describes New England roads of the Colonial period, early road surveys and construction methods, including plank roads, and the vehicles that used the first turnpikes. There is also a short section, entitled "The First Public-Service Corporation" which describes the first American turnpike franchises or charters granted by the various legislatures. Numerous halftone views add to the handsome makeup of the volume.

Throughout the volume the author pays particular attention to the financial results of the various turnpike companies. The balances were on the wrong side of the ledger. As this soon must have been evident the author concludes that one of the governing reasons for the organization of so many turnpike companies was the general benefits they were expected to confer on the communities served.

A short section at the close of the book, entitled "Ending as It Began," states that in Virginia, within the last few years, some of the counties have reverted to the use of toll roads to collect funds in aid of maintenance. Thus, to quote from the book, there has been a return to "A two-and-a-half-century-old precedent established by Charles II when, after providing that a road should first be put in thorough repair, he authorized the erection of toll gates across it by which it was hoped to collect from those using the road the cost of maintaning it."

Such a book must be very largely a labor of love, since at best the sales can produce but a limited return to the author compared with the time and money that he must have spent in gathering and preparing his material for publication. But this does not detract from the value of such books. Indeed it is often the best testimony to their high character.

Conservation and Use of Water

WATER RESOURCES: Present and Future Uses—By Frederick Haynes Newell, Professor of Civil Engineering, University of Illinois. A Revision of the Addresses Delivered in the Chester S. Lyman Lecture Series, 1913, Before the Senior Class of the Sheffield Scientific School, Yale University. New Haven, Conn.: Yale University Press. London: Oxford University Press. Cloth; 7 x 10 in.; pp. 310; illustrated. $4.50.

While Professor Newell was still at the head of the United States Reclamation Service, he addressed the Yale Scientific School under the Lyman Fund for lectures on Water Storage Conservation. That was in 1913. Those lectures were made the basis of a volume the preparation of which was postponed by the war. The work has since been completed, "a new setting being given to it," the author states in his preface, "by the conditions which had developed" meanwhile.

The author first briefly discusses research, reconstruction, conservation, hydro-economics, economics and both engineering and broader relations. He then takes up water, precipitation, evaporation, run-in, run-off, storage, dams in general, and reclamation service dams in particular. At this point there is a change in plan, in that five main "uses of water" are considered. These are for (1) support of life, or domestic and city water supply; (2) food production, or irrigation and drainage, under which the investigations and the construction and maintenance work of the Reclamation Service are gone into; (4) water power and navigation; (5) regulation for flood prevention and protection of fish, etc. A final chapter deals with legal and legislative problems.

The treatment throughout is non-technical. A large part of the text and nearly if not quite all of the many handsome illustrations relate to irrigation—confined to studies and works of the U. S. Reclamation Service. This is natural but does not make for balanced treatment needed to justify so broad a title as the book bears. For instance, although the author states that the most extensive use of water is for city supply, his section on this subject is very brief and general. The most novel feature of the volume is a distinct recognition of the use of water for sewage disposal by dilution as legitimate. The book abounds with sound and useful suggestions.

Publications Received

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be obtained without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or, in case of books or papers privately printed, then to the author or other persons indicated.]

ACCOUNTS IN THEORY AND PRACTICE: Principles—By Earl A. Saliers, Ph.D., Assistant Professor of Accounting in the Sheffield Scientific School of Yale University. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 301. $3.

Written for "a first course in the principles of accounts," primarily for first semester work but with the hope of wider usefulness. In six parts, each of "about the proper length for review and examination purposes." An appendix contains questions on each chapter. The parts deal with principles, partnerships, expansion of accounting records, corporations, financial statements and special application of principles.

ANALYSIS OF PAINT VEHICLES, JAPANS AND VARNISHES —By Clifford Dyer Holley, M.S., Ph.D., Professor Chemical Engineering, University of Michigan and Chief Chemist, Acme White Lead & Color Works. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6 x 9 in.; pp. 203; illustrated. $2.50 postpaid (13s. 6d. net).

BIRTH STATISTICS: The Birth Registration Area of the United States, 1918. Washington, D. C.: Bureau of Census. Paper; 9 x 12 in.; pp. 312. 40c. from Superintendent of Documents.

BULLETIN OF THE NATIONAL RESEARCH COUNCIL: Research Laboratories in Industrial Establishments of the United States of America. Compiled by Alfred D. Flinn, Sec., Engineering Foundation, Assisted by A. J. Porskievics, Member American Institute of Electrical Engineers and Ruth Cobb, National Research Council. Washington, D. C.: The National Research Council of the National Academy of Sciences. Paper; 7 x 10 in.; pp. 126.

Alphabetical list of 297 laboratories which by liberal interpretation do some research work, with nature of industry, chief of staff and number and classes of assistants, nature of research work, and "unusual equipment"; also geographical, scientific and engineering and commercial lists of the same laboratories. Federal, state, municipal and educational laboratories are not included.

THE BUSINESS MAN AND HIS BANK—By William H. Kniffin, Author of "The Practical Work of a Bank," "The Savings Bank and Its Practical Work," etc. New York and London: McGraw-Hill Book Co., Inc. 6 x 9 in.; pp. 278; illustrated. $3.

A plain exposition of banking as it concerns all who use banks whether for personal or business accounts, loans, etc. Besides explaining the various transactions between banks and their customers there are chapters on preparing statements, collections, reading bank statements, acceptances, bank examinations, the Federal Reserve Bank and foreign exchange. Useful and interesting to any one who has a bank account.

CITY MANAGERS' ASSOCIATION: Sixth Yearbook, 1920. New York: Harrison G. Otis, Secy., Tribune Bldg. Paper; 6 x 9 in.; pp. 183. 50c.

Contains reports from most of the 185 cities that have adopted the city manager plan, together with *Proceedings* of 1919 convention.

CLAY-WORKING INDUSTRIES, SILICA BRICK, AND BUILDING OPERATIONS IN THE LARGER CITIES IN 1918—By Jefferson Middleton. Washington, D. C.: United States Geological Survey. Paper; 6 x 9 in.; pp. 87.

COAL, IRON AND WAR: A Study in Industrialism Past and Future—By Edwin C. Eckel, Assoc. Am. Soc. C. E., Fellow, Geol. Soc. America, Late Major, Engrs., U. S. A. New York: Henry Holt & Co. Cloth; 6 x 9 in.; pp. 375. $3.

COAL-MINE TIMBERING: Trade and Industrial Series, No. 19. Washington, D. C.: Federal Board for Vocational Education. Paper; 6 x 9 in.; pp. 103; illustrated. 15c. from Superintendent of Documents.

COAL-MINE VENTILATION: Trade and Industrial Series No. 11. Washington, D. C.: Federal Board for Vocational Education. Paper: 6 x 9 in.; pp. 63; illustrated. 10c. from Superintendent of Documents.

A COMPREHENSIVE CITY PLAN FOR EAST ST. LOUIS, ILLINOIS: Prepared for the War Civics Committee by Harland Bartholomew. City Plan Engineer. St. Louis, Mo.: The Author. Paper; 8 x 11 in.; pp. 60; illustrated.

Covers all phases of city planning except zoning, for which adequate legislation is lacking in Illinois.

DREDGING ENGINEERING—By F. Lester Simon, B.S. in C. E., Assoc. M. Am. Soc. C. E. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 182; illustrated. $2.50.

EARTH WORK AND ITS COST: A Handbook of Earth Excavation—By Halbert Powers Gillette, Editor of *Engineering and Contracting*, M. Am. Soc. C. E., American Institute of Mining Engineers, etc. Third Edition. New York and London: McGraw-Hill Book Co., Inc. Flexible cover; 5 x 7 in.; pp. 1,346; illustrated. $6.

EXPORTER'S GAZETTEER OF FOREIGN MARKETS: A Condensed Survey of the World's Markets and Industries Published for the Use of Manufacturers, Exporters, Bankers, Shipping and Allied Trades. Compiled and Edited by Lloyd R. Morris, Research Editor, the *American Exporter*. New York: Johnston Export Publishing Co. Cloth; 6 x 9 in.; pp. 766; illustrated. $10.

Contains a large mass of statistical and general descriptive matter regarding the products and commerce of the various countries of the world. Areas and populations are given. There are summaries and diagrams showing the total production of the world in various lines, as well as other world wide statistics.

HELPING MEN OWN FARMS: A Practical Discussion of Government Aid in Land Settlement—By Elwood Mead, Professor of Rural Institutions, University of California, Former Chairman, State Rivers and Water Supply Commission, Victoria, Australia. New York: The Macmillan Co. Cloth; 5 x 8 in.; pp. 228; illustrated. $2.25.

INTERNATIONAL CABLE REGISTER OF THE WORLD: In Conjunction with Western Union Telegraphic Code, 1919. Compiled by International Cable Directory Co. New York and London: The Co. Cloth; 8 x 10 in.; pp. 1,404. $15.

THE LIGHTING OF PIERS AND WAREHOUSES: Information Compiled by A. L. Powell and R. E. Harrington, Lighting Service Department, Edison Lamp Works of General Electric Co. Harrison, N. J.: The Co. Paper; 6 x 9 in.; pp. 16; illustrated.

An admirable pamphlet. Takes up the reasons for adequate lighting, the general requirements of lighting, choice and size of lamps and the methods of laying out the lights on both piers and warehouses.

MASSACHUSETTS STATE DEPARTMENT OF HEALTH: Report, 1918. Boston, Mass. The Department. Cloth; 6 x 9 in.; pp. 260.

MATHEMATICS FOR ENGINEERS, PART II—By W. N. Rose, B.Sc. Eng. (London), Late Lecturer in Engineering Mathematics at the University of London, Goldsmiths' College, Teacher of Mathematics, Borough Polytechnic Institute. New York: E. P. Dutton & Co. Cloth; 6 x 9 in.; pp. 419; illustrated. $7.

A METALLOGRAPHIC STUDY ON TUNGSTEN STEELS—By Axel Hultgren, Metallurgical Engineer. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6 x 9 in.; pp. 133; illustrated. $3.

Based mainly on investigations at the Institute of Technology, Charlottenburg, Germany, in 1913-14. The studies were completed in 1914-18 at the Royal Institute for Testing Materials, Stockholm, and in the laboratory of the SKF Ball Bearing Co., Gothenburg, Sweden. The original paper was written in Swedish in 1918. The translation is supplemented by information subsequently brought to the attention of the author.

MINNESOTA STATE DRAINAGE LAWS: Arranged and Annotated Under the Direction of Clifford L. Hilton, Attorney General; Assisted by Commissioner of Drainage and Waters and Frank L. Cliff of the Big Stone County Bar. St. Paul, Minn.: The Attorney General. Paper; 6 x 9 in.; pp. 209.

NATIONAL DRAINAGE CONGRESS: Proceedings, 1919. Chicago, Ill.: Edmund T. Perkins, Pres. Paper; 6 x 9 in.; pp. 144.

NEW YORK STATE BRIDGE AND TUNNEL COMMISSION: Report, 1920, to the Governor and Legislature of the State of N. Y. Albany, N. Y.: The Commission. Cloth; 9 x 12 in.; pp. 82; illustrated.

OFFICERS, BOARDS, AND COMMISSIONS OF TEXAS—By Frank Marn Stewart, Instructor in Government, Secretary, Bureau of Government Research. University of Texas Bulletin No. 1854. Austin, Texas: The University. Paper; 6 x 9 in.; pp. 66; folding diagram.

PERSONNEL ADMINISTRATION: Its Principles and Practice —By Ordway Tead and Henry C. Metcalf, Ph.D., Members of the Bureau of Industrial Research, N. Y. C. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 538. $5.

RAILROAD CURVES AND EARTHWORK—By C. Frank Allen, S.B., M. Am. Soc. C. E., Professor of Railroad Engineering in the Massachusetts Institute of Technology. Sixth Edition, Revised. New York and London: McGraw-Hill Book Co., Inc. Flexible Leather; 5 x 7 in.; pp. 289; illustrated. $4.

The section on circular arcs, "which received original treatment" in the 1914 edition, has been enlarged to make the book still more useful in highway work. Some earthwork computation methods "new to textbooks, from valuation practice," have been added, together with a few pages on haul. Other revisions have been made. Earlier editions were reviewed in this section of *Engineering News* for Nov. 12, 1903; April 16, 1914.

RESULTS OF MAGNETIC OBSERVATIONS: Made by the United States Coast and Geodetic Survey in 1919—By Daniel L. Hazard, Assistant Chief, Division of Terrestrial Magnetism. Washington, D. C.: U. S. Coast and Geodetic Survey. Paper; 6 x 9 in.; pp. 27. 5c. from Superintendent of Documents.

THE SELECTION AND PLACEMENT OF EMPLOYEES: Employment Management Series, No. 2. Washington, D. C.: Federal Board for Vocational Education. Paper; 6 x 9 in.; pp. 84; illustrated.

SHOP PRACTICE FOR HOME MECHANICS: Use of Tools, Shop Processes, Construction of Small Machines; Contains a Chapter Also on Theoretical Mechanics and on Miscellaneous Information Relative to Shop Work—By Raymond Francis Yates, Author of "Model Making," "How to Make and Use a Small Chemical Laboratory," etc. New York: The Norman W. Henley Publishing Co. Cloth; 6 x 9 in.; pp. 320; illustrated. $3.

SOME APPLICATIONS OF THE PITOT TUBE IN WATERWORKS—By William M. Crowe, Assistant Engineer, Bureau of Water, Philadelphia, Pa. Reprint from *Fire and Water Engineering*, Sept., Oct., and Nov., 1919, issues. Philadelphia, Pa.: Simplex Valve & Meter Co. Paper; 6 x 9 in.; pp. 31; illustrated.

THE STANDARD ELECTRICAL DICTIONARY: A Complete Manual of the Science in Two Parts—By T. O'Connor Sloane, A.M., E.M., Ph.D. Author of "Arithmetic of Electricity," etc. with Addition by Prof. A. E. Watson of Brown University. 1920 Edition, Revised and Enlarged. New York: The Norman W. Henley Publishing Co. Cloth; 5 x 7 in.; pp. 767; illustrated. $5.

Apparently the changes in this edition consist in the addition of "a second part" (185 pp.) "containing all the newer developments." This necessitates looking in two places to make sure of any reference besides compelling the owner of the previous edition to buy what he already possesses without the advantage of having the new matter inserted in its proper place. But presumably had this plan not been followed a considerable higher price for the book would have been necessary.

THE STATISTICAL METHOD IN PROBLEMS OF WATER SUPPLY QUALITY—By Abel Wolman, Maryland State Department of Health. Reprinted from Quarterly Publications of the American Statistical Association, June, 1920. Baltimore, Md.: The Author. Paper; 6 x 9 in.; pp. 14.

STRUCTURAL STEEL: Australian Standard Specification. Melbourne, Australia: Institute of Science and Industry. Paper; 6 x 9 in.; pp. 19; illustrated.

STRUCTURAL STEEL WORK: Relating Principally to the Construction of Steel-Framed Buildings—By Ernest G. Beck, Wh. Ex., Assoc. M. Inst. C. E. New York and London: Longmans, Green & Co. Cloth; 6 x 9 in.; pp. 462; illustrated. $7.50.

TIMBER DEPLETION, LUMBER PRICES, LUMBER EXPORTS, AND CONCENTRATION OF TIMBER OWNERSHIP: Report on Senate Resolution 311 by the Forest Service, U. S. Department of Agriculture. Washington, D. C.: The Department. Paper; 9 x 12 in.; pp. 71; illustrated. 25c. from Superintendent of Documents.

VOCATIONAL ARITHMETIC—By Clarence E. Paddock, Wentworth Institute, Boston, Mass., and Edward E. Holton, Head of Dept. of Machine Shop Practice, Technical High School, Springfield, Mass. New York and London: D. Appleton & Co. Cloth; 5 x 7 in.; pp. 232; illustrated. $2.

For students in vocational schools and men in shops. The preface says: "The usual branches of arithmetic are treated in a simple way, and the large number of practical problems gives opportunity for much exercise and option. The problems have been carefully selected and will be found interesting and useful to persons of varied interests, and to this end are presented applications to several vocations, as shop work, carpentry, foundry work, masonry, and excavation.

YALE ENGINEERING ASSOCIATION: Year Book, Including a Record of Association Affairs from the Annual Meeting of Jan. 23, 1919 to the Annul Meeting of Jan. 21, 1920 Inclusive. New York: Office of the Secretary, Third Ave. at 130th St. Paper; 6 x 9 in.; pp. 127.

Letters to the Editor

Rigid Joint Analysis in Concrete Frames

Sir—With the editorial in your issue of July 15, p. 97, on the simplification of reinforced-concrete design the writer is heartily in accord. But might it not be well to add that, in the pursuit of ultra-refinement in stirrup spacing, large secondary stresses often receive less attention than they should? A concrete building is, after all, a more or less indeterminate structure, and large bending moments are undoubtedly thrown into the supports of so-called simply supported members.

Take the case of a large beam framing into an exterior column. The writer has found considerable variation in the practice of different designers in computing the bending moment in the column. Some ignore it entirely. Another assumes that 80 per cent of the load is applied at the interior face of the column. The best practice seems to say "We know from experience that our standard section column for that span won't show any cracks"—perhaps a safe, but hardly a rational method. On the other hand, if the method of slope deflections is used on the assumption of a perfectly rigid joint the bending moments found would endanger most existing buildings.

The writer and doubtless other engineers would be exceedingly glad to know of tests showing actual moments found in exterior columns supporting large girders.

HENRY WILLCOX,
Construction Engineer, Kalmus, Comstock & Wescott, Inc.
New York City.

Comparisons of Paving Costs

Sir—In an article on "Paving Cost Comparison" in *Engineering News-Record* of July 8, p. 76, the city of Washington, D. C., is listed with a cost of $6.26 per square yard for asphalt paving. We would appreciate information as to how this cost is arrived at. To the best of our knowledge and belief it is not a true cost, in fact it is excessively high.

Washington, D. C. CRANFORD PAVING CO.

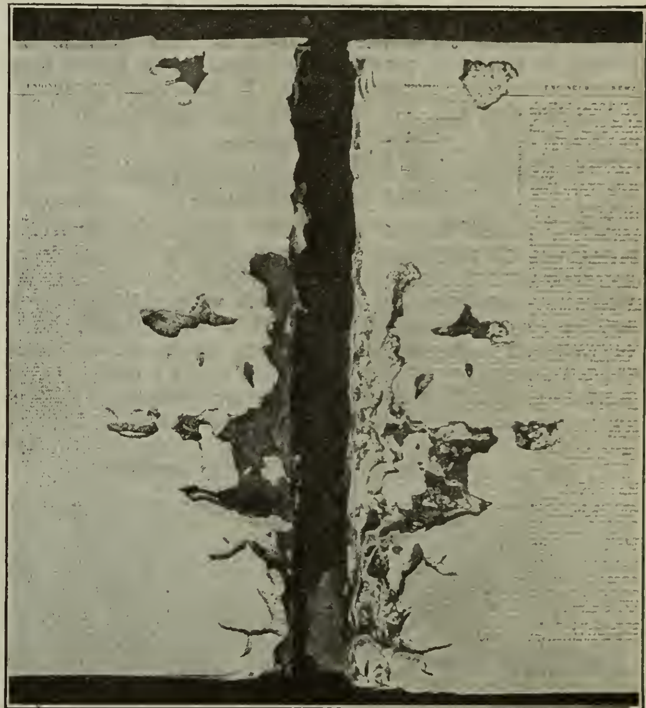
The explanation is in the basis upon which the figures were compiled. It appears that tthe Chicago Board of Local Improvements attempted to make a comparison on the square-yard basis of completed pravement including grading, concrete base, top and binder, and curbing. The figures of $6.26 for Washington and $4.15 for Chicago were obtained on an assumption of a standard 30-ft. roadway and an average 12-in. depth of grading, which would make one-third cubic yard of grading for every square yard, and three-fifths of a foot of curb per square yard. Figures obtained showed that for top and binder only the city of Washington was paying $2.96 per square yard, and for granite curbing $2.50 per lin.ft. In the absence of data on grading or concrete it was assumed that the prices would be practically the same as those prevailing in Chicago, and the original table shows that these items were estimated under those conditions. The comparisons of Chicago and Washington would be as follows:

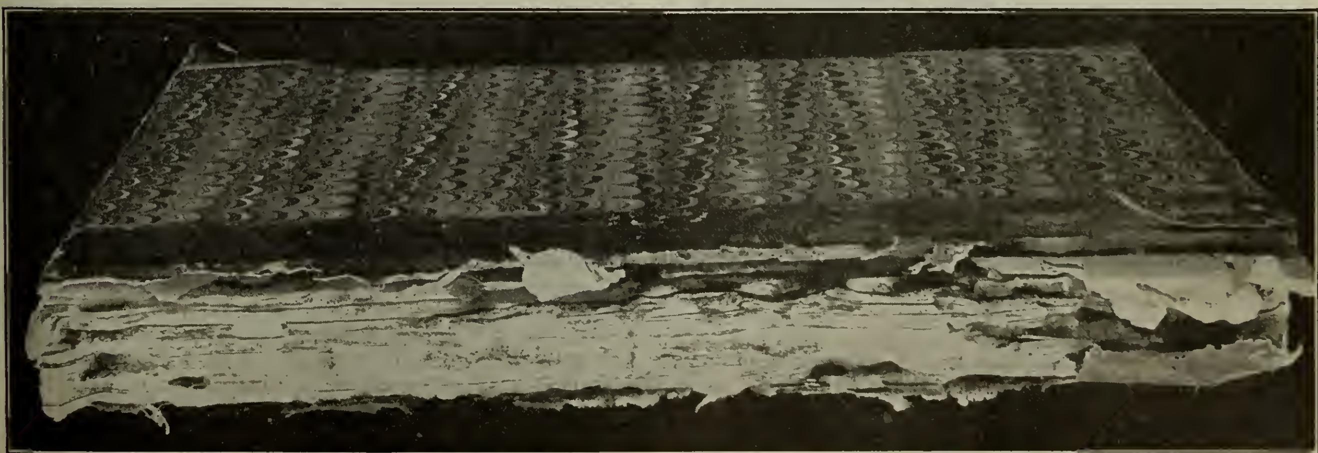
	Chicago	Washington
Grading per sq.yd.	$0.60	$0.60 (assumed)
Base per sq.yd.	......	1.20 (assumed)
Top and binder per sq.yd.	2.88	2.96
Curb per sq.yd. pavement	0.67	1.50
Total	$4 15	$6.26

—EDITOR.

White Ants Avenge Exposure of Methods

Sir—You may be interested in the photographs which I am enclosing showing damage by termites or white ants to a bound volume of *Engineering News-Record*. This bound copy was recently found ruined in a library in an infested building in Pittsylvania County, Va.





HOW WHITE ANTS DAMAGED BOUND VOLUME OF "ENGINEERING NEWS-RECORD"

Possibly this damage was done in revenge for the exposure of their methods in the June 3 issue of *Engineering News-Record*, p. 11_.

T. E. SNYDER,
Acting Forest Entomologist,
U. S. Department of Agriculture.
Washington, D. C.

City Engineers and Private Work

Sir—The charter of one of our large and growing municipalities provides that the city engineer shall do all the work for the Department of Public Works and shall devote his entire time to the duties of his office. He is employed to serve only the public, yet a very small portion of his time, for which the people pay, is used legitimately. This engineer solicits and gets other work, the doing of which is approved by the Mayor! The case of this city engineer violating all ethical codes is not an exceptional one. It is merely illustrative of conditions in many parts of the country where full-time-pay engineers indulge in putting over outside work, in contravention of their moral and official duties. The practice is not only unethical but it brings hardships to engineers who have to pay their own overhead and other expenses and who are compelled to compete with these city engineers for private work.

One of the objects of engineers as a body is to maintain a high professional standard. Can this high standard be raised or even maintained so long as those persons who persist in unethical practice are permitted to retain membership in engineering organizations? EDMUND P. BURKE.

Los Angeles, Cal. Municipal and Sanitary Engineer.

Hogwire for Riprapping on Irrigation Canal Embankments

Sir—The use of hay under wire netting for protecting new earth fills on reservoir slopes was noted in *Engineering News-Record* of Aug. 28, 1919, p. 378, but nothing was said about the varied uses to which wire netting may be put in riprap work. On the Twin Falls tract, Idaho, hogwire has been used over willows, sagebrush, or hay to protect the banks of the main canals and laterals, (1) at points of transition of current below structures such as gates, checks, drops and flumes; (2) on the made bank on the outside of curves to stop current erosion; (3) where wave action causes a sloughing of the earth fills.

FIG. 1. WILLOW "UPHOLSTERING" HELD IN PLACE BY HOGWIRE

Rock for riprap has been unduly expensive on more than one tract upon which the writer has done maintenance work. On one project hogwire was placed over willows on an eroded canal bank on account of the rapidity with which the wire could be placed. Rock could not be obtained quickly as the haul was excessive. Willows which grew on the adjoining bank, trailing the small limbs in the water and thus retarding the current, were cut for the work. They were wired into one-man-size bundles for ease in loading, hauled to the place needing protection and unloaded onto the slope with the small ends down. The bundles were broken and the willows spread to give a mat thickness of about 3 in. The willows were not spaced regularly but any large openings in the mat were closed with a handful or two of the smaller branches. Hogwire in double-width strips was then unrolled over the mat. Across the hogwire ⅜-in. twisted reinforcing rods were spaced 10 to 20 ft. c. to c. and secured by pins 2-ft. long of the twisted bars with hook ends. The pins were driven carefully so as to revolve with the spiral of the metal until the head hooked over the transverse rod. The outside and middle pin also hooked over the heavy edge-strand of the hogwire.

FIG. 2. UNWIRED SAGEBRUSH RIPRAP PULLED OUT BY ICE

Four men and a team could lay a half-mile of this "upholstering" in a ten-hour day when the willows were cut and left on the banks near the place to be protected. The cutting was usually done by men in the operation force, who did not handle the brush. The cost was a little less than \$5 a rod. Rock work would have cost from \$25 to \$50, depending on th source of the rock.

In the accompanying view, Fig. 1, the outside of a curve in a canal carrying 1,400 sec.ft. in the heavy-draft season is shown "upholstered" just before the winter flow ended and the maximum flow was turned in. After 2½ months tules growing up through the riprap wire were plainly visible. Where tules grow silt is being deposited The bank shown was built up to a depth of 4 in. by the silt deposited during the high-water of the season. In another year the building-up process will be more than doubly marked, in spite of the fact that this canal bank is made of the volcanic ash soil of the Snake River Valley, which is as fine as flour.

A tube was devised to hold the pins in such a way that they could be driven accurately from a raft when the water was too deep to do the work on the bank afoot. After the water was lowered in the fall it was found that the work, while not so smooth, was fully as effective as the work done in the dry. The cost was doubled, however, due principally to the slowness of the labor working from the rafts. Only urgent necessity would prompt the use of this form of protection when it must be laid under water.

Early in the history of the project it was found that the banks on both sides of the main canal needed protection, and the work was done through several seasons, with sagebrush the only material at hand. This form of protection now covers 10 miles of the original bank, and is an admirable protection as long as the ice of the winter run does not pull it from its position. The brush was imbedded by the stalk end in the mud of the bank; rock was placed upon it in thin layers, the brush of the top of the plant forming the cushion upon which the water impinged. Of late years the high stage of the winter flow permitted ice to freeze to the upper part of the riprap where the weight of the confining material was small. The result of subsequent lower stages has invariably pulled out and floated away large sections of this valuable work. The ice was especially destructive in 1918 and 1919 because the frost was going out of the banks at the time that the water

was fluctuating in the canal. Hogwire riprap does not pull out with the ice, nor do the aquatic growths which catch upon it go with the ice. Rather the wire holds the ice when the water goes down and the ice melts on the bank where it forms, leaving the work intact.

Where "moss" aquatic vegetation in a canal exists it is entirely possible to restore banks not too much caved by placing the wire to conform to the original slope of the bank, covering it with netting, and then raising the stage of the water so that the "moss" and drift catch on the netting to form a mat under which silt will catch and deposit. The bank can often be brought to the original slope and held there until permanent settlement takes place.

R. M. ADAMS,
Superintendent Maintenance, Twin Falls Canal Co.
Twin Falls, Idaho.

Experience Shows Shinkage of Earthwork

Sir—The conclusions stated in the letter, "Shrinkage of Loosely Filled Earthwork in Embankments," by Charles Prelini (*Engineering News-Record*, July 15, 1920, p. 135), "1st. That earth in embankments will always be found of larger volume than in cuts. 2nd. That the earth does not shrink," does not accord with our experience in the construction of the Yale "Bowl."

This structure consists of an earth embankment surrounding an oval playing field, 500 ft. x 300 ft., the inner slope of which is faced with concrete and wood, in steps, and forms the support for the spectator's seats. The embankment is pierced with thirty tunnels which provide entrances to the amphitheater at the center of the slope; two other tunnels lead directly to the playing field.

The embankment was mostly formed from material scraped from the enclosed area, the top of the embankment being about 26 ft. above and the playing field about 27½ ft. below the general surface of the ground. The material was clean sand and gravel—the surface loam being saved for top dressing the field—varying in size from that which would pass a 100-mesh sieve to cobbles three or four inches in diameter; probably 80 per cent of the whole was of a grade suitable for mortar sand.

Below the level of the top of the tunnels the only compacting which the material received was that obtained by a thorough watering, as it was being deposited, and by the tamping received from teams driven over it in making the fill. Above the tunnels, the material was placed by drag line scrapers in ridges extending across the embankment, then leveled off into layers about six inches in thickness, sprinkled with water and rolled with horse drawn rollers; a smooth and a grooved roller each passing, alternately, four times over each layer.

The volume of the excavation and embankment were both carefully measured, and, as nearly all of the material was obtained from within the enclosure, and the small remaining portion from the field immediately outside, with an average haul of not more than one hundred feet, the loss by transportation was negligible. A comparison of the volume of the excavation and embankment, allowing for the sand used in concrete, showed that the former exceeded the latter nearly 7 per cent.

There was a wide difference of opinion among the engineers connected with the work as to the amount of shrinkage which would subsequently take place in the embankment and the writer was therefore curious to ascertain what it was. Consequently thirty-one bench marks were established around the rim of the "Bowl." These consisted of ½ in. rods, about 4 ft. in length, set vertically in the embankment, the lower end embedded in a lump of concrete and the upper end terminating about six inches below the surface. Levels taken on these points showed an average settlement of about one-quarter of an inch after two years; the maximum of any bench being .044 ft. Four of the points showed a settlement, after two years, of .01 ft. or less. About one-half of the settlement occurred within the first month after the embankment was completed.

If evidence, additional to our measurements, was required to show that earthwork shrinks, it was furnished by the fact that it was much more difficult to drive stakes into the embankment than it was into the same material before it was disturbed; showing that its density had been increased. These facts, I think, prove, conclusively, that earth not only shrinks during the construction of an embankment but also, that even with extreme care used in impacting the material when it is being placed, some settlement will subsequently occur.

CHARLES A. FERRY,
Engineer, Yale "Bowl."

Beams vs. Trusses for Pier Shed

Sir—In *Engineering News-Record*, June 24, 1920, p. 1232, there appeared an article describing precast concrete roof trusses used in the shed of Pier No. 6 at Cristobal, Canal Zone. The reasons for the adoption of this type of construction are not evident. It is difficult to locate any advantage over the ordinary form of beam and girder structure.

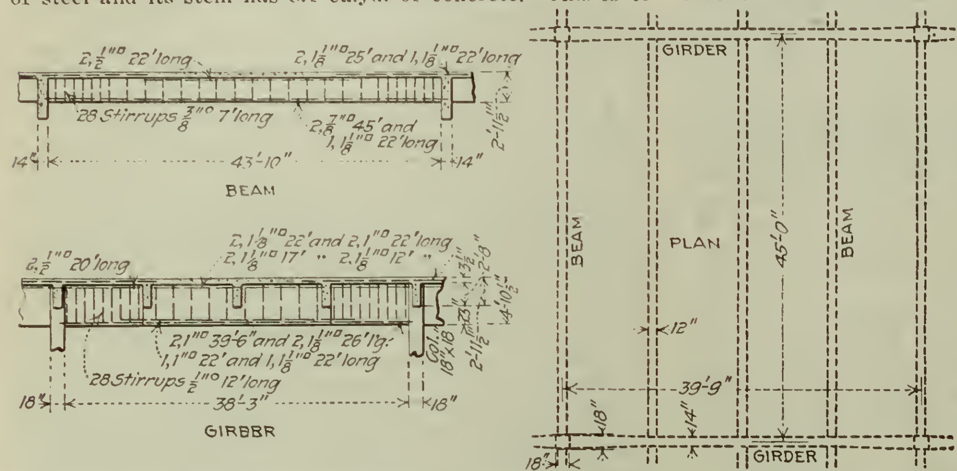
The quantities of steel and concrete in the smaller trusses compare favorably with the corresponding members of a beam and girder roof, but the steel in the heavy cross trusses seems to be excessive. Assuming a unit stress of 16,000 lb. per square inch in the steel, the bars in the tension members have an excess varying from 35 per cent to 170 per cent over the required areas, the higher excess, however, being in a minor member which would have little relative effect upon the structure as a whole. There is a large amount of steel in compression members as well as in those members at the ends which have no calculated stress. Furthermore, the bars at intersections of members and the necessary long laps of all tension bars contain a relatively large amount of steel. These facts account for a considerable portion of the total amount of steel used, yet 4,000 lb. per truss still appears to be more than would be required under any considerations. Criticism should also be permitted concerning the distance at which bars are kept from the face of concrete in many members. A safer structure would result if bars were placed closer to the corners. In one section the concrete is 20 x 10 in., while the rectangle through the centers of outer bars is 9 x 4 in.

The truss scheme results in a higher building than would be required in the case of a beam and girder roof maintaining the same clear headroom. Also the columns are heavier and of more difficult construction than would be required for a building of ordinary monolithic construction. On a complicated layout requiring many different sizes of trusses this scheme would necessitate a large form cost. Also, the truss plan results in three concreting operations for that part of building above the foundations and main floor, while the usual plan would require only one for any part of building. The trusses were cast in a plant adapted to that work only, the columns were poured separately and in place. The roof slab was cast after the trusses had been erected. Therefore the saving in time is hard to understand.

Accepting the layout of building given by the published diagram, surely the following details would show that beams and girders would prove to be more economical than are the trusses. Fig. 1 shows a partial plan, Fig. 2 is an elevation of a typical interior beam, and Fig. 3 shows an interior girder. In designing the beam $\frac{1}{12} wl^2$ and $\frac{1}{16} wl^2$ were used for negative and positive moments, respectively. In the girder the negative moment was taken as $\frac{2}{3}$ and the positive as $\frac{1}{2}$ of the simple beam moments for the same clear span. These moments are justified by facts relative to such cases, especially since all loads are uniform and constant. And it is the writer's trust that the near future will witness the general use of such moments for ordinary building work in reinforced concrete. Furthermore, actual stresses are used in truss design and, in fairness, these moments should be used in beams designed to carry the same loads, particularly since the sum of positive and negative moments is 17 per cent greater than the total moment possible. The design unit stresses used are 16,000 lb. in the steel and 650 and 750 lb. in concrete for positive and negative bending, respectively. Concrete is assumed as taking shear at 60 lb. per

square inch over the $b'jd$ section. Stirrups take the remaining shear, additional stirrups being used throughout the portion of beam having small shear. The slab is assumed the same as in truss type building. End spans of beams and girders would have somewhat greater moment. The same sections could be used and the steel increased, also using some compression steel in the bottoms at supports. Crane loads are not taken into account as they do not affect the members considered. Crane load data was not given in the article.

Each beam contains 730 lb. of steel and the stem has 4.35 cu.yd. of concrete as compared with 1,000 lb. and 3.5 cu.yd. for the corresponding truss. Each girder contains 1,520 lb. of steel and its stem has 8.1 cu.yd. of concrete. This is to



SUGGESTED ALTERNATIVE BEAM AND GIRDER DESIGN FOR CRISTOBAL PIER SHED

be compared with 4,000 lb. of steel and 8.5 cu.yd. of concrete in the cross truss. Using the unit prices for the trusses as built and taking the slab prices as correct for beam and girder materials, the concrete and steel in each beam costs $14 more than that of the small truss while the indicated saving for each girder is $95. For the concrete and steel alone there is a net result slightly against the trusses. No figures can be given as to cost of forms as there is no available data to show probable number of times that these could be used. It would seem that there would be an advantage in the simple form details required for the beam and girder construction.

Besides the foregoing items, all walls and columns would be of less height in the beam and girder building, since the total depth of roof structure is 4 ft. 8 in. less than in the truss structure. Instead of the 30 in. square interior columns with complicated top forming, a section 18 in. square would be sufficient to carry the beam and girder roof and the rigid top connection would eliminate the necessity of the expanded section at base. There would be a similar saving in wall columns. The beam and girder type of building has the additional advantage of requiring simpler construction plant since no equipment would be needed other than that used for the roof slab of the truss type. The probable saving in the structure as a whole would lie principally in the 4 ft. 8 in. reduction in height of columns and walls and in the lighter sections of the former, although the beams and girders likely would cost somewhat less than the corresponding trusses. The steel prices used in comparing costs of beams with those of trusses are severe in that prices of slab steel were adopted as the only stated item that could be taken for the purpose. A smaller steel price would be just since large sizes are used in the trusses and beams, while all slab steel is under base material.

All things considered, it would seem that the beam and girder construction would have resulted in a more economical building without in any manner detracting from the value. Possibly there were some governing conditions, not stated in the article, which would cast a different light upon the subject. Also, it is possible that there were other loads besides the roof carried by the heavy trusses and of which no mention was made. If such is the case, corrections are invited.

The writer has had to resort to trusses in a few cases of unusual reinforced concrete design, but almost invariably has found ordinary beam and girder construction to be more economical for such work as that under consideration.

LEONARD C. JORDAN,
New Rochelle, N. Y. Consulting and Designing Engineer.

[The above letter was submitted to G. W. True, the author of the article in question and he has replied as follows:—EDITOR.]

Sir—Mr. Jordan's comments on the article entitled "Precast Concrete Trusses in Panama Pier Shed" might possibly be applicable on a small sized project or when a number of trusses of variable size were required. Experience on previous pier construction on the Isthmus indicated that precast concrete work would be fully as rapid a form of construction as concrete poured in place, and hence the precast beams which were originally considered were naturally superseded by the precast trusses after both had been fully investigated. The results shown on the progress charts appear to have fully justified the adoption of the precast units. Mr. Jordan states that the anticipated saving by using continuous beams would lie principally in the reduction in the height of columns and walls, as well as in the lighter section of the former. As a matter of fact, the shed was built at a minimum height and the question of raising the entire elevation was seriously considered for architectural reasons. Moreover, as the possibility of changing the structure to a two-story shed was taken into consideration, the size of the columns were increased to provide for this contingency.

The cross-trusses were originally designed for a heavier load than was eventually used. When it was shown conclusively by tests and certain experimental handling that the designing load could be modified in the smaller trusses, it was permitted, but as the greater number of cross trusses had been built when this change was made, the design of the cross trusses was not revised. Had this change been made at the beginning of the work, the amount of steel in this item would naturally have been reduced with a consequent reduction in cost for the entire project.

The original article (under "method of construction) states that each form for the longitudinal trusses was used about thirty times. It is questionable whether ordinary forms on beams could have been used as many times as this even with repairs.

The spacing of bars in section BB was determined by the clearance required by other bars at the adjacent joints and hence could not well be avoided. Since it occurs in a tension member, the spacing cannot be considered as objectionable.

It should be remembered in criticizing concrete truss design that experimental data relative to such structures is very meager and that with our present knowledge of the subject, any design which shows even a slight saving over beams should be pronounced a success. The economy effected by the concrete trusses in this work when compared with structural steel under wide variations in unit costs speaks for itself.

Thus far, there are numerous points that can be settled only by individual judgment. Obviously, a description of various details of trusses actually built and in successful use will unquestionably aid the profession to eventually standardize this class of work.

GUY W. TRUE,
Assistant Engineer, Panama Canal.
Balboa Heights, C. Z.

Crawfish Cause Trouble at a Power Plant in North Carolina

Sir—We have a wide irregular canal one mile long built along the bank of the river to convey the water from the dam to power house. About one-fourth mile below the dam we have had trouble from the start with crawfish burrowing through the bank and starting troublesome leaks. They seem to confine themselves to a space about 50 ft. long. Numerous attempts to stop their burrowing have been tried but as yet none has been successful.

Some six or eight years ago a row of 2 in. splined wood piling was driven in the center of the bank, but in a short time leaks appeared again. We have dug up the burrows on the canal side of the bank several times and puddled them over each time, but that has only proved a temporary repair. It would always stop the leak until the burrows were again opened to the forebay by the crawfish. Our last effort consisted in digging a trench 4 ft. deep, driving 9-in. steel sheet-piling 12 ft. long to cut off the leaks, but this was in only very small measure successful. We then dug down behind the piling in two places and found that after digging 8 ft. deep we could still run a small pole some 8 ft. farther straight down indicating that these crawfish burrows extended at least 16 ft. below the ground if not more and that the driving of longer piling would likely not be effective in stopping the trouble.

The water loss is not serious but frequent high water makes the leak dangerous.

The problem now reduces to some effective method of impregnating the earth of this section of the bank with some chemical, and to a depth that will kill the crawfish or that will drive them away permanently. If we can drive them away from this place we do not think they will give trouble elsewhere. We have the government bulletin on "Crawfish as Crop Destroyers" but that does not apply.

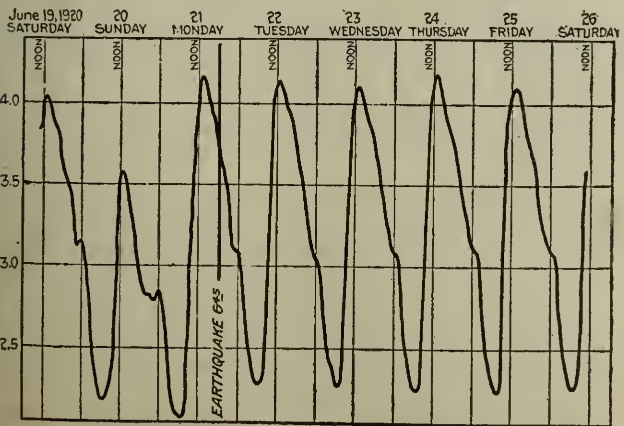
We considered plastering a portion of the canel side of the bank with concrete, but as yet we favor trying the experiment of impregnating the soil with some chemical that will be effective in either killing the fish or driving them away.

We are soliciting any information as to suitable chemicals for this experiment but any suggestion not intimated here that might prove worth trying will be most welcome.

A SUBSCRIBER.

Effect of Earthquake on Sewage-Flow Gage at Los Angeles, Cal.

Sir—The effect of the earthquake which occurred in the vicinity of Los Angeles on June 21 of this year was recorded by an automatic water register at the Inglewood gauging station on the line of the outfall sewer of this city in a manner which may prove of interest to your readers. The accompanying diagram shows quite clearly by the vertical line (June 21) how the needle at this station moved during the period in which the earthquake was noted. It is considered that probably the effect of the earthquake was to start a wave in the sewer conduit. This sewer has a vertical diameter of 73 in. and it will be noted that the average



EFFECT OF EARTHQUAKE JUNE 21 ON FLOW IN OUTFALL SEWER AT LOS ANGELES, CAL.

normal flow of sewage in this conduit is about at the springing line of the sewer. Just before this wave reached the gaging station, the depth of flow was about 3 ft. 9 in. and this depth was raised to about 4 ft. 4 in. when the wave reached the station. As the wave receded the flow dropped to a little less than 3 ft. showing that the vertical distance between the bottom and the crest of the wave was a little over 16 in. After reaching the low point, the needle indicated that the depth of 3 ft. 9 in. was again obtained, after which the needle resumed its customary travel.

It is considered that probably the direction of this quake was parallel to the line of the sewer, which would tend to increase the effect at the gaging station.

The writer would be pleased to know of similar cases which have been recorded in sewers from such causes; also to answer any questions concerning matters which have not been described in the above.

JOHN A. GRIFFIN,
Los Angeles, Cal. City Engineer.
By W. T. Knowlton, Engineer of Sewers.

The Danger in Immigration

Sir—I notice occasional articles in your paper relating to immigration, labor supply, etc. In all that I have read the effect on the employment of engineers, the slowing up of public improvements, the earnings of capital, or similar viewpoints are the only ones given consideration. It seems to be taken for granted that a continually increasing population is in itself a desirable thing, even though it inevitably brings us closer to the European social and economic standard of living, and intensifies the struggle for existence that is already too keen.

Recent letters advocate the admission of Orientals and a return to the indiscriminate immigration of Southern Europe on the ground that it will help industry. Without questioning the personal worth of these people or their civilization, I believe that, regardless of our material development, further dilution of American citizenship should not be allowed or encouraged. Regardless of its economic effect on me or the country, the more unassimilated foreigners there who are to return to their old homes the better it pleases me.

It is my opinion that a mongrel race is in the same class as mongrel stock and that the melting pot is largely an illusion fostered by sentimentalists, steamship companies and big industries who hope for profit.

In the face of all the trouble we have recently had during the war with un-American sections of our population, industrial interests are clamoring for a resumption of former practice. We have one great race problem. Why should we add more as suggested by Mr. Erickson in a recent issue? I believe that the question of our employment as engineers should be secondary to the larger question of what is best for the future of the country.

By race I do not mean nationality, religion, or language, for these may cut across race lines. This country, as is pointed out by a recent writer on this subject, was peopled from the north of Europe. Its population increased with great rapidity with slight immigration until 1850, and would have continued to do so had not heavy immigration begun. Our country would have been populated and developed by a homogeneous race with no outside help if this had not occurred. The sure result of an influx of a people of lower standards of living is the lowering of the increase of the dominant type. There are countries in Europe whose population do not represent the people who made their names great in history. They live on the fame of a dead race.

For these reasons I sympathize with the people of California and Australia, and also the labor unions on the immigration question, though the latter's interest is as selfish as that of their opponents.

A man may be assimilated politically, but you cannot change his race. He either succumbs to another type when in contact with it or he overcomes it.

Civilization may be lost and regained, but a race or a species once lost, is gone forever.

Ogden, Utah. E. E. KIDDER.

Hints for the Contractor

Pontoon Pipe Line for Dredging Withstands Rough Seas

EXCELLENT service in rough seas was given by the pontoon pipe line illustrated in dredging a ship channel 200 ft. wide and 15½ mi. long in the exposed waters of Atchafalaya Bay on the Gulf of Mexico. The pontoons were steel and 47 x 12 ft. x 2 ft. 10 in., and each carried a 50-ft. length of pipe on a turntable at the middle of the pontoon. The pipe line was carried straight out at right angles to the side of the dredge

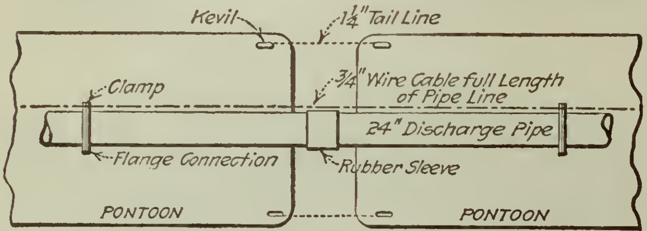
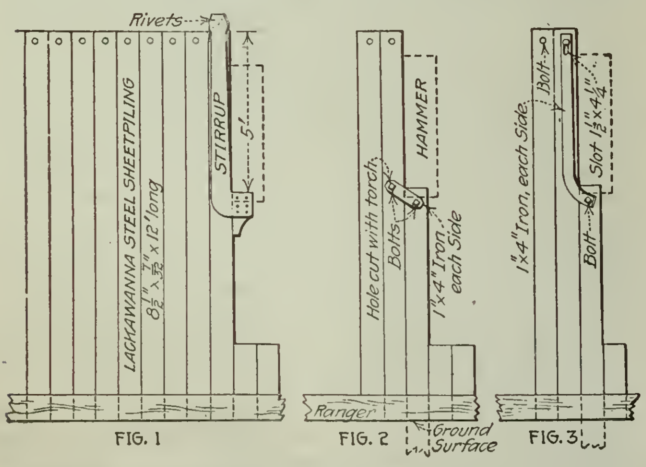


DIAGRAM OF PONTOON AND PIPE CONNECTIONS FOR SPECIAL SERVICE

and held in line by a cable extending from the dredge to a pile sinker anchored outboard a distance of 100 ft. greater than the length of the pipe line, which was variable. Other construction details are indicated by the drawing. This construction, says U. S. Assistant Engineer T. E. L. Lipsey, in the *Military Engineer*, "proved to be one of the best ever seen and was capable of withstanding the most severe weather and seas."

Driving Steel Sheet Piles Without Headroom For a Piledriver

BY USING a shackle to pull down part way a second pile, as each pile was driven home, steel sheeting was successfully sunk under bridge arches where the headroom at the start did not permit the driver to be mounted on the pile tops. To construct two tailrace conduits under adjoining arches of a railway bridge, trenches nearly as wide as the spans and going 12 ft. deeper than the bridge pier footings had to be retained



METHODS OF DRIVING SHEET PILES WITH HEADROOM LIMITED

by 12-ft. steel pile sheeting. In starting this sheeting at the surface, the tops of the piles reached nearly to the soffits of the arches and a steam driver could not be mounted on them until they had been driven about 5 ft.

A series of experiments determined a successful method which is illustrated by the drawing. First, the attempt was made to drive the piles singly using a stirrup like that shown by Fig. 1, but with its foot at the side of the pile. Vibration of the pile made this method ineffective. Then the stirrup was changed to the form shown by Fig. 1, with better results, but the operation was very slow. A 7-ft. pile was then driven and pulled with the thought that a 12-ft. pile might be inserted in the hole and then driven, but this experiment failed because the hole caved in. Next the process shown by Fig. 2 was devised. With one pile driven about half down, using the stirrup, the hammer was

RIG FOR HANDLING HAMMER IN DRIVING SHEETING UNDER BRIDGE ARCH

set on top and a shackle attached, as shown, to the adjoining pile. Then in driving the first pile home the second was pulled down half way. The hammer was then mounted on the second pile. The idea was practicable, but the short shackle sheared out the bolt holes. A long shackle as shown in Fig. 3 remedied the trouble.

As perfected the method was to assemble on the ground a sheet of nine piles, interlocked, and up-end the sheet as a unit against the guide rangers. The first pile was driven half way using the stirrup of Fig. 1. Then the shackle shown by Fig. 3 was applied and the first pile was driven home, with the hammer on top, and the second pile pulled down half way. The hammer and shackle were then shifted and the operation repeated until all nine piles were at bottom. Another sheet of nine piles was assembled and driven and so on. By this

method as many as 16 piles in 10 hr. were driven when the ground was good. If boulders were encountered it sometimes required hours to sink one pile.

As shown by the view, the hammer was hung from a tripod on rollers and handled by a hand winch. A detail found useful was to mount the top pulley on a plank, which, sliding in guides, could be pushed forward and withdrawn by a lever to adjust the hang of the hammer.

The work described was performed at Hamilton, O., as a part of the operations of the Miami Conservancy District, Arthur E. Morgan, chief engineer, Charles H. Paul, assistant chief engineer, and C. H. Locher, construction engineer.

Bridge Pier Foundation Carried to Rock by Air Bell

By W. M. Ray,
Assistant Engineer, Baltimore & Ohio R.R., Pittsburgh

In the reconstruction of the Baltimore & Ohio R.R. bridge over the Allegheny River at Herr's Island, Pittsburgh, Pa., the cofferdam built for extending one of the piers leaked so seriously that open excavation became impracticable. Under the conditions an air bell was used to reach sound bottom, with entire success.

Starting from the Pittsburgh side at the foot of 33rd St., the bridge crosses the main channel of the river, Herr's Island, and the back channel to the north or Allegheny side of the city. In the back channel the location of the new bridge diverges from that of the old structure, though the latter is retained to carry a low-grade track to the island. Because of the divergence special conditions governed the construction of the piers in this part of the structure. Two piers had to be built as extensions of the corresponding old piers,

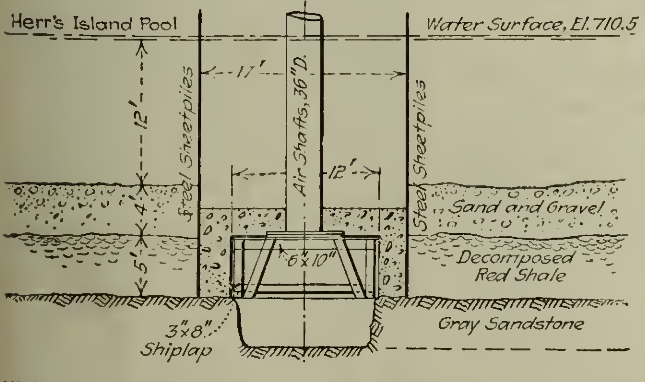


FIG. 1. CROSS-SECTION OF AIR BELL IN COFFERDAM, PIER *N* FOUNDATION. B. & O. BRIDGE, PITTSBURGH

known as Piers M and N. The principal difficulties, and those which led to the use of the air bell, occurred in case of Pier N.

Soundings at this pier showed a depth below the pool stage of 12 ft. to river bottom. The soil below consisted of 4 ft. of sand and gravel and 5 ft. of decomposed red shale overlying sandstone. As it was desired to reach the sandstone foundation the site was first dredged to a depth of 18 ft., or to within about 3 ft. of the rock, and the pier area was inclosed by a cofferdam consisting of a single row of interlocking steel sheetpiles. The inclosed area was further dredged to within 1 ft. of rock and the cofferdam wall banked on all sides with excavated material.

Attempts to pump the cofferdam developed considerable leakage, especially at the end next to the old masonry pier, where the cofferdam was joined up with the old piers by inclosed pockets filled with clay and sealed with concrete deposited by tremie against the old masonry. Previous inspection by diver had indicated that the old pier had probably been started in a floating timber box or caisson sunk on a site previously dredged to a hard bottom. As there was considerable vibration in the old pier under passing trains it was not considered advisable to continue pumping the cofferdam and thereby drawing water through and under the old footing. These considerations led to the adoption of the air-bell method for completing excavation and depositing concrete in the cofferdam. It should be said that a compressor plant and a force of foundation workers were available on account of the recent completion of three pneumatic caisson foundations in the main river channel.

The cofferdam was about 17 x 33 ft. in inside dimensions. The air bell consisted of an inverted box 12 x 48 ft., 5 ft. high, which was built on the island and hoisted into position over the cofferdam by derrick boat. After three air-shaft sections were attached the

FIG. 2. DERRICK BOAT LIFTING AIR BELL INTO COFFERDAM, PIER *N* FOUNDATION

bell was sunk to bottom inside the cofferdam, leaving a space of about 2½ ft. on all sides between it and the steel sheetpiling. Concrete was then deposited by tremie around and over the bell, thus sealing the top and sides (Fig. 1), after which the cofferdam was unwatered and concrete deposited in the dry to water level.

Air pressure was then applied sufficient to unwater the bell and permit cleaning out the excavation under it. As the rock surface thus exposed was soft the excavation was carried 4 ft. into the sandstone under the area of the bell. Then the entire excavation and interior of the bell were concreted under air pressure.

The air bell was of light construction, as the conditions of its service were entirely different from those governing the construction of regular caissons for pneumatic work; there were no launching or cutting-edge stresses to be provided for and the concrete inclosing the bell was expected to counteract the interior air pressure. In this case the bell was built of 3 x 8-in. ship-lap pine sheathing spiked to nine cross-frames of 6 x 10-in. pine timber.

Under the circumstances, and with compressed-air equipment at hand, the use of the bell as described proved to be a quick and economical method.

News of the Week

New York, August 19, 1920

Huge Reservoir on Colorado for Imperial Valley

Dam 600 Ft. High Would Store 25,000-000 Acre-Feet for Irrigation, Flood Protection and Power

(Conference Reported for ENGINEERING NEWS-RECORD *by J. B. Lippincott, Consulting Engineer, Los Angeles.)*

A hearing on the development of the Colorado River was held at San Diego, Cal., Aug. 3 by Arthur P. Davis, director of the U. S. Reclamation Service and president of the American Society of Civil Engineers. There were approximately 100 delegates present, including state engineers from Colorado, Arizona and Nevada, personal representatives of the governors of the various states that lie partly within the drainage basin of this stream, representatives of several irrigation districts and companies, the cities of Los Angeles and San Diego, the American Legion and others.

The problem under consideration was the impounding of the flood waters of the Colorado River for three purposes: (1) Irrigation of additional arid lands below the Grand Canyon of Colorado, both in the United States and Mexico. (2) The prevention of over-flow and flood damage caused by the high waters of that stream. (3) The generation and distribution of hydro-electric power attained in connection with these storage problems.

The hearing was held under the Kincaid Act, passed by Congress in May, 1920, entitled "An Act to Provide for an Examination and Report on the Condition and Possible Irrigation Development of the Imperial Valley in California." This act instructed the Secretary of the Interior to formulate a policy for this great enterprise, and particularly to make recommendation as to the extent to which in his opinion the United States should contribute to the cost of carrying out the plan; also the approximate proportion of the total cost which should be borne by the various irrigation districts or organizations now organized, or which may organize in the future, and the manner in which their contribution should be made.

The Kincaid Act carried an appropriation of $20,000 for further investigations of Imperial Valley irrigation possibilities, conditioned on provision for at least one-half the cost of the investigations being provided for by "associations and agencies interested in the irrigation of the lands of the Imperial Valley." The Imperial Irrigation District has made a contribution of $40,000 and the Board of Public Service of the City of Los Angeles has offered any additional funds that may be necessary for the adequate completion of the study in time for report to Congress next winter.

Borings Being Made

Borings are being made for a dam site in what is known as Boulder Canyon, a narrow granite canyon situated near the extreme southern end of the State of Nevada. If these foundations prove satisfactory, it is proposed that a dam be constructed at this point, designed for a possible maximum height of 600 ft., with a storage capacity averaging 25,000,000 acre-ft., which would be sufficient to regulate all the flood flows of the Colorado River from above that point and to provide a water supply sufficient to irrigate all lands that could be reached by gravity below it, either in the United States or Mexico.

The importance of the problem can scarcely be overestimated. All of the delegates at the hearing were in favor of a large storage reservoir on the Colorado River. Director Davis will make the necessary survey and field investigations and formulate a plan which will be presented to Congress in accordance with the Kincaid Act.

More Favorable Shipment of Road Materials Now Secured

A more sympathetic attitude toward the movement of road materials by the railroads now prevails, in the opinion of Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads. The Bureau of Public Roads is keeping in close touch with the Interstate Commerce Commission and has detailed personnel to assist the car service commission of the American Railroad Association in handling requests for cars to be used to transport materials for road maintenance and for the completion of unfinished contracts. In a letter to state highway departments Mr. MacDonald outlines in detail the steps which must be taken to secure cars. He points out that it is the desire of the Interstate Commerce Commission that the shippers and the local railroad officials co-operate to settle, in so far as is possible, their transportation problems without calling upon agencies in Washington. He also points out that ways are being found to route returning coal cars in such a manner that they can be utilized for the handling of road materials, without interfering with the order giving priority to coal cars.

Civil Engineers to Vote on Federation

At Annual Convention Decision is Reached to Submit Question to Membership in Referendum Ballot

Action taken at the annual convention of the American Society of Civil Engineers held at Portland, Ore., Aug. 10-12, indicates that an early decision will be reached, by referendum ballot to the membership, on the question of joining the Federated American Engineering Societies. The Board of Direction at first favored delay until the legal status of the proposal could be investigated, but the meeting expressed its desire for immediate action.

The following resolutions of the Board of Direction summarize the action taken with regard to the federation:

"WHEREAS, The Board of Direction at its meeting of Aug. 9, 1920, at Portland, Oregon, adopted the following: 'Moved that the secretary be authorized to secure as soon as possible legal opinion from Parker & Aaron as to whether the society can, under its charter and constitution, enter the Federated American Engineering Societies, and if not what action may be taken to secure such power; and that contingent upon favorable opinion being received there be issued immediately a referendum ballot as submitted by the Joint Conference Report to be accompanied by pro arguments prepared by Messrs. Wall, Henny and Hoyt, and con arguments prepared by Messrs. Pegram, Alvord and Tuttle, and sent out by the secretary,'

"AND WHEREAS, the Annual Convention at its meeting of Aug. 10, 1920, passed by a vote of 73 to 13 the following: 'Moved that it is the sense of this meeting, (1) that the action of the Board of Direction of the American Society of Civil Engineers relative to joining the Federated American Engineering Societies taken at the meeting of Aug. 9, 1920, should be reconsidered; and (2) that the Board of Direction of the American Society of Civil Engineers be directed to submit at once the question of the American Society of Civil Engineers becoming a charter member of the Federated American Engineering Societies to referendum vote to the corporate membership of the American Society of Civil Engineers as recommended by the Joint Conference Committee, said ballot to be accompanied by a copy of the constitution and by-laws of said federation; and (3) that the Board of Direction of the American Society of Civil Engineers be

further instructed in event of favorable vote on said referendum to proceed at once to take such steps as may be necessary for the American Society of Civil Engineers to become affiliated with said federation.' Now then be it

"RESOLVED: that without rescinding its action the Board of Direction as expressed in its resolution of Aug. 9, now further resolves that in courtesy to the desires expressed by the annual convention the secretary is hereby instructed that without waiting for legal advice he should issue to the corporate membership without delay a referendum ballot on the following question, 'Shall the American Society of Civil Engineers become a Charter Member of the Federated American Engineering Societies?', this referendum to be accompanied by arguments for to be prepared by Messrs. Wall, Henny and Hoyt, and arguments against to be prepared by Messrs. Pegram, Alvord and Tuttle, together with a copy of the constitution and by-laws of said federation and copy of this resolution, and be it

"FURTHER RESOLVED: That the president and secretary are hereby instructed to at once secure from Parker & Aaron, the society's counsel, an opinion as to whether the society has the power under its charter and constitution to enter the Federated American Engineering Societies, and whether the amendments as at present proposed will accomplish such purpose, and if not what action must be taken by the society to secure such power, and that the executive committee shall inform the corporate membership of its substance as soon as possible if this can, in the committee's judgment, be done without jeopardy to the interests of the society."

General Contractors Seek Data on Cost of Owning Equipment

The Committee on Methods of the Associated General Contractors of America has tabulated the expenses of owning various machines as percentages of the capital investment. This tabulation is given in the accompanying table, copies of which have been sent to all members of the association for criticism so that a check upon the adequacy of depreciation and repair charges may be had from men who are familiar with the practical operation of the various types of machines. The data for this table have been collected from various sources, including manufacturers of equipment.

In sending out a circular letter including this cost tabulation the secretary of the association has requested answers to various questions regarding owning equipment. It is well known that the biggest problem in determining rental charges is depreciation and repair, and these questions accompanying the tabulation refer to the average salvage value for condemned equipment, the average economical life of plant, percentage assigned by contractors to shop repairs, and the percentage allowed for field and minor repairs.

Equipment:	Economical Length of Life in Years	Annual Shop Repairs Per Cent of Capital Investment	Annual Field Repairs Per Cent of Capital Investment
Auto cranes	5	6	5
Automobile trucks	3	20	20
Automobile trailers	5	6	5
Backfiller, power	4	6	7
Ballast spreaders	8	6	4
Boilers, upright	6	25	5
Boilers, locomotive	8	16	4
Buckets, clam shell	6	6	4
Buckets, orange peel	6	7	6
Buckets, drag line	4	5	3
Cars, steel dump	8	4	3
Cars, wood dump	6	3	2
Cars, flat	8	3	3
Cars, hopper	5	3	3
Compressors, portable:			
Steam	6	5	3
Gasoline	5	6	4
Electric	6	3	3
Concrete chutes	2	10	15
Conveyor, belt	2	4	6
Conveyor, bucket	2	6	6
Crushers, rock	6	5	3
Derricks, wood	5	4	4
Derricks, steel	10	3	3
Dragline excavators:			
Steam	6	9	8
Gasoline	4	10	10
Electric	8	7	7
Drill, tunnel carriages	5	8	8
Riggs, traction well	8	5	10
Rigs, tripod	4	5	10
Rigs, jackhamer	4	4	6
Engines, gas	6	8	8
Engines, steam	10	5	5
Excavators, cableway	6	4	12
Excavators, keystone	6	6	4
Excavators, trench traction	5	8	6
Finishing machines:			
Tampers	3	10	8
Graders:			
Road	3	12	6
Elevating	4	15	7
Hammers, riveting	5	6	4
Hoists, steam	10	6	4
Hoists, gasoline	5	8	6
Hoists, electric	8	5	3
Locomotives, industrial:			
Steam	8	7	4
Locomotives, gasoline	4	10	10
Locomotives, electric battery	4	15	4
Locomotive cranes:			
Steam	8	7	8
Mixers, steam	7	6	4
Mixers, gasoline	4	8	6
Mixers, electric	7	6	4
Mixers, steam:			
Paving	7	6	4
Mixers, gasoline:			
Paving	4	10	6
Motors	6	6	4
Pile drivers, steam	6	7	5
Pile drivers, track	10	5	3
Pile hammers, steam	6	7	3
Pipe, galvanized	3	..	6
Plows	3	15	10
Pneumatic concrete placing	5	4	8
Machine:			
Pumps, centrifugal D.C.	8	6	4
Pumps, piston D.C	6	7	5
Pumps, pulsometer	10	2	4
Pumps, Emerson	10	2	4
Rails	10	3	4
Rerk Channeling Machines	6	7	8
Rollers, steam road	10	4	3
Rollers, gasoline road	6	6	4
Scrapers, wheel	3	6	4
Scrapers, slip	2	25	10
Scrapers, fresno	2	25	15
Shovels, steam	6	7	6
Shovels, gasoline	4	9	7
Shovels, electric	7	6	5
Switches	3	3	3
Towers, steel elevator	4	3	4
Tractors, wheel, gasoline	6	8	5
Tractors, caterpillar, gasoline	5	15	10
Wagons, dump	4	17	3
Wagons, hauling	4	12	3
Wagon loaders, power	5	10	6

Material Handling Section Formed by Mechanical Engineers

The Material Handling Section of the American Society of Mechanical Engineers was formed at an organizing meeting held in the Engineering Societies Building, 29 West 39th Street, New York City, Aug. 13, presided over by Robert M. Gates of the Lakewood Engineering Co. The purpose of this section, as announced, is to "promote the art of the mechanical handling of all materials" and a general sentiment was expressed at the meeting in favor of co-operation with other organizations, including the Material Handling Manufacturers Association and the Society of Terminal Engineers, in the furtherance of this object.

W. L. Dickinson suggested that close co-operation should exist between the new section and the American Institute of Electrical Engineers on account of the relation of electrical equipment to mechanical material handling. F. M. Feiker, vice-president, McGraw-Hill Co., Inc., proposed that the section deal largely with the economies of material handling engineering rather than with the details of equipment and mechanical problems. Discussion developed proposals to include in the activities of the section consideration of broader phases of rail and water transportation, but the general sentiment was to confine activity to consideration of internal material handling problems. Shortage of common labor was emphasized as an all important factor.

A nominating committee of three members was elected to select one or more candidates each for the office of chairman, vice-chairman and secretary of the section, to be elected by letter ballot to the membership. These officers, constituting the Executive Committee, will when elected designate the time of the next meeting and special subjects to be discussed.

Boston Molasses Tank Cases on Trial

Trial of accident claim cases resulting from the collapse of an elevated tank filled with molasses, on Commercial St., Boston, on Jan. 21, 1919, has begun with the hearing of evidence before Col. Hugh W. Ogden as auditor. The claims number over 100, but many of these have been consolidated for more rapid progress of the litigation. The amount of the claims is said to total \$3,000,000. They are brought against the United States Industrial Alcohol Co., owner of the tank, and under the direction of the court the auditor is required first to determine the defendant's liability, the apportionment of damages being a subsequent step.

Duluth Ferry Bridge Declared Unsafe, To Be Inspected

A preliminary engineering report stating that the well-known ferry bridge at Duluth is unsafe led the city council on Aug. 2 to order a second inspection of the structure by an outside engineer. The report on the first inspection said, among other things, that many of the rivets are poorly driven, that the track rivets are in bad condition, and that parts of the bridge are rusting seriously.

Recommend Rebuilding of Weak Bridges in Indianapolis

If the position of the city's engineering department is upheld by the Board of Public Works of Indianapolis, Ind., a number of existing bridges that are too weak for modern traffic will be rebuilt before a new bridge is constructed. In reporting on a petition for the improvement of Twenty-first St., involving an important new bridge, J. C. Elliott, Assistant City Engineer, recommended that the petition be disapproved, as nine bridges elsewhere in the city are in dangerous condition and require rebuilding. One of the structures (Kentucky Avenue, over White River) may soon be posted for a three-ton maximum load. One or two of the other bridges have already been closed. A few of the canal bridges are very old wooden structures and in especially dangerous condition.

Contracts Let for County Court House in New York

Contracts exceeding $5,000,000 for a number of the main items in the construction of the new county court house were awarded by the Board of Estimate of New York City on Aug. 12: Steelwork, to Bethlehem Steel Bridge Corp., $1,280,000; brickwork and concrete floors, to D. E. Connor at $880,000 and $658,000; limestone, to H. Hanlien & Son, $2,372,000; roofing, to Hermann & Grace Co., $48,000. Guy Lowell, the architect for the court house, recommended that limestone be selected in place of granite for the facing, as being more than $100,000 cheaper and requiring less time to furnish; the limestone is to be furnished in 11 months and all of the cutting is to be done within the city. The foundation work had been awarded previously to Rogers & Hagerty, for $1,900,500.

American Work for Swiss Tunnel

A contract for pneumatic concrete mixing plant for lining the water tunnel of a hydro-electric development in the Alps has been secured by the Concrete Mixing & Placing Co., Chicago. The tunnel will be 4½ mi. long, of horseshoe section 9½ ft. high and 9 ft. wide, with a lining 10 in. thick in rock and 20 in. in soft material. The contractors are John Reusch & Sons, St. Gallen, Switzerland.

City To Pay Claims for Discharge of Public Service Engineers

Claims of engineers employed by the Public Service Commission, New York City, for services given to the city on a volunteer basis during January, 1919, are to be paid if the Board of Estimate adopts a resolution just submitted to it by Comptroller Craig. On Jan. 1, 1919, part of the engineering staff of the Public Service Commission was discharged because no appropriation for their services had been made by the Board of Estimate. However, a number of the discharged employees continued at work, volunteering their services in order to keep the subway planning and construction operations going until the beginning of February, when an appropriation was passed by the Board of Estimate. For these volunteer services claims upon the city were submitted by the employees in question. These claims, totaling 39 in number, cover periods of service ranging from three to thirty-one days and amount to a total of $5,462.90.

In presenting the resolution for payment of these claims, Comptroller Craig reviews the conditions leading up to the failure of the appropriation on Dec. 30, 1918, and the various elements of lack of harmony between the Board and the Commission, including failure of the Commission to submit its request for appropriation in such form that the moneys involved could be allotted to their respective construction and operation contracts, as provided by law. He then cites the volunteering of service by the dismissed employees and says:

"Unquestionably the City of New York has received the full benefit of their services. Because of the action of the Public Service Commission, however, no legal liability exists to make payment for such services. The Public Service Commission in their public announcement of Dec. 31, 1918, stated that they were laying off from duty 323 employees because of the reasons aforesaid. It turned out, however, that by actual count the number of employees so laid off for alleged lack of appropriation was not 323 but 39. I, therefore, certify that such claims are and each of them is illegal and invalid as against the City of New York, but that notwithstanding such illegality and invalidity it is in my judgment equitable and proper for the City of New York to pay the amounts of the said several claims, the sum specified being the amount of compensation in each case that the several and respective employees would have received had there been no interruption in their tenure of service."

It is expected that this resolution will be passed promptly by the Board of Estimate, and that thereby the unfortunate situation existing at the time mentioned, described in *Engineering News-Record* of Jan. 9, 1919, p. 112, may be finally cleared.

Forest Products Laboratory Holds Decennial Celebration

Over 200 visitors attending the decennial celebration of the U. S. Forest Products Laboratory at Madison, Wis., represented lumber and wood-working associations and companies, forestry schools, the U. S. Forest Service and other interests. In an address on "Legislative Measures for Forest Conservation," Governor Philipp of Wisconsin took the position that reforestation is not a state duty but the duty of the national government, since timber grown in any one state is distributed throughout the country. Colonel W. B. Greeley, chief forester, U. S. Forest Service, said that the policy should be not to use less wood but to grow more by using the idle acres of burned and logged-off timber lands.

Dr. Birge, president of the University of Wisconsin, spoke of developments for combined technical and industrial research. C. P. Winslow, director of the laboratory, explained its purposes and the wide scope of its work, and estimated that this work represented an annual value of $30,000,000 in increased production and decrease of waste. Following the celebration there was a conference on reforestation, a meeting of the technical committee of the National Lumber Manufacturers' Association, and a meeting of deans of forestry and engineering schools.

Hool and Johnson Form Consulting Engineering Firm

George A. Hool, of Madison, Wis., and Nathan C. Johnson, of New York City, have announced the formation of the firm of Hool & Johnson, engineers, with offices in New York, Milwaukee and Cleveland. Associated with them is the laboratory and engineering staff of the James H. Herron Co. of Cleveland. Mr. Hool is professor of structural engineering at the University of Wisconsin and is the author of a number of text-books; Mr. Johnson for some years has been in consulting practice in New York City, specializing in the technique of concrete manufacture. The two have also been associated in the authorship of well-known text-books on concrete and have another book on building construction now in the press.

The new firm will undertake designs, plans, estimates, contracts and specifications, supervision of construction of all kinds in concrete, steel, and other materials, as well as the inspection, testing and use of construction materials, researches, investigations and development of industrial processes and new industrial matters. In this work it will operate in conjunction with the laboratory of the Herron Company. Service is also offered in examinations and reports, consultations, adjustments and arbitration, and as counsel in engineering and patent cases of various kinds.

Baltimore to Vote on $51,000,000 for Public Improvements

The City of Baltimore, Md., will submit to the voters early next month three loans to be used for public improvements, as follows:

(1) Port improvements, $10,000,000; this being the first installment of a total $50,000,000 loan authorized by the Maryland Legislature.

(2) Water supply improvements, $15,000,000.

(3) General improvements, such as street paving and sewers, $26,000,000.

The administration of these loans, according to information received from Henry G. Perring, chief engineer, Department of Public Improvements, will be handled by two commissions appointed from the citizens, the Port Improvements Commission handling the port and harbor improvements and the General Improvement Commission the other loans. In commenting upon the character of the appointees to these new bodies Mr. Perring says:

"It is interesting to note that Baltimore has in the past recognized the value of engineers at the head of commissions or boards. Thus we find the harbor engineer is president of the Harbor Board, the water engineer is president of the Water Board, the consulting engineer is head of the Paving Commission; all these being bodies that have been functioning in the city for many years. In the new commissions, Mayor William F. Broening has recognized the value of engineers to the city, and the ordinance authorizing the commissions provided that the harbor engineer should be ex-officio a member of the Port Improvement Commission, and the chief engineer of the city an ex-officio member of the Public Improvement Commission."

The engineers of the community and the public at large, says Mr. Perring, are particularly gratified that Mayor Broening has appointed as head of the Port Development Commission J. E. Greiner, consulting engineer, of Baltimore.

Bidding on Preliminary Survey for Delaware River Bridge

On Aug. 12 the engineering committee of the Delaware River Bridge and Tunnel Commissions of New York and Pennsylvania held a hearing at which architects and engineers discussed the cost and time of a "preliminary survey" for the proposed Philadelphia-Camden bridge. J. A. L. Waddell, C. W. Leavitt, Henry Goldmark, Joseph M. Huston, Sanford Lewis, Henry B. Seaman, Ralph Modjeski, J. L. Harrington and others conferred with the committee. Offers were made to carry out the "survey" for less than $100,000 and complete the work within six months. At the close of the hearing the committee requested all the engineers and architects interested in the case to submit definite proposals during the following week in order that the committee might make a recommendation as to what engineers should be employed to do the preliminary work.

Rumors in well informed circles are to the effect that a board of engineers will be formed to carry on the bridge design and construction. It is not known, however, whether this same board will conduct the preliminary engineering. George S. Webster, chief engineer of the Bureau of Surveys of Philadelphia, is prominently mentioned for a leading place on the board.

Mills Adopt New Weight Standards for I-Beams and Channels

A new table of standard weights for minimum sections of I-beams and channels has just been adopted by the Association of American Steel Manufacturers, according to an announcement issued by J. O. Leech, secretary. By the change, the well-known weights current since 1896 are altered to bring them into agreement with the standard dimensions of the shapes; a 9-in. 21-lb. I-beam, for example, now becomes a 9-in. 21.8-lb. I-beam, and the latter weight corresponds to the published dimensions of this minimum 9-in. beam, under the standard methods of computation of weights and areas.

To summarize the history of the standardization briefly: In 1896 the association adopted a list of standard profiles of structural steel sections. Fifteen years later it adopted standard methods of computation for published weights and areas. The weights that were published for the minimum thicknesses of beams and channels did not correspond exactly to the published areas, and it has long been known that it is impracticable to furnish these sections true to both the published weights and dimensions.

To correct this situation the Association has now adopted as American standards the weights per foot shown in the last column of the table below for the sections of minimum web thicknesses which do correspond to the published dimensions.

Depth, Inches	Weight, Pounds per Foot: Present Weight	New Weight
	I-BEAMS	
3	5.5	5.7
4	7.5	7.7
5	9.75	10.0
6	12.25	12.5
7	15.0	15.3
8	18.0	18.4
9	21.0	21.8
10	25.0	25.4
12	31.5	31.8
12	40.0	40.8
15	42.0	42.9
15	60.0	60.8
15	80.0	81.3
18	55.0	54.7
20	65.0	65.4
20	80.0	81.4
24	80.0	79.9
24	105.0	105.9
	CHANNELS	
3	4.0	4.1
4	5.25	5.4
5	6.5	6.7
6	8.0	8.2
7	9.75	9.8
8	11.25	11.5
9	13.25	13.4
10	15.0	15.3
12	20.5	20.7
15	33.0	33.9

There is to be no change in the profiles and properties of sections of minimum web thickness, nor in the weights and properties of the intermediate and maximum sections. The new weights are to be put into effect Sept. 1 by all of the companies rolling these sections.

Portland Cement Engineers Hold Seminar in Seattle

Western district engineers of the Portland Cement Association were called to a seminar in Seattle on Aug. 16-18 to discuss engineering problems in which cement is a factor, particularly the construction of concrete highways. District engineers were to be in attendance from Los Angeles, Denver, San Francisco, Helena, Portland and Seattle. In addition the meeting was to be attended by C. N. Reitze, western district manager, Seattle; William M. Kinney, general manager, Chicago; A. N. Johnson, consulting highway engineer, Chicago; and C. R. Ege, engineer of Road Bureau, Chicago. In conjunction with the meeting there was scheduled an inspection of several hundred miles of concrete roads in Washington, including a number of jobs where construction is under way, and typical aggregate producing plants.

Chicago Officials Indignant at Engineering Society's Attitude

Under the heading "Thompson Backs Francis Against the Engineer Clan," the Chicago *Post* reports that the civil service commissioners are indignant at the sharp resolution adopted by the local chapter of the American Association of Engineers on the dismissal of two bridge engineers from the city employ (resolution noted in this journal Aug. 12, p. 334). The report states that Mayor Thompson will ignore the resolution of the chapter demanding the removal of the civil service commissioners and C. R. Francis, commissioner of public works. That the resolution did not lack in effect is indicated by the statement in the report that Joseph Geary, one of the commissioners in question, "waxed warm as he discussed the resolution of the engineers."

Kerckhoff Tunnel Holed Through

On July 27, the Kerckhoff tunnel, which is to supply the new Auberry (Cal.) plant of the San Joaquin Light & Power Corp., was holed through in the tangent between north portal and adit 1. With this step fully two months have been gained on the original schedule. Work began in June, 1919. The tunnel is 18,000 ft. long and 17 x 17 ft. in section. As described in *Engineering News-Record* of Feb. 12, p. 314, the work was attacked from a number of headings, reached from the portals and two adits.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston; Holyoke, Mass., Sept. 7-10.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Sept. 13-17.

SOUTHWEST WATER WORKS ASSOCIATION, Waco, Tex.; New Orleans, La., Sept, 20-23.

AMERICAN ASSOCIATION OF PORT AUTHORITIES, Montreal; Chicago, Sept. 30-Oct. 2.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Valparaiso, Ind.: St. Louis, Oct. 10-15.

The Southwest Water Works Association will hold its ninth annual convention Sept. 20 to 23 at the St. Charles Hotel, New Orleans, La. In addition to the presentation of papers, there will be round-table talks and a series of short talks on difficulties and how they were overcome. E. L. Fulkerson, Waco, Tex., is secretary.

The New England Water Works Association will hold its 39th annual convention at Holyoke, Mass., Sept. 7-10. Sessions will be held Tuesday afternoon and evening, and three a day on Wednesday and Thursday. The preliminary program lists about 20 papers and half a dozen committee reports as scheduled for presentation, with the probability of several papers being added. Friday afternoon will be devoted to a "Superintendents' Session," at which papers on practical problems will be read.

Personal Notes

THEODORE SPEIDEN, JR., has been appointed division engineer maintenance of way of the Baltimore & Ohio R.R., with headquarters at Philadelphia.

HOWARD MURRAY, vice-president of the Shawinigan Water & Power Co., has been elected a member of the board of directors of the Dominion Bridge Co., Montreal. During the war he was chairman of the Explosives Committee, Imperial Munition Board, at Ottawa.

GERARD H. MATTHES, for the past five years hydraulic engineer with the Miami Conservancy District, has been appointed assistant engineer in the U. S. Engineer Office at Chattanooga, Tenn., where he will have immediate charge, under Major Harold C. Fiske, of the investigation of the Tennessee River provided for in the River and Harbor Act. The investigation will cover the future development of the river for navigation and will be made with special reference to water powers, flood control and the mineral resources of the upper Tennessee basin in so far as these can be expected to have an influence on navigation on the Tennessee River and its navigable tributaries. Mr. Matthes' experience covers 25 years in hydraulic engineering, of which 11 have been in hydropgraphic work, municipal and irrigation engineering, 7 in hydro-electric and 7 in flood control work.

C. O. FOSS, chief engineer of the St. John & Quebec Ry., St. John, N. B., has been appointed one of the three members constituting the newly created Hydro-Electric Commission of New Brunswick.

RALPH R. BENEDICT, formerly assistant superintendent of parks of Kansas City, Mo., and for the past two years with the Ordnance Bureau of the War Department at Washington, D. C., has been appointed assistant to the chief highway engineer of the State of Illinois, Department of Public Works and Buildings, Division of Highways.

S. B. GINN, principal assistant engineer of the railroad department of Brier Hill Steel Co., has been appointed office engineer for the Ohio region of the Erie R.R., with headquarters at Youngstown, Ohio.

A. B. EATON has resigned as city engineer of El Dorado, Kan., to accept a position with the Brown-Crummer Bond Co., of Wichita, Kan. He will represent them on a paving contract at Bartlesville, Okla.

T. S. BOSWELL has been made assistant to chief engineer maintenance of way and structures of the Southern Ry., Lines East, with headquarters at Charlotte, N. C. He was recently superintendent, at Asheville, N. C.

ALEX MILNE, superintendent of water-works of St. Catherines, Ont., has been elected president of the newly formed Canadian section of the American Water Works Association. R. L. Dobbin, superintendent of water-works of Peterboro, Ont., has been elected secretary of the section.

W. G. CHACE, chief engineer of the Greater Winnipeg Water District from 1913 to June of this year, when he resigned to organize Research & Development, Ltd., a Manitoba corporation purposing to initiate new industries in that province based on its resources and on such other commercial enterprises as might offer opportunity of success, has been appointed president and manager of the Canadian Lock Joint Pipe Co., with headquarters at Toronto.

H. B. LARNER, the new health officer at Montclair, N. J., is a graduate of Massachusetts Institute of Technology, Department of Biology and Public Health. Following graduation in 1918 he became a member of the U. S. Public Health Service and for a year was stationed in the South engaged in rural sanitation studies, epidemiological investigations and other public health work. For the past year he has been health officer for Goldsboro, N. C.

R. T. DAVIS has been promoted from the position of assistant engineer of the Erie R.R., to that of division engineer at Huntington, Ind., succeeding J. R. Sexton, recently made regional engineer.

M. HIRSCHTHAL has been appointed concrete engineer on the Delaware, Lackawanna & Western R.R., with headquarters at Hoboken, N. J. He suceeds A. Burton Cohen, whose resignation was recently noted in these columns.

Obituary

HENRY GOUGH STANTON, for the past six years in the service of the Department of Railways and Canals, on the Ontario-St. Lawrence canals, at Cornwell, Ont., died in that city, Aug. 9, aged 65. Prior to going to Cornwall he was engaged in railroad work in Mexico, as well as on the trans-continental railways, and also as resident engineer on the St. Peter's Canal on Cape Breton. He was born in the City of Quebec.

WILLIAM PIERSON FIELD, consulting engineer, Newark, N. J., died at Llewellyn Park, West Orange, N. J., Aug. 8. He graduated from Princeton University in 1883 and took a post-graduate course in the University of Stuttgart, Germany. Aside from supervising the erection of many manufacturing plants in the vicinity of Newark, Mr. Field designed and supervised the building of the First Regiment Armory in that city and armories in Camden, Paterson, Jersey City and Trenton.

Business Notes

THE CONCRETE MIXING & PLACING CO., Chicago, has resumed business on the return from war service of its president, H. B. Kirkland. The company may be addressed at 123 W. Madison St., Chicago.

G. F. WICKES, formerly sales and construction engineer for the Pittsburgh-Des Moines Steel Co., Des Moines, Iowa, and H. C. WICKES, formerly assistant engineer for the Pittsburgh office of the above-named company and later chief engineer for the Stacey Manufacturing Co., Cincinnati, have organized the Wickes Engineering & Construction Co., of Des Moines, to handle the construction of elevated tanks and towers, standpipes, oil tanks, bridges and culverts.

A Consolidation of Engineering News and Engineering Record McGraw-Hill Company, Inc.—JAMES H. McGRAW, *President*

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E. J. MEHREN
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Motor Vehicle Increase

THE increase in motor vehicles from 1 in 2,000 to 1 in 15 of population from 1906 to 1919, shown in detail on p. 299 of our issue of Aug. 12, illustrates the great problem that has confronted the highway engineer. It is a continuing but changing problem. The motor-vehicle saturation point has not been reached but the rate of increase of passenger vehicles will decline and that of motor trucks—now the chief concern of the road engineer—will rise. Assuredly there is need for searching study of highway design, as well as of bridges in relation to motor trucks. The last-named subject is discussed at some length on a following page.

Facilitating City Contracts at Detroit

ADOPTION by a special commission of a "sliding scale" contract form recommended to the Detroit Common Council as a means of speeding work upon that city's $50,000,000 sewer construction program was noted on p. 349 of our issue of Aug. 19. It is hoped that the new contract form, which at least minimizes the material price and wage risk encountered in current bidding, will re-awaken the interest of contractors in sewer work at Detroit, which has lagged until recently and not more than 25 per cent progress was being made upon the program mapped out by the Commissioner of Public Works. Though designed specifically for sewer work its proponents claim for the contract applicability to all forms of municipal improvement. Municipalities in general will await with interest the effect upon bidders of such a contract.

Parochialism Personified

THAT part of the country lying west of the Hudson does not appreciate the extent to which New York's expensive port levies tribute on the country at large. Constant reference, then, to the insularity of the officials of the city is worth while. In time national public opinion may begin to have some effect on New York's politicians, who, it is only fair to say, are backed up by a large part of the commercial interests of the city. The latest official outburst is from President La Guardia, of the Board of Aldermen, one of the two republican members of an administration under democratic control. In praising the prospect of new piers replacing some ancient ones on the North River he said: "I believe that after these eighteen new piers have been completed and the Staten Island water-front development carried through and Jamaica Bay made a great water terminal the port of New York need not worry about what New Jersey does. In fact, with these improvements accomplished, New Jersey will be at our mercy." And if New Jersey, of course, the rest of the country. The tremendous costs of lightering non-local freight will continue because of the narrowness of those guiding New York's destinies.

Standardizing Building Codes

A FEW weeks ago we commented on the absurdity of the variations in moment coefficients in flat-slab design in the building codes of the country (see Aug. 12, p. 289). This is only one example of the lack of uniformity in such codes, which represent the taste and fancy of their framers to an extent not at all warranted by the variations in knowledge of the physical facts these codes reduce to practice. In an effort to standardize such regulations the National Federation of Construction Industries is now engaged in the worthy task of tabulating the provision of the principal codes of the country. After the tabulation is made the federation will enter upon a campaign of education, not, it says, to determine the proper provisions but to give building officials a bird's-eye view of the situation so that they may realize the divergences now existing. It is hoped that merely calling attention to differences may tend to reduce them in such revisions as are continually being made.

Utilizing the Army Ports

NEARLY two years have elapsed since the armistice and nothing has been done toward utilizing for overseas shipments the port terminals, which were not completed in time to be of military service. Many of the war structures have had to be scrapped and their cost charged up to the general losses of war. Such should not be the case with the terminals. Their design was made primarily for military purposes but some of them at least are singularly adapted for the commercial needs of the ports where they are located. Terminal design in this country has been notoriously backward. To many the war terminals seemed a step in advance, but their real utility can only be gaged by their performance. Surely the War Department should be able now to release most of them for commercial use and should furthermore be able to arrange some workable scheme for their being taken over by private or public interests. A committee investigated their disposition some months ago. Why does not the department take some action?

Something New in Ships

IT IS safe to say that no structure of sizable proportions developed by the war showed such striking originality of design as the articulated concrete tankers described on another page of this issue. The large concrete ship was really a product of the war, though in Sweden practice was slowly leading up to it. With the exception of the Macdonald tankers, however, the concrete ship was an orderly development of the steel ship—the reproduction of a standard type in another material with only such change as the properties of the new material demanded. The Government, which prac-

tically controlled all shipbuilding, was not disposed to go further into unexplored fields than seemed absolutely necessary. Such conservatism did not hamper the builders of the cylinder tankers; in fact, their project left conservatism far behind and ventured well into boldness. The proof of their success will be in the behavior of the vessels, but the average concrete engineer will look with some misgivings at the longitudinal strength of the joints between the new and old concrete. Aside from that danger, the extent of which will doubtless be considered by the designers in an expected early article, the conception of construction is admirable and has seemingly worked out well. The engineers responsible for the tankers have certainly given the engineering world something new.

Wider Use of Railway Standards

THAT present conditions of economics and finance will tend to enforce the wider adoption of standards of design and practice in railway service is the opinion of Charles A. Morse, chief engineer of the Chicago, Rock Island & Pacific R.R., as expressed in a statement quoted on page 395. Although Mr. Morse refers to the standards of but one society, it may be pointed out that several technical societies have for years past had committees which spend time and energy in devising standard designs and recommended methods of practice. Here again there is possibility of conflict between the standards of different societies and it appears that those of but one should prevail in general adoption. The introduction of these standard designs and methods, though urged by the societies, is so slow and limited that the fullest advantage from universal use is not even approached. Three causes for this may be cited: Indifference or inertia, a prejudice or preference for present individual practice, and a failure to see the economic advantages of the recommended practice in relation to the railway system as a whole. Immediate personal or local trouble that may arise from a change to new and improved methods is apt to be seen much more clearly than the ultimate economy and benefit to the individual road and to the railways in general. In Mr. Morse's opinion, coming development will be a spur to action in this respect. It may be suggested that good judgment will counsel action before spurring becomes necessary.

Changing Conceptions of Refuse Disposal

THAT time brings changes the world over is illustrated by refuse disposal in England. While it never was as true as popularly conceived in this country that all city refuse in England is burned in destructors, nevertheless for decades it was the accepted theory and to a large extent the practice there. The war there, as here, made it necessary to conserve all possible municipal waste, and there, as here, it is likely that much of this conservation will be continued. At a recent meeting of "cleansing" superintendents at Sheffield, a speaker, according to the London *Surveyor* of June 25, "advocated the combination of the destructor with an efficient system of salvage." The *Surveyor* says: "We are disposed to agree with his contention that the destructor is by no means yet out of date. But the day is rapidly passing when the indiscriminate destruction of all the contents of refuse bins will be regarded as the ideal at which to aim."

Garbage reduction has never gained a foothold in England, but some of the garbage was utilized in one way or another before the war, while during the war considerable garbage was fed to hogs, though apparently by relatively small municipalities. Sorting out paper and other salable material from refuse has long been practiced in England. Today, it appears that the United States is far ahead of Great Britain in the matter of utilizing garbage, if not also in sorting and reclaiming refuse. The great American advance in this particular during and since the war has been in feeding garbage to hogs, now practiced by a number of large cities. There is ample opportunity for further advance along this line and also in the field of refuse sorting and utilization.

For some months past New York City has presented an example of changing conceptions in another direction. It has caused the shutdown of a garbage utilization plant operated by a contractor who paid the city large sums a year for the garbage and has been reverting to the wasteful and otherwise objectionable practice of dumping garbage at sea. It is high time that this was changed, but there seems to be little likelihood of change, or at least rational change, under the present city administration.

Highway Bridges and Motor Trucks

FIVE years ago there were about 70,000 commercial motor vehicles on our roads. Today there are 700,000. During the tenfold increase since 1915, the motor truck has penetrated everywhere, and instead of frequenting only the main highways it now seeks out every road, even the most remote. Except in a few states it travels without restriction as to load and speed. A truck weighing ten, fifteen or twenty tons is free to pound its way along any country road and over dozens of bridges, small and large, that were not built to carry such loads or resist such violent impacts. A condition of danger is being created for us, almost unsuspected.

Already there is a disturbing frequency of failures of highway bridges under motor trucks. Statistics of these failures do not exist, but we risk little in saying that they are increasing in number. A typical press clipping reads: "A drawbridge on the state highway between —— and —— collapsed today, dropping a four-ton truck into the water. Governor ——, who is on a motor tour of the state, was to have passed over the bridge about the time the collapse occurred but he was advised of the break and directed to reach this city by detour." Many such occurrences do not get into the newspapers, however. An engineer writes of two floorbeam failures in bridges near his town, where because of the absence of serious results no press report was published. As a matter of fact these failures are even more significant than those involving complete collapse, for the most dangerous weakness against concentrated loads is to be found in floor systems, not in main girders, and therefore when floors are broken through by the increasing traffic loads the result is to be regarded as the inevitable outcome of the conditions that have been allowed to develop. Accident may play a part in some bridge failures and make them interesting objects for engineering investigation, but the occurrence of floor failures and the breaking down of small bridge spans under motor trucks

is a simple indictment of weak bridges and excessive, unregulated, traffic loads.

How inadequate is the strength of existing bridges was well brought out in a survey of bridge capacities made during the war by a state highway department for military purposes. The survey covered all road bridges in the state, including those under township and county control. Briefly summarized, it showed that many of them could not carry more than a one-ton load without exceeding the usually accepted limits of safe stress; only a small percentage of all could carry a five-ton truck. There is no reason for thinking that other states are in better condition. This is startling when we consider that the truck-building industry has its center of gravity in the field of trucks of 2 to 2½ tons capacity, vehicles whose gross weight often exceeds five tons, while at the same time there is a steady increase in the number of much heavier trucks, with gross weights frequently of 12 to 15 tons and more.

That heavy truck loading plays a controlling part in the matter, now that motor trucks are traversing all the byroads, is reflected in the statement made to us by an engineer that recently, while looking at a fifty-year-old bridge, a serviceable and well preserved structure, he learned that a truck carrying twelve tons of freight had crossed it a few days previously. The bridge was not designed for loads even approaching this; droves of cattle and possibly a light road roller were the heaviest loads that the bridge engineer had to consider in former years. Relatively high wheel loads occur even under trucks of moderate capacity, a point well brought out by figures of actual truck wheel loads obtained from authentic sources, given by an investigator of the subject in our issue of June 27, 1918, p. 1228. But frequently the loading of trucks goes far beyond rating limits, and the figures quoted are doubtless much below the facts of road service.

It is quite obvious that the chances of the conjunction of heavy load and light bridge are each day becoming greater, in perilous degree. Thousands of bridges, even tens of thousands, are creating a menace through their own weakness and the increasing frequency and ubiquity of heavy motor truck loads passing along the roads in rapid flight. Not only direct load effects are concerned, but shocks and blows of unknown amount are set up by the fast-moving vehicles crossing over rough floor surfaces, so that we cannot even determine in a reliable way how close we are to the danger point.

Until it may be possible to rebuild all bridges that are now too weak, safety can be found only through regulation of bridge use on the one hand, and control of maximum loads and speeds on the other. By posting every bridge in the country for its capacity, and taking steps to see that loads greater than the posted capacity do not cross the bridge, a very large degree of protection can be obtained. Limitation of maximum truck loads, and control of speeds of travel, will increase this protection. The necessity for such protection has been made imperative by the great increase in number of trucks.

State highways departments, it is fair to say, have recognized the existence of the bridge problem for a number of years; certainly their bridge engineers have been well aware of conditions. But the departments have been utterly submerged in their road construction problems. Charged with the duty of applying vast sums of current expenditure appropriated to pavement construction, confronted by problems that momentarily, at least, are bigger than our resources, they have lost sight of the bridge question while wrestling with the difficulties of deciding what pavement to use and how to put it down. From the pavement standpoint, however, limitation of truck loading is a problem that will bear delay. Too rapid wearing out of pavement may be costly, but it is not a matter of life, of public safety. The failure of bridges is of very different kind; a single load can destroy a bridge. Such a condition can not be left to work itself out at leisure. For the time being, the bridge problem must take precedence over the pavement problem in spite of the much greater magnitude of the latter.

Division of authority and responsibility has played a part in bringing the problem to its present urgency. States control only the bridges on main roads, and the outstanding danger arises from the bridges on town and county roads. Nevertheless the state is clearly the authority through which relief must be sought. Both limitation of truck loads and speeds by law and the posting of bridge capacities can only be brought about by state action. To secure legislative action to this end, the state highway departments may well take the initiative. Engineering sentiment will support them in advocating the necessary laws.

However, not only the preservation of old bridges but also the design of new ones is involved, and here the state is directly interested. At present no one can forecast what future highway loadings may be, since the industry is still permitted to develop in a quite unregulated way. In the design of new structures on main roads, therefore, guessing at maximum loads is involved just as obviously as it was in the design of the bridges of fifty years ago. The designer of a new highway bridge may well be pardoned if he contents himself with load assumptions chosen at random for in any event he has no recourse but to let developments come as they will, and live in the faith that his bridge may have a reasonable length of life before increase of load makes it obsolete. But if the loads and speed can be regulated now his design will be much more closely suited to the service requirements it must meet, and waste of money thus avoided.

What the present moment demands is that steps be taken at the earliest possible moment, in every state of the Union, to fix truck load limits and if possible limits of their speed. Time is lacking to delay action until a nationwide understanding can be obtained as to what these limits should be. Nor is it important to secure harmony at the start, for after local action has been secured everywhere it will be time enough to set about harmonizing the individual requirements. At the same time that load limits are fixed locally, it is important that laws be passed requiring the posting of all bridges and putting severe discouragements on attemps to disregard the posted limits.

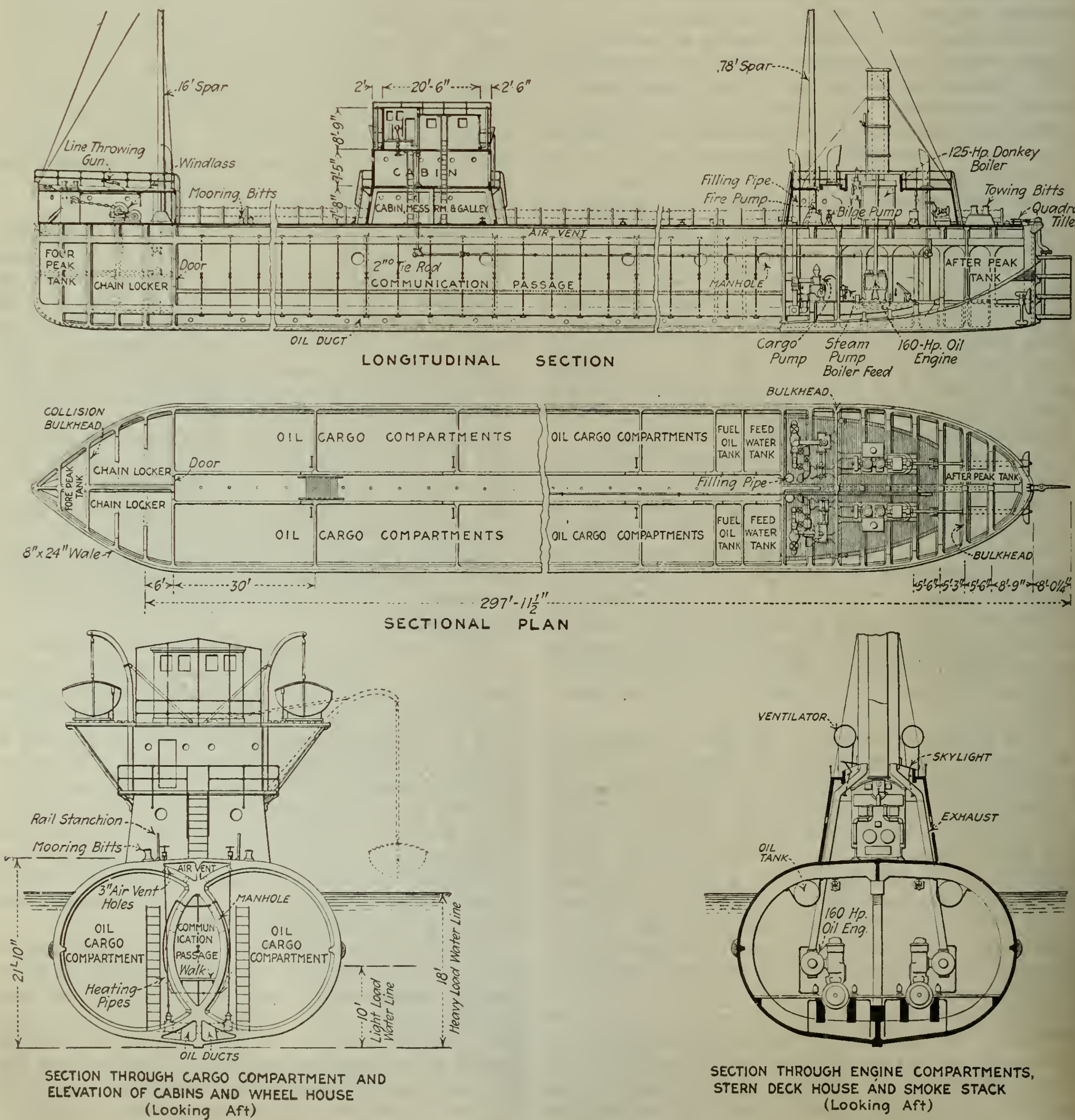
With such preparation, the slow and difficult task of bridge revision can be taken in hand on the basis of the load limits set by law. This part of the work, however, will be bound to take a number of years at best, and can be of no service for protection at the present or in the immediate future. Ultimately we will have both stronger bridges and controlled truck practice; for the present the way to safety must lie through regulation alone.

Concrete Tanker Built of Separately Cast Cylinders

Sections of Two Interlocked Cylinders Poured Upright on Platform and Turned Horizontally To Be Joined Together To Make 2,000-Ton Oil Carrying Self-Propelled Vessel

On July 24, 1920, there was launched at Aransas Pass, Tex., the first of two reinforced-concrete oil tankers of most radical design. Projected just before the end of the war they were well progressing when the hurricane of September, 1919, wrecked the yard and delayed completion of the vessels. One of the two ships is now ready for a trial trip and the other will be launched in a short time. These boats, of approximately 2,000-ton deadweight capacity and nearly 300 ft. long, are made up of nine separate sections, cast separately and joined together in place on a long launching way. Of those sections seven are of identical construction, being of double circular shape and cast upright and turned to a horizontal position. The bow is poured separately and moved to its proper location, while the stern is poured in place.

Details of the design of these remarkable vessels will appear in an early issue of this journal. There are presented here a series of views of their construction and an outline of the methods used, both furnished by



CONCRETE TANK STEAMER 300 FOOT LONG, BUILT OF SEPARATELY CAST CYLINDERS

the Macdonald Engineering Co., Chicago, which designed and built the tankers.

During the latter months of the war T. E. Byrnes, president of the France & Canada Oil Transport Co., New York, secured permission from the Emergency Fleet Corporation to construct at Aransas Pass, Tex., a fleet of reinforced-concrete ocean-going barges for transporting oil from Tampico to Aransas Pass. After consideration of many designs it was decided to construct these vessels in accordance with proposals put forward by the Macdonald Engineering Co., along lines which though radical promised economy in construction and efficiency in operation.

The vessel consists of two interlocking cylinders, so spaced as to make the relation between beam and depth dimensions approximately the same as is usual in vessels of standard type. The interlocking of the cylinders provides along the midship line of the vessel a buoyancy chamber extending the entire length of the cargo space, and this chamber also serves as a passageway from bow to stern. The main portion of the cylinder on each side of the buoyancy chamber is cargo space for oil; the smaller chambers at the bottom serve as ducts connecting the oil compartments with the cargo pumps; and the similar chambers just below the deck act as relief pipes, carrying air from the cargo compartments to ventilators at the bow and stern.

The ship is 298 ft. long overall, 33 ft. 9 in. beam and 21 ft. 10 in. deep. It will have a deadweight cargo capacity of approximately 2,000 tons, or 14,000 barrels of medium oil. Transverse bulkheads are spaced 30 ft. apart, each vessel thus containing seven compartments on each side of the buoyancy chamber, or a total of fourteen.

A few weeks after the contract for these vessels was placed the war ceased and propelling equipment, not previously obtainable, could be secured. It was therefore decided to make the tankers self-propelled, using internal combustion engines. The stern section was redesigned to provide engine space, and other necessary alterations were made to meet the changed program.

It will be noticed that the vessel is built without transverse frames. This feature was an essential part of the method of construction proposed by the builders and followed out in the work. Each section 30-ft. long was built on end by the use of sliding forms raised continuously night and day by patented jacks—a method of building developed by the constructors in their long experience in concrete grain elevator work. This manner of working produces concrete more free from joints or lines of cleavage than any other method, and is also very fast in practice. For instance one section—26 ft. 10 in. of actual depth of concrete—was run in 28 continuous hours.

By employing sliding forms and raising them free of the concrete work as the section was finished the same forms could be lowered to their original place again and used for building similar sections for an indefinite number of ships. This duplication it was thought would effect great economies in construction.

The use of the sliding form makes the simultaneous construction of ribs or other offsets impossible. The transverse strength of the ship section therefore depends on arch action. The arch is under unsymmetrical hydrostatic loading, the lower end of the arch, nearest the keel of the vessel, being subjected to the maximum pressure, while the upper end is under less stress. Calculations of the arch were made for conditions both light and fully loaded, and with extreme valley and crest assumptions for waves. The results called for a thickness of concrete of 10 in. at the bottom end of the arch and 7 in. at the top end. The outer skin, therefore, is of a thickness showing a gradual increase from 7 to 10 in. with modifications along the buoyancy chamber, air and oil ducts, and the deck and bottom structure. In considering this thickness it must be remembered that there are no ribs, so that what would appear an excessive skin thickness in a concrete ship of standard construction must be viewed in the light of the frame omission. Furthermore, as the vessel was of frankly experimental design it was not thought wise to take chances, leaving any lightening of weight to the dictates of experience in actual service.

The bow section, 30 ft. long, and the stern section, 52 ft. long, being ship shape rather than parallel sided, were necessarily built in fixed forms, arranged for sliding apart to permit duplicating the concrete work for the next ship.

The sequence of construction was as follows:

A reinforced-concrete foundation platform 1,100 ft. long, supported on piles, was built alongside the launching slip to provide for the construction and assembling of two vessels. The program contemplated side launching.

Sliding forms were erected on raised wooden platforms for the seven parallel sections for each ship, and suspended from overhead wooden trusses so that they could be lifted entirely free of the concrete work as each section was finished.

The reinforcing steel was then placed, the longitudinal bars (at that stage of the work vertical) being held by wooden templates at top and bottom, and the transverse steel being wired to them. All steel in a section was placed before concreting started.

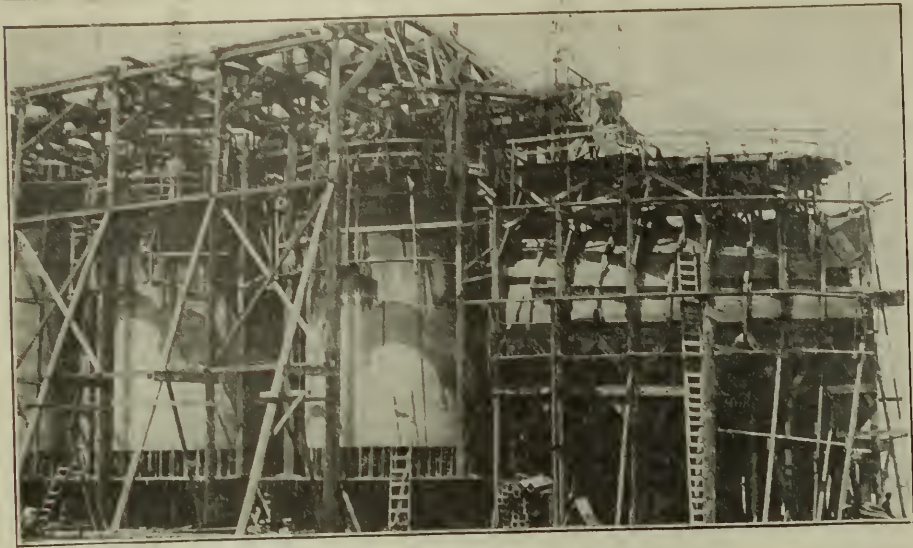
The steel of the transverse bulkhead was laid horizontally on the wooden supporting platform, the bulkhead becoming the bottom of the section in its upright position.

The concrete was then poured, the sliding form being kept going night and day until the section under way was completed.

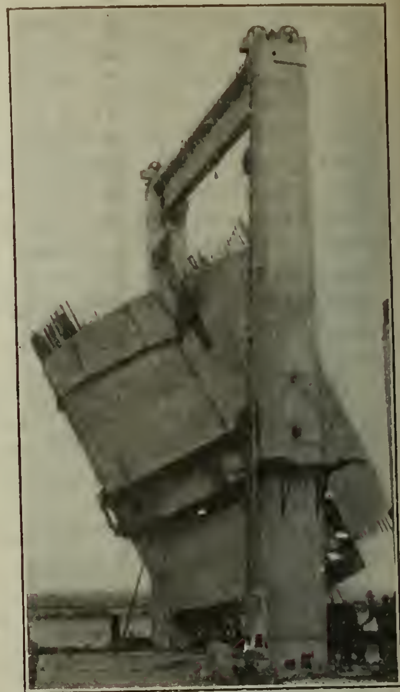
The sliding form was then raised clear of the concrete work, and the section was then ready, after allowance for proper setting of the concrete, to be turned to the horizontal position and moved into its final place in the ship.

Next the concrete section, still vertical, was lowered by jacks onto steel carriers or "creepers" operating on railroad rails set in the concrete foundation platform. The creepers consisted of rollers running between the rails and I-beam supports carrying the section, the rollers being carried upward around the rear end of the I-beams and restored to place at their forward ends as the movement progressed. The tractive force was provided by a steam-operated winch and cable.

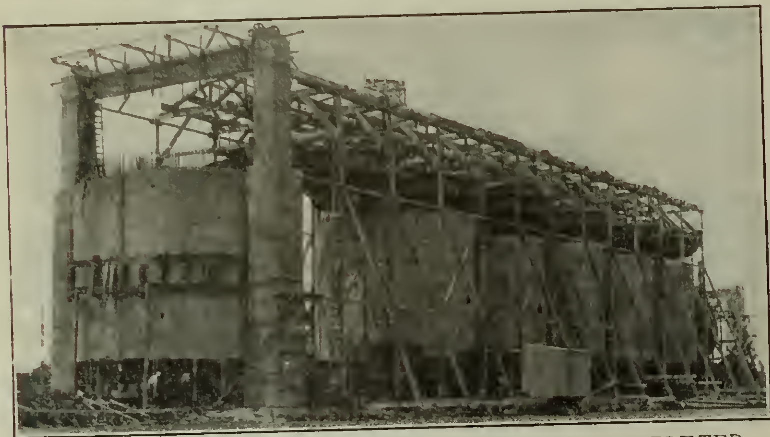
The section was moved forward into a tilting cradle, a structural steel frame carried by shafts running through concrete supporting columns. It was next turned to a horizontal position by winch and heavy tackle and placed on wooden cradles carried on the creepers mentioned above. The creepers then transported it to its final place in the ship.



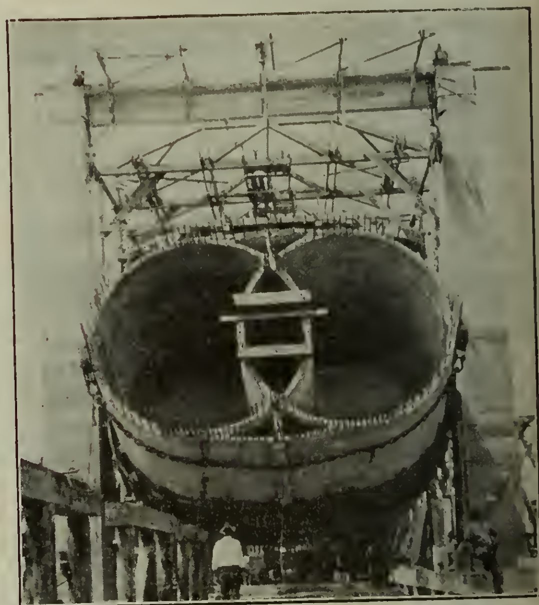
CASTING THE TYPICAL SECTIONS AND THE STERN



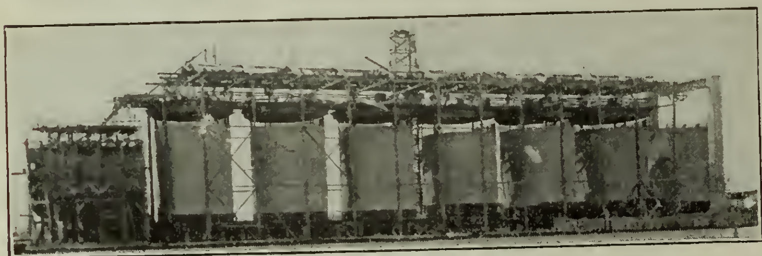
TURNING A SECTION FROM THE VERTICAL TO HORIZONTAL



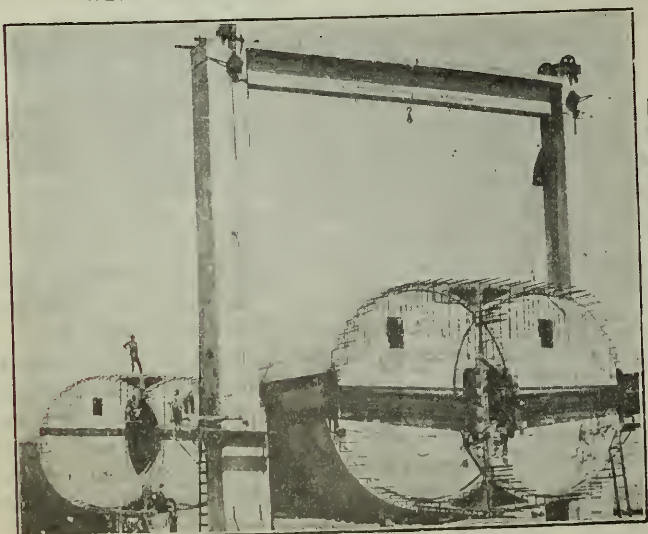
ALL BUT ONE OF THE SECTIONS PRACTICALLY COMPLETED



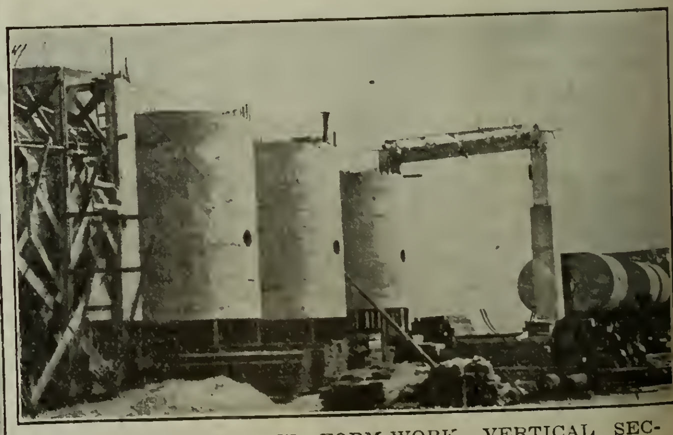
SECTION ALMOST IN HORIZONTAL POSITION



SIDE VIEW OF THE COMPLETED TYPICAL SECTIONS

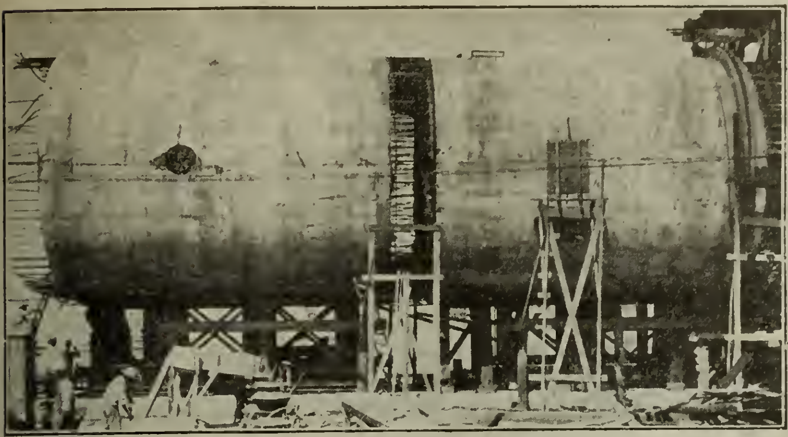


DROPPING SECTION ONTO CRADLE

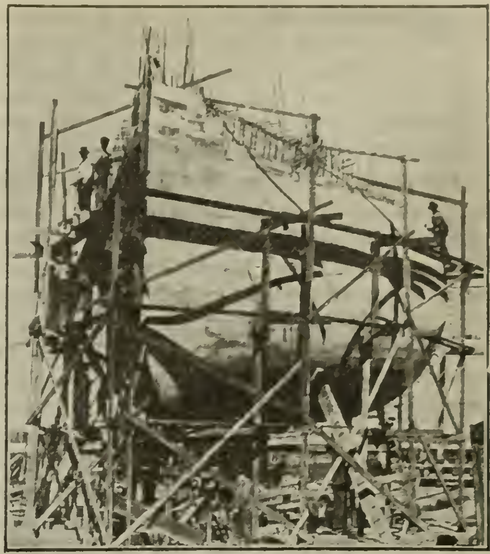


FROM LEFT TO RIGHT—FORM-WORK, VERTICAL SECTIONS, TURNING FRAME, HORIZONTAL SECTION

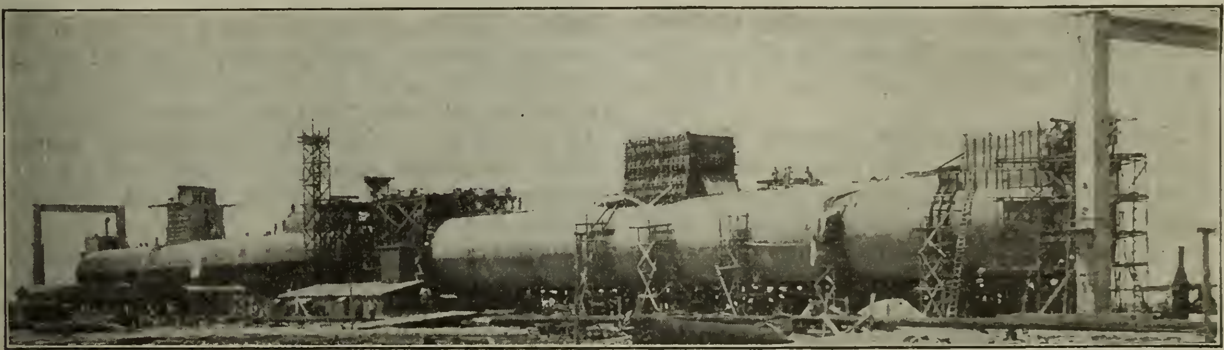
Building 2000-Ton Concrete Tanker



CLOSING TWO OF THE JOINTS

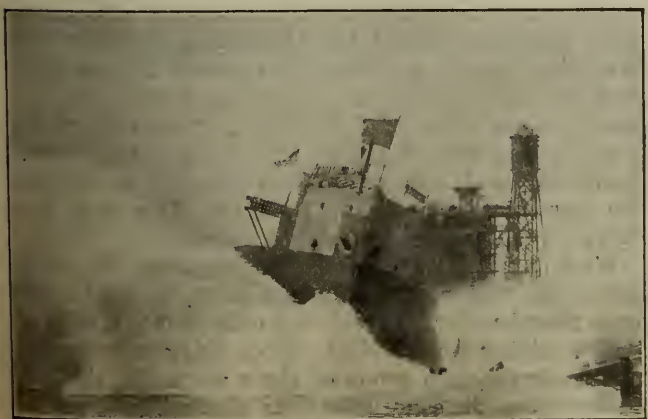


CASTING THE BOW OF THE BOAT

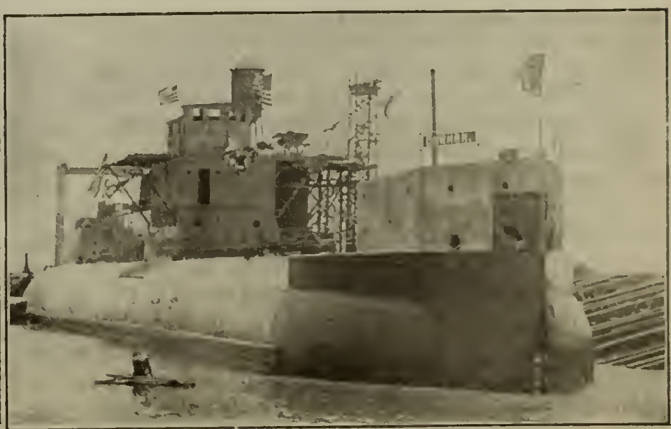


FINAL WORK ON JOINING THE HULL

COMPLETED BOAT READY FOR LAUNCHING



LAUNCHING



LAUNCHED

Each section was molded 26 ft. 10 in. long, instead of 30 ft., but the longitudinal reinforcing steel (vertical while molding) was the full 30 ft. length, projecting 3 ft. 2 in. beyond the upper end of the concrete. This reinforcing meshed with similar steel bars at the end of the adjacent section when the ship was assembled horizontally. The lap of the longitudinal reinforcing was figured of such length that, with the bond stress assumed between steel and concrete, the full allowable tension on the rod would be developed. At the same time, since owing to the method of construction it was not possible to stagger the joints at the ends of the main longitudinal reinforcing, it was thought well not to depend upon bond entirely; and each main bar was therefore clipped to the adjacent bar projecting from the next section by three S clips.

The 3 ft. 2 in. open joints were then concreted by shooting each edge of the joint with cement guns and simultaneously pouring the space between the edges. This secured a bonding between the old and the new concrete not otherwise possible, and at the same time obviated any trouble which might have occurred from sand pockets in the mass of reinforcing had the entire joint been filled by the gun. The concrete of the joint is slightly thicker toward the inside than the rest of the skin.

The sliding form leaves the concrete absolutely smooth without board marks. The concrete of the joint where poured in fixed forms necessarily displayed slight inequalities. These joints, therefore, were bush-hammered to roughen them and were then shot with a thin coat of gunite to give a smooth surface.

The stern section was built in its launching position in fixed forms and the parallel sections were then successively placed in line with it. The bow section was also built in fixed forms, but was supported on cradles and moved into location by creepers after all of the parallel sections were in place.

Hurricane Wrecks Yard

On Sept. 14, 1919, the shipyard was overwhelmed by a terrible Gulf hurricane. There was some 12 ft. of water over it, driven by a 98 mile wind. At that time all of the parallel sections of two ships had been molded, and all were standing on end on their platforms except that three sections of No. 1 hull had been turned to the horizontal and wholly or partially placed. The sternmost cargo section had been put in position and its reinforcing had been clipped to the steel bars of the stern section, which was just ready for concreting to start the next day. The form work for the stern was badly damaged and the reinforcing somewhat displaced but the cargo section next to it (called No. 7) was neither moved nor damaged. No. 6 section, which was in place on shores but had not been clipped to No. 7, was lifted bodily and dropped beyond the inshore edge of the concrete foundation slab. It was undamaged and was readily jacked back into place. No. 5 section was on the creepers and almost in place at the end of No. 6. The cradles were skewed, but the section escaped harm. The bow of No. 1 hull had been concreted; the shores below it were crippled and it dropped about 5 ft. Some skin cracks occurred, which were readily repaired with the cement gun. No other concrete work of the ships was damaged, but the partially completed stern forms of No. 2 hull were entirely carried away; and the sliding forms, with their supporting trusses, over each building way, were wrecked and had to be taken down—thus temporarily upsetting the entire program of duplication on which the plant was based.

The hurricane also carried away the entire railway conencting Harbor Island with the mainland, some seven miles distant; and partly filled channels formerly navigable. Transportation of men and supplies from that time had to be by water, under discouraging conditions; the railway is still not replaced—though it will be shortly. The hurricane opened great channels and lakes through the shipyard, carried away all lumber and buildings, buried or overturned equipment and left over all a mass of heavy crude oil from some 125,000 bbl. lost out of destroyed storage tanks in the neighborhood. In spite of the unpleasant outlook the France & Canada Oil Transport Co. decided to finish the two tankers under construction, and from last September the work has proceeded under conditions at first almost impossible, and necessarily causing great delay, but gradually improving.

The vessels will be driven by twin screws, the power being supplied by Bolinder engines of water injection type. The steam for operating the cargo pumps, anchor, windlass, steam steering gear and accessories is supplied by a 125 hp. Almy water-tube boiler. For unloading oil cargo there are for each ship a pair of 18 x 14 x 20 in. Cameron single cylinder pumps. A 5-kw. Matthews lighting set and Coen oil burning equipment for the boiler is included. Wireless is provided.

Deckhouses are of concrete; the officers' and crews' quarters are in a house amidships where the navigating direction and wheelhouse are located. Provision for a total personnel of twenty-five men is made.

Light-Weight Concrete Used

The concrete in these vessels is a mixture of one part cement, standard grinding, to one part crushed coke, ½ in. and smaller. It has an average weight, exclusive of reinforcing, of approximately 110 lb. cubic foot. Sixty-day crushing tests showed a strength of from 3,500 to 4,000 lb. per square inch. Compression stresses on concrete in bogging and sagging are under 1,000 lb. in other portions of the ship, concrete is, in a few cases, stressed as high as 1,500 lb. under momentarily excessive hydrostatic pressure.

All reinforcing is of high carbon steel, the limiting stress being placed at 16,000 lb. except in bulkheads.

Owing to the method of building these vessels it was found convenient to leave the sections at the elevation they assumed when turned to their horizontal position. At the same time the nature of the site, and other industries thereon, required the assembling platforms and launching ways to be close to the water. It was therefore decided to build the launching ways at the unusually steep slope of 3 to 12 deg. with ends of the ways leading down to the surface of the water. It was considered that this would be preferable to building the launching ways with a flatter slope and then dropping the ship vertically into the water.

When preparing for the launching, the weight of the vessel was wedged onto 10 sand jacks, most of which were placed under her keel, and onto timber cradles on the 27 sliding ways. Nine timber triggers were provided, one for each group of three ways. At the time of launching, the sand jacks were released, bringing the entire weight onto the 27 sliding ways. With the release

of the triggers, the movement of the ship into the water, owing to the steep slope of the ways, occupied but a flash of time.

The launching was carried out with entire success and the vessel was found to draw almost exactly the calculated amount of water. When launched her draft amidships was 9 ft. 6 in. which will be increased to 10 ft. 9 in. with all machinery, water, bunker oil and stores on board. The full load draft will be 18 ft.

Space for water is provided in forward and after peak tanks and in a cross section of the double cylindrical hull, 8 ft. 6 in. long, immediately forward of the stern or machinery portion. Ahead of the double feed water tank just mentioned, a section of the double cylindrical hull 6 ft. long is bulkheaded off for bunker oil tanks.

Unfortunately, the hurricane of September, 1919, carried away the detailed cost records of the work up to that time. Even had they not been, it would be exceedingly difficult to arrive at dependable conclusions as to what the vessels would have cost had the later construction been carried on under nurmal conditions, instead of those following the hurricane. The indications are that reinforced-concrete tankers of this type and constructed in the manner shown can be built for very considerably less than steel tankers. Their action in service will, therefore, be watchd with unusual interest.

The first vessel was christened the "R. P. Durham," in honor of the vice-president of the Macdonald Engineering Co., who originated the general features of the design. The method of construction was worked out by James Macdonald, president of the company, and Mr. Durham. Both the type of ship and manner of construction are covered by patents. The consulting naval architect for the France & Canada Oil Transport Co., for decision of matters of marine concern, was Theodore D. Wells of New York City. At the shipyards, George R. Brooks was consulting engineer for the owners during the greater portion of the period of construction, their interests latterly being in the hands of George P. Darlington. Special credit is due L. H. Stanley, superintendent of construction for the Macdonald Engineering Co., throughout the work, for his loyalty to the operations and efficient handling of it under the unheard of conditions subsequent to the hurricane.

Strength of Aged Cement

Because of cement shortage in the District of Columbia the Corps of Engineers has proposed to use some cement which had been in storage about eighteen months. In order to determine the proper strength assumptions for concrete made of such cement the Bureau of Standards made a number of tests on it. The cement as received was first put through a sieving process to remove the lumps. The cement after sieving, as well as the crushed lumps, were then made into separate concretes which were compared with concrete made from cement recently purchased in the local market. It was found that a 1:1¼:2½ mix of the old cement would give approximately the same strength as a 1:2:4 mix of fresh cement, and it was recommended that the lumps be sieved out of the old cement before using. Similar tests were conducted on aged cements submitted by the U. S. Engineer Office at Vicksburg, Miss. The results indicated that a 1:2¼:4½ mix of the aged cements gave approximately the same strength as a 1:3:6 mix of fresh cement.

Repeated-Stress Safety Factors Quickly Determined

Table of Factors Based on Unit Stress and on Repetitions—Goodman's Diagram and Recent Test Data Used

BY J. B. KOMMERS

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IN *Engineering News-Record* for Nov. 27-Dec. 4, 1919, the writer discussed the subject "A Broader Use of Johnson's Formula for Repeated Stresses," making use of Johnson's, or Goodman's, diagram, and also of the exponential formula which connects unit stress and cycles which cause failure in repeated-stress tests. Based on the assumption that a decrease cf 9 per cent in unit stress doubles the cycles for rupture, it was shown that a very simple relation exists between the factor of safety f based on unit stress and the factor of safety f_1 based on number of cycles for rupture, as follows:

$$0.136 \log f_1 = \log. f \qquad (1)$$

In using this formula it is assumed that the unit stresses obtained from Goodman's diagram would cause failure after 5,000,000 cycles of stress, and the factor of safety f is used in connection with stresses obtained from Goodman's diagram.

There is a certain type of problem, not mentioned in the previous article, which should be explained in connection with the above formula. Suppose a material has an ultimate strength of 150,000 lb. per sq. in., and an elastic limit of 100,000 lb. per sq.in.; what number of cycles of stress would this material be likely to withstand before rupture for various values of minimum and maximum stress? Specifically, four sets of stresses may be investigated:

$$\begin{aligned} -25{,}000 &\text{ to } +25{,}000 \\ 0 &\text{ to } +50{,}000 \\ +25{,}000 &\text{ to } +75{,}000 \\ +50{,}000 &\text{ to } +100{,}000 \end{aligned}$$

It will be noticed that these values are all within the elastic limit, as they should be, and that they also all have the same total range of stress, namely, 50,000 lb. per sq.in. This choice has been made to bring out the fact that according to Goodman's diagram the range of stress alone does not determine the number of cycles that can be withstood before rupture.

Applying to these four cases J. B. Johnson's fundamental formula,

$$S'_1 = \frac{\frac{1}{2} S_u}{1 - \frac{1}{2}\frac{S'_2}{S'_1}} \qquad (2)$$

in which

S'_1 = maximum unit stress as taken from Goodman's diagram,

S'_2 = minimum unit stress as taken from Goodman's diagram,

$S\hat{u}$ = static ultimate strength of the material, the following results are obtained:

Case 1, $\frac{S'}{S'_1} = -1$ and $\frac{1}{2} S_u = 75{,}000$, therefore $S'_1 =$ 50,000 lb. per sq.in. This means that the material could withstand ± 50,000 lb. per sq.in. for about 5,000,000 times before failure. But the stress to be applied is only ± 25,000 lb. per sq.in., therefore $f = 2$.

From formula (1), $f_1 = 164$, and therefore $N = 5{,}000{,}000 \times 164 = 820{,}000{,}000$.

Case 2, $\frac{S'_2}{S'_1} = O$ and $\frac{1}{2} S_u = 75{,}000$, therefore $S'_1 = 75{,}000$ lb. per in. But the material is to withstand only 50,000 lb. per sq.in. so that $f = 1.5$. From formula (1), $f_1 = 19.7$, and therefore $N = 98{,}500{,}000$. In a similar manner the third case gives $N = 9{,}100{,}000$, and the fourth case gives $N = 5{,}000{,}000$.

TABLE I—VALUES OF f AND CORRESPONDING VALUES OF f_1.

f	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90
f_1	1.00	2.02	3.82	6.87	11.9	19.7	31.8	49.5	75.3	112
f	2.00	2.10	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90
f_1	164	234	331	457	624	851	1120	1480	1950	2510
f	3.00	3.10	3.20	3.30	3.40	3.50	3.60	3.70	3.80	3.90
f_1	3,240	4,070	5,190	6,610	7,940	10,200	12,000	15,100	18,600	21,900

For use in problems of this kind table I, appended, gives values of f and the corresponding values of f_1, thus making it unnecessary to calculate f_1 from the formula.

Highway Department Organization and Administration

Centralized Control of Personnel, Finance and Operations Are Essential Principles, Says Pennsylvania Executive

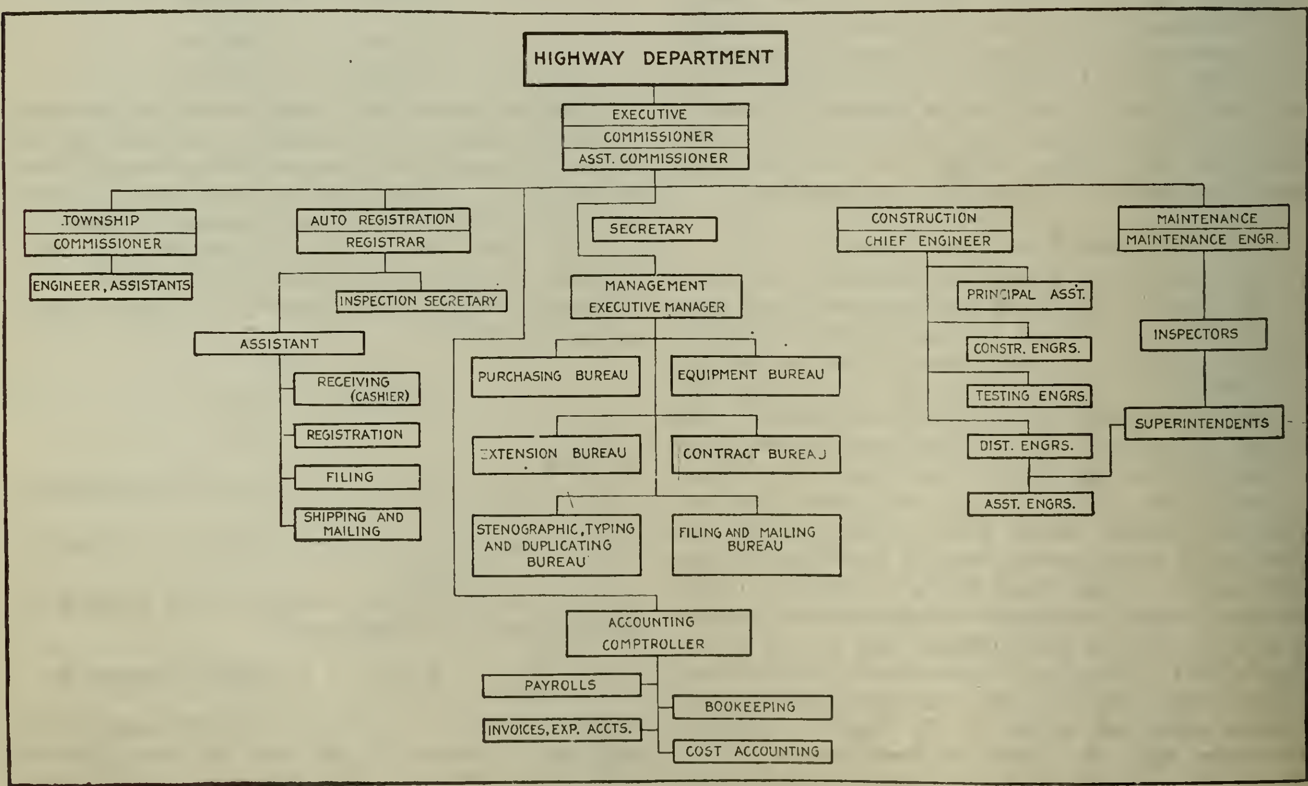
George H. Biles, assistant state highway commissioner of Pennsylvania, believes that, in view of the immense responsibility placed upon highway commissions in the expenditure of millions of dollars of the people's money, they should "plan for the greatest good to the greatest number, eradicate divisional or sectional lines of work on a broad, comprehensive scale." The following paragraphs embody Mr. Biles's views on the proper constitution of a highway commission:

One of the basic principles in the creation of an organization is to obtain zealous and efficient men who are responsive at all times to the demands of the situation and who will work as a team for the realization of the aims and purposes of the executive. Some encouragement in the form of recognition for meritorious service must be given such men. This is possible only when salaries are not fixed by statute, for when an employee is engaged he should be given a fair compensation and an incentive to put forth his best efforts to merit advancement. There should be but few statutory positions carrying fixed salaries, save the executive officials. Men, under much stress, either go up or out, they cannot stop or grow stale.

Where Authority Should Rest

In developing an organization, combining technical and business functions for work on large scale, such as a state highway department, it is our theory that statutes should be passed empowering the state organization to supervise expenditures and operations, and extend engineering and advisory assistance to the counties, townships or towns. The highly trained engineering force and the organization of the state should be at the disposal of the county to avoid abortions, which are bound to result where innumerable engineers, with as many different ideas, are permitted to operate promiscuously. If there is one thing that will jeopardize the consummation of a road program, it is poor work, which may result from bad engineering or careless inspection. Work should be done under standard specifications and competent inspection. The inspector of a contract is the most important individual on the work, for upon him depends the success or failure of carrying out the engineer's plan. The inspection force should be composed of fair-minded, intelligent and practical men, who hold allegiance to no one save their superiors. These men should be paid a wage commensurate with the importance of the work. It has been our experience that where communities appropriate large sums of money or issue bonds, they welcome the co-operation of the state, as it creates a sense of security on their part, and in good roads campaigns throughout the state this protection has been the biggest contributing factor to their success.

It is through such co-operation that the comprehensive idea of state systems of main primary roads can be extended to the counties on secondary systems or roads of local importance, which tie into the main system, with the ultimate



satisfaction of seeing roads built, not for any selfish interest, but to meet the demands of traffic, starting somewhere and ending nowhere, and creating a network of uniformly good highways. Build roads that with reasonable maintenance will be there at the maturity of your bonds, build for the future, capitalizing high maintenance cost and putting this into the roads.

Organization and System

In the administration of highway work on the scale that most of our states are launching at this time, the great single requirement is organization and system. We all have been zealous to the extreme in advocating large appropriations for highway work and money has been thrust upon us with a free hand and now we are bid to perform. Let us first appreciate the wisdom of that truism, "Preparedness is half the battle," and study our problem. Think of it in terms of its similarity to the large industrial organizations where modern business principles predominate and we will realize the magnitude of our task. If we stop and think of the working unit involved in the disbursement of $1,000,000 for this class of work and multiply this by forty, or fifty, or more, as some of us must do, it will be apparent at once that it becomes an undertaking for big business organization and management. There is infinitely more to it than the assembling of large numbers of engineering corps and draftsmen for the preparation of surveys and plans, for this, in a measure, is but incidental, as a contractor who had encountered almost insurmountable difficulties once said to us, "Building roads on paper is not putting them on the ground." There should be a blending of business and technical thought as the basis of action.

In the first analysis the duties of the several units of the organization should be grouped on a functional basis, the segregation of the special or distinct functions automatically creating the several separate divisions. Authority should be centralized in the executive head between whom and the several operating divisions there should be a coordinating branch or body, known as the management division in charge of an executive manager.

The accompanying chart is a graphic representation of Mr. Biles's conception of highway organization.

Estimated British Railway Deficit

The British Ministry of Transport announces that there is an apparent deficit of £54,500,000 likely to accrue to the Exchequer from the state control of railways in Great Britain and Ireland during the current fiscal year ending March 31, 1921, says a recent issue of *Commerce Reports*. The Minister of Transport has accordingly requested the Railway Rates Advisory Committee to suggest increases in the tariffs for various railway services which will wipe out the deficiency by the close of the following June. The last increase in rates was ordered in the latter part of December, 1919.

The Ministry announces that the following is a statement of the per annum increase for the principal items of increased expenditure since last October, when the question of rates revision was referred to the Railway Rates Advisory Committee:

Increased cost of materials	£12,000,000
Increased cost of coal	3,500,000
Increases to shopmen, 11s	4,000,000
Increases to conciliation grades, 5s	4,500,000
Increases to enginemen, 3s; Increases to conciliation grades, 1s	2,000,000
Findings National Wages Board	7,000,000
Increases under sliding scale consequent upon rise in cost of living and other concessions, April 12 to July 1	6,800,000
Hire of rolling stock	750,000
Rates, taxes, and compensation	3,200,000
Total	£43,750,000

Adoption of Standard Practice in Railway Work

AUTHORITY as to safe and economical construction and maintenance of American railways is represented by the "recommended practice" of the American Railway Engineering Association, and a more general adoption of these recommendations is likely to result under the present transportation act. This statement summarizes the opening part of a paper in the Association's bulletin for July (No. 227) by C. A. Morse, chief engineer of the Chicago, Rock Island & Pacific R.R. The major part of this article is given below:

With the passage of the Esch-Cummins transportation act, the Interstate Commerce Commission is instructed to make such rates as will, in addition to paying operating and maintenance expense and a proper depreciation, return a certain rate of interest on the investment in the railroads as a whole or in certain groups. In order to be fair to all railroads and to the patrons of the railroads, there should be a classification of the different roads and different sections of the same road, based upon density of traffic, weight of locomotives and frequency and speed of passenger trains. There should be a specification covering construction and maintenance of each class of road, so that the money expended by the different roads will be fairly uniform. No records or recommendations that will permit of this action are based on such general study and careful consideration as those of the American Railway Engineering Association, and it is fair to presume that its recommended practice will be adopted.

There is a strong probability that a stop will be put to the present practice whereby over 50 different sections of rail are rolled between the weights of 70 and 140 lb. per yard, when seven sections will answer all the purposes and are all that are recommended by this Association. A set of rail rolls costs about $5,000 and a rolling mill has to carry an investment of $250,000 for rolls to roll 50 sections, when they would have to carry an investment of but $35,000 to be prepared to roll seven sections. The railroads, and through them the public, have to pay the interest on this additional $215,000 invested by each mill in surplus rail rolls. But the public is not going to continue to pay increased railroad rates to meet the whims of individual railroads.

The same thing applies to rail joints. One of the practices that has the least reason for existence and which costs an immense amount of money per year is that of the variation in punching or drilling bolt holes in rails. There is absolutely no reason why all rails of the same sections should not be drilled with the same spacing. With this standardized, all joints for that section of rail would be drilled alike. Frogs and switches should be the same for the same class of railroads, thus doing away with the innumerable patterns that manufacturers have to carry, and permitting the manufacture of frogs and switches for stock instead of having to make them to order, as is the present practice.

There should be uniformity in width of roadbed, width of cuts at subgrade, depth of ballast, amount of shoulder for ballast of different kinds; also in the use of treated track, bridge and switch ties, and the use of tie-plates. Many roads which have recognized the economy of treated ties and tie-plates have not used them on account of immediate expense.

The new conditions are going to call for the practice that is the most economical in the long run, as the public will have to pay the bills in rates and is entitled to have these rates as low as the best and most economical practice will permit. It is to be hoped that the reorganized American Railroad Association will be used by the Interstate Commerce Commission as the medium through which uniformity of practice can best be secured and that it will be given mandatory powers necessary to enable it to secure these results.

French Government To Regulate River Rhone

Proposed $300,000,000 Project Will Develop Water Power, Improve Navigation and Provide Water for Irrigation

By Thorndike Saville
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PROBABLY the most important and gigantic engineering work now being planned in France is the development of the Rhone River from Lake Geneva (Lac Leman) at Geneva to the sea. The proposed development is to be in the threefold interest of water power, navigation and irrigation. Studies have now been completed and the results presented to Parliament, which is shortly expected to authorize the undertaking. While a complete description of the project is not feasible at present, an outline of the salient points of the proposed development should be of interest to American engineers.

The Rhone, after it leaves Lake Geneva (Fig. 1), flows for some 16 miles to the Swiss frontier through a soft alluvium, descending 131 ft. Then commences the French portion which may be divided into several sections. The first is through the Jura to Chateau du Park, a length of 18 miles and fall of 236 ft. The second section is from Chateau du Park to the confluence of the Saone and Rhone below Lyons. This section is less torrential than the first, and at times navigable for small flat-bottomed boats. It has a length of 38 miles and fall of 335 ft. These first two sections of the river are comprised in the area known as the Upper Rhone (Haut-Rhone) and are to be developed the first.

The section from Lyons to the sea is known as the Lower Rhone (Bas-Rhone). From the confluence with the Saone to the confluence with the Isere there are 64 miles with fall of 170 ft.; from the Isere to the Ardeche, 55 miles with a fall of 223 ft.; from the Ardeche to the Gardon, 43.5 miles with a fall of 112 ft.; from the Gardon to Arles, 14 miles with a fall of 26 ft.; from Arles to the sea, 30 miles with fall of 24 ft. On a total length of about 530 km. (329.3 miles) from Geneva to the sea there is a total fall of 372 m. (1,220 ft.). The Upper Rhone is practically non-navigable, and is essentially a torrential stream. Below Lyons the river is full of rapids but has been rendered navigable by certain regulatory works mentioned below. The present plan calls for the immediate development of the water powers of the section above Lyons. These will be readily utilized at a minimum of expense, and the revenues and power derived from them will be of aid in constructing the remaining works. Briefly, the plan contemplates: (1) Rendering the river entirely navigable by the construction of canalized passes (*derivations*) around the most objectionable rapids; (2) the development of power at the dams placed at the heads of these passes; (3) the use of some of the water for irrigation, which will be pumped by some of the electric power developed. The location of the passes, dams, and power plants are shown in Fig. 1.

This somewhat idealistic scheme for the three-fold utilization of the Rhone is of recent origin and represents an entirely new point of view. As late as 1911 the feeling was very strong that the development of the river for navigation was the concern of the state, while that for hydraulic power was essentially for private interests. The development for agriculture was always subsidiary to the preceding. Since the war, however, with the destruction of the coal mines in the north of France and the immediate need of intensive agricultural development, opinion has entirely changed and now all interests are at one in unanimous desire for the triple development. It is believed that the total undertaking will cost in the neighborhood of 1,530 millions of francs ($295,290,000), of which 1,320 millions is for development of electrical energy and 210 millions for accessory works (passes, etc.) to render the stream

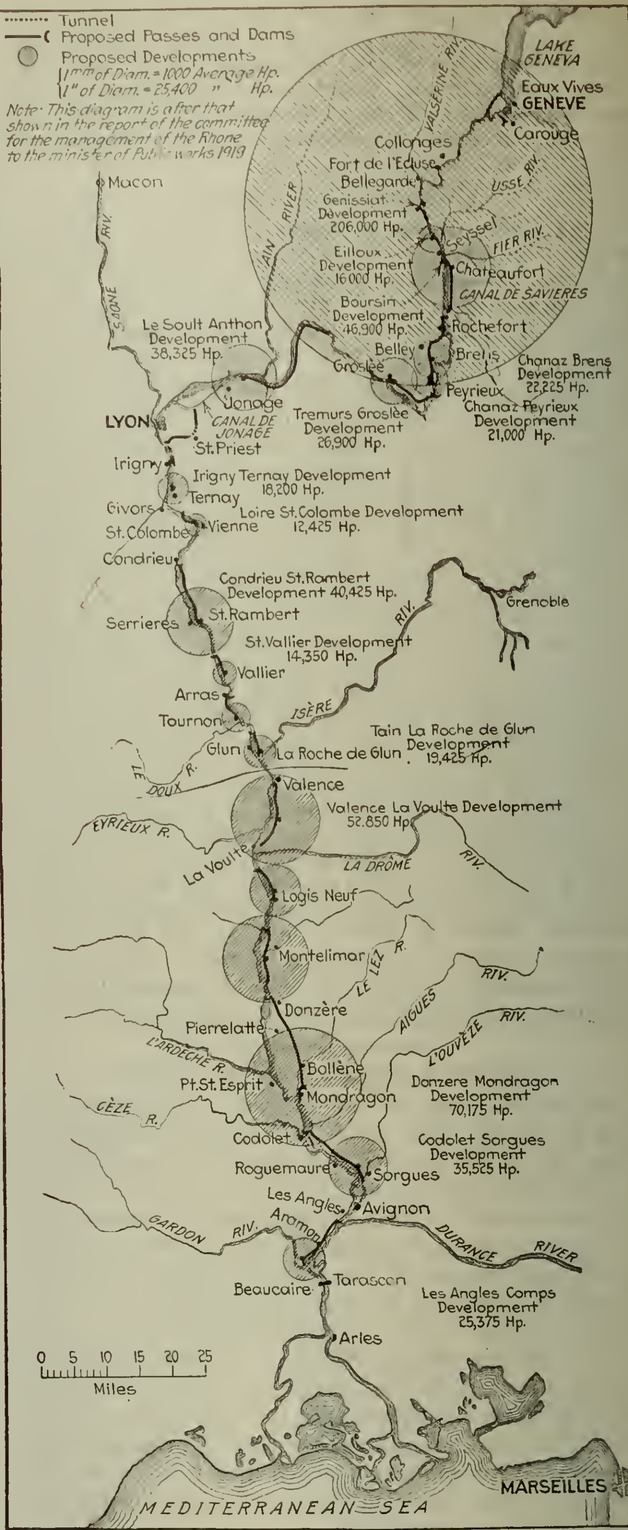


FIG. 1. MAP OF RHONE RIVER SHOWING PROPOSED REGULATORY WORKS

navigable. It was originally conceived that the state should contribute the latter sum only, but in view of the natural benefit arising from the power development and the attendant agricultural advantages, it is now suggested that the state contribute 610 millions of francs or about 40 per cent of the total cost.

The project, which has been favorably reported to Parliament, is due to M. L. Armand, chief engineer in the Ponts et Chaussees, charged with the regulation of the Saone and Rhone.

The plant for the Upper Rhone between Lyons and Geneva, comprises passes of various lengths fed from movable dams operated either by Stoney valves or by wickets as on the Seine. The passes will have a section of 3,445 sq.ft. which will provide for a maximum discharge of 12,350 cu.ft. per sec. The velocity will vary from 1.15 ft. per sec. to 3.61 ft. per sec. (2.46 miles per hr.). The depth of the passes will be 16.4 ft., and the width will be 295 ft. at a point 1 ft. above the water surface, except in certain stretches of difficult excavation where it will be reduced to 164 ft. All curves, with one exception, will have a radius of at least 3,280 ft. (1,000 m.). The locks were originally planned to be 263 ft. in length by 39.5 ft. in width, but these dimensions will doubtless be enlarged, as noted hereafter, to a greater length and 65.6 ft. of width.

The proposed constructions on the Upper Rhone are planned to accommodate barges of 1,000 tons capacity.

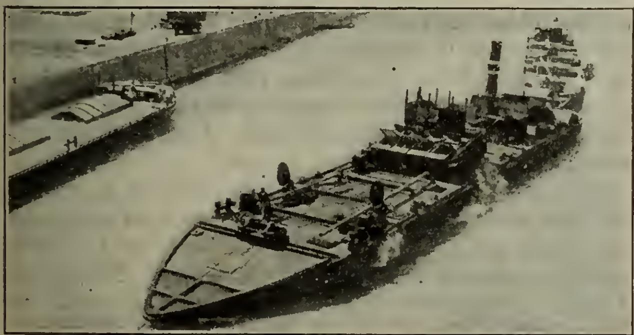


FIG. 2. TOW BOAT ON RHONE PULLING ITSELF UP-STREAM BY CABLE AND WINCH

The standard canal boat in use nearly everywhere in France is of 300 tons (the French or metric ton = 1,000 kilograms, = 1.12 tons of 2,000 lbs.) capacity, 38.5 m. long, 5 m. wide, and draws 1.75 m. (126 x 16.4 ft. by 5.74 ft. draft). On the rivers and larger canals there are 600-ton barges, 210 ft. long, 26 ft. wide and drawing 6 ft. The latter are essentially the dimensions of the barges now in use on the Lower Rhone, dimensions which cannot be exceeded on account of the difficulties of navigation on the river during low water. The greater economy in the use of 1,000-ton barges is obvious, and the canalized river above Lyons can readily be made to accommodate them. It is believed also that by maintaining dredges below Lyons the river may be made navigable for these barges during ten months of the year, until the

FIG. 3. TRAINING WALLS AND GROINS ON RHONE

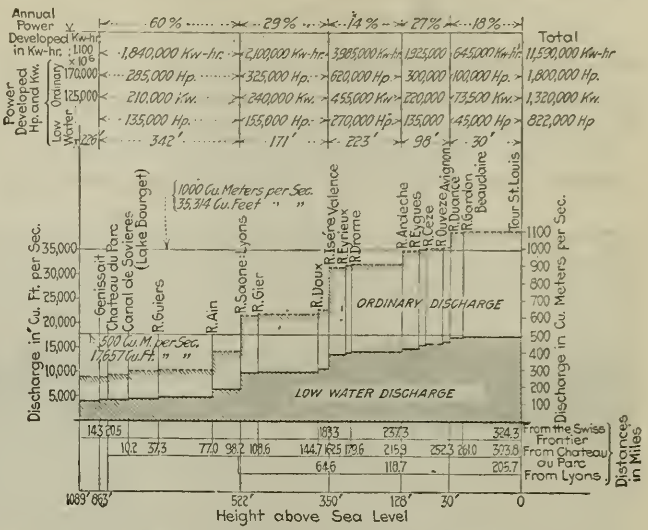


FIG. 5. WORKING PROFILE ON RHONE RIVER

canalization of the lower Rhone is completed. Barges of this size are already in use in portions of the canal from Marseilles to Arles.

These new and large boats will be handled by electric towing apparatus, thus cutting down the expense of the powerful tow boats now used. A typical example, showing the cable by which the boat pulls itself up stream is indicated in Fig. 2, and illustrates the difficulties of navigation as practiced at present.

There is planned also a great terminal port just below Lyons, 2 km. below the confluence of the Rhone and Saone. This port will be connected with the main navigable channel by a lateral canal from the Jonage Canal. The cost of the port, which will be used for storage and transportation, will be 30,000,000 francs ($5,790,000).

The project below Lyons to Arles is essentially the same as for the Upper Rhone. The problem here is somewhat simpler by the fact that the river has already been extensively controlled by regulatory works for the purpose of rendering it navigable. These works consist of dikes parallel to the stream, confining it and causing it to deepen its channel. The dikes are frequently connected with the shore by groins perpendicular to the channel which serve to entrain gravel and build a natural bank. Dikes and groins are constructed of stone. Typical examples are shown in Figs. 3 and 4. These works were begun in 1878 and have been prosecuted ever since with considerable success. The minimum depth in the channel before undertaking the regulatory

works was 0.40 m. (1.31 ft.). Today it is 1.35 m. (4.43 ft.). Before the improvements the annual suspension of traffic on account of low water averaged 70 days per year. At present on not more than five days per year is traffic suspended on this account.

The passes will in all cases be formed by locks at either end and will be fed from the river, which will be dammed at the upper end. At several of these points (shown in Fig. 1) where the fall is considerable, hydroelectric developments will be made. As noted before, those of the Upper Rhone will be developed first as least expensive to construct per unit of power developed. At other points the dams will be larger and have for their principal use the feeding of the passes. The profile of the route showing the falls to be developed is shown in Fig. 5. There is to be developed a total mean annual output of 750,000 hp. The estimated power development on the river is shown in the accompanying table. It is planned to give concessions for this power to last 75 years. The first development on the Upper Rhone would then be financed as follows:

"The capital of 360 millions (francs) is increased above the value at issue by surplus earnings above interest charges and will have a final value of 380 millions at retirement. Of this, 300 millions will be realized by selling bonds at 6 per cent, and 80 millions by stock at 8 per cent. This assumed, in the first ten years of the development it is expected that only 33 per cent of the energy produced can be utilized, and that 75 per cent of the energy will be utilized during a second period of forty years. During this latter period amortization of the bonds will be made, and all (the power) will be utilized at the end of this period. Then during a third period of twenty-five years, amortization of the stock will be made.

"Under these conditions, if during the first period of ten years it is possible to sell 300 million kw-hr. at 0.05 fr. (96c.) and 330 million kw.-hr. at 0.03 fr. (58c.) there will be, after payment of interest on stock and bonds, an income of 1,000,000 fr. ($193,000) during each of the first ten years. During the second period of forty years, in the course of which the bonds would be retired, it will be sufficient to sell 800 million kw.-hr. at 0.04 ft. (78c.) and 550 million kw.-hr. 0.015 fr. (29c.) for the annual net income to be two million francs ($386,000). During the third period of twenty-five years, in the course of which the stock will be retired, it would be sufficient to sell 1,000 million kw.-hr. at 0.03 fr. (0.58c.) and 800 million kw.-hr. at 0.01 ft. (19c.) to give a net annual income of twenty-one million francs ($4,050,000). At the expiration of the concession it should be possible to sell 1,000 million kw.-hr. at 0.02 fr. (0.39c.) and 800 million kw.-hr. at 0.01 fr. (19c.), and there would be an annual income of sixteen millions francs ($3,086,000)."

The development of the Lower Rhone, financed in a similar fashion, is estimated to cost 750 million francs. These figures and the quotations above, are taken from

FIG. 4. STONE TRAINING WALLS ON RIGHT. GROINS ON LEFT

a report by a government committee constituted in August, 1918, to investigate and submit recommendations to Parliament. The engineering scheme adopted is that of M. Armand, and the financial scheme is that of M. de la Brosse, inspector general of Ponts et Chaussees. The data has been given here as of interest in illustrating the method which the French government proposes to use in financing a project estimated to cost some $300,000,000. The entire plan is most ambitious, but seems to have been carefully worked out, and no doubt will be undertaken in part at least when construction activities return to normal.

The agricultural developments to be made in connection with what has been described above have been made the object of a very exhaustive study by M. Trote, chief engineer in the Ponts et Chaussees. The details of this co-operation cannot be formulated until the hydro-electric plants are in operation. It is believed that these will be able to furnish the moderate amount of power necessary for pumping water to the agricultural districts at a very low rate per kw.-hr. Also, this cheap power will be used in electric haulage on the river passes.

An interesting corrollary of the general regulation of the Rhone is the proposed raising of the level of Lake Geneva. This lake is the great regulatory of the Rhone, and its level is carefully controlled by international agreement so that it does not vary more than 60 cm. (2.36 in.) in a year. The raising of this level by 10 cm. would suffice to increase the discharge of the Rhone by 10 cubic meters per second (353 sec.ft.) for 67 days, and negotiations are now under way with this object in view.

The writer is indebted to the kindness of Georges

TABLE SHOWING PROPOSED POWER DEVELOPMENT ON THE RHONE RIVER—HORSEPOWER

	Mean Low 3 Months	Water-Mean 6 Months	Water-Mean High Water 3 Months
1. Falls of Genissait (Upper-Rhone)....	107,000	206,000	260,000
2. Falls, Chateau du Parc to Jonage....	134,500	190,500	171,300
3. Falls below Lyon..................	427,500	387,600	335,100
Totals..........................	669,000	784,100	766,400

Bechmann, consulting engineer, of Paris, and to L. Armand, of the Ponts et Chaussees at Lyons for information and data relating to the above project, and for permission to visit the regulatory works which have already been constructed.

The assumption is made in the table that there is a constant discharge of 1,240 sec.ft. maintained in the passes, and that the variation in power is due to variation in effective head. It is interesting to note that in the torrential unimproved river above Lyon the power developed increases in general with the increase of flow

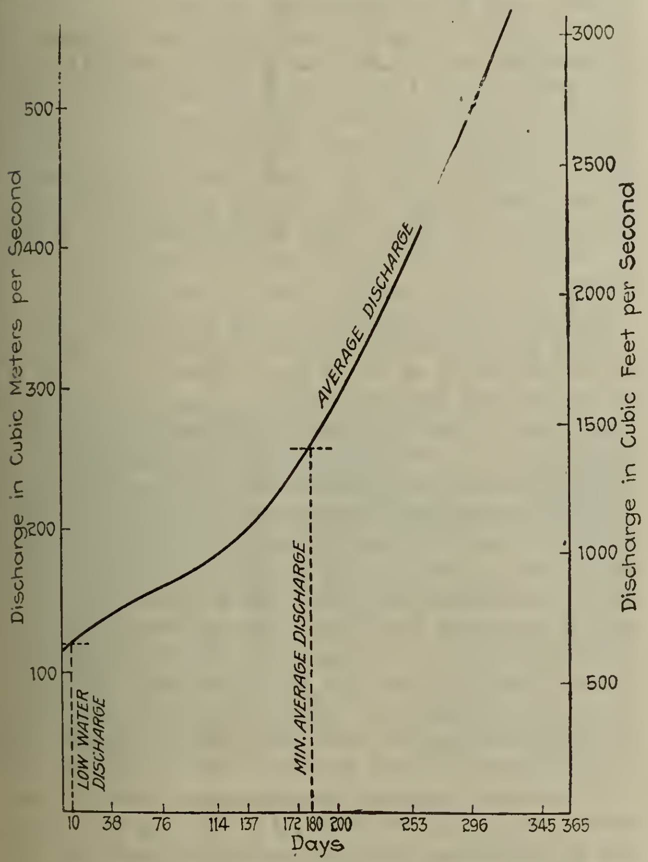


FIG. 6. HYDROGRAPH OF THE RHONE RIVER

in the river. Below Lyon, in the improved portion of the river, in which section the chief tributaries enter, the power developed varies inversely with the discharge of the river.

$40,000,000 for Canadian Roads

Plans providing for the expenditure of $40,000,000 to improve the highways of Ontario and Quebec have been approved by the Canadian government under the operation of the Federal Highways Act. The total outlay contemplated in Ontario is $22,200,000, of which the Dominion government will contribute $5,800,000, the Province $12,000,000, and the municipalities $4,400,000. The principal item is the highway from Windsor to the Quebec boundary. The projected outlay of Quebec is $17,390,000, of which the Dominion will contribute $5,000,000, the Province and municipalities furnishing the balance. In Quebec three standard highways including the King Edward highway from Montreal to Rouses' Point, the Quebec and Montreal North Shore road, and the road from Sevis to Jackman, Maine, are already finished or practically so, and conform in every respect to the standard prescribed by the act.

Tile Drainage a Factor in the Control of Rivers

Will Not the Subsurface Percolation Which Follows Drainage Result in Storage and Better Distribution of Runoff?

By Hyatt L. Frost
McKee, Frost and Smith, Connersville, Ind.

WHAT can we accomplish toward getting materially more of our annual precipitation into the lower subsoil stratum? A practicably constructive solution of this problem means much to most of our humid climate sections. Will systematic tile drainage in these regions of heavy rainfalls put more acre inches of water into the lower subsoil, that is, into the stratum below tile line? An affirmative answer to this question furnishes the major premise for the final conclusion reached in this article.

All the writers on soil physics and allied subject agree that underdrainage is the most, or quite an, effective means of preventing soil erosion, because such drainage—not merely of wet soils, but of all the heavy clays—opens up the subsoil. This is largely brought about by deepened root growth and their resultant decay whereby additional millions of small and many large perpendicular drainage channels are formed in every acre. These channels increase in a progressive ratio as the system grows older. The result of ten or more years of such drainage is a new zone of honeycombed subsoil.

The introduction in comparatively recent years in American agriculture of the deeper rooting plants, particularly some of the tap rooted clovers, is quite materially helping in this direction. That this deeper rooting is many times intensified by tile drainage there can be no doubt. Underdrainage not only quickly and early in the season better dries out the top soil, but rapidly lowers the top line of the upper subsoil water zone. It is a law of plant growth that where moisture is wanting in the top soil, more roots early in life set deeper for their moisture supply. Underdrainage drying out top soils and opening up subsoils inevitably must induce deeper rooting. On my own systems of underdrainage, erosion has materially decreased by reason thereof, and I am sure there is better drouth resistance. Not only have I observed decreased erosion, but decreased outlet flowage from year to year after three to five years' installation of the systems. In short, the older the system becomes the less it works—at its outlet. Observing drainage farmers note the same phenomena.

This has led to further investigations and deductions. I found that old timber-ditched and stone-drained tracts continued to care for the precipitation long after these drains had ceased to work at the outlets, and in some cases as effectually as before. I drained, in 1900, a tract that many springs for thirty years before, had become a bog till near May. This system had a very precarious outlet and I cared for it for five or six years but later owners allowed the outlet to become completely sealed. Still this tract took care of the March, 1913, flood of 9½ in. of rainfall and was ready for gardening in about three weeks, when before March rains of 3 and 4 in. rendered it wholly unfit for from four to six weeks. This tract is now built on and basements are not flooded as was the case near its upper end prior to

the drainage. The only conclusion, after eliminating all possible doubt-creating factors, is that the subsoil was effectually and permanently opened up by a few years of underdrainage.

On theory alone we would logically conclude that if even but for a few hours there shall hang over a lower subsoil a zone of thoroughly saturated upper subsoil, gravitation would put more water below in large part to reach some subterranean reservoir. In short, when we find that a heavy zone of water gravitates through the top soil into the upper subsoil, independent of any augmenting factor such as increased root channels, logically we must conclude that more would get into the lower 3 to 5 ft. zone.

Of course, *first* impression would be that this augmented water supply in the upper subsoil would finally all gravitate transversely into the tile and thence be discharged at the outlet but when we actually find such is not the case, we are forced to the conclusion that the discharge shortage gets below the tile line.

Tile Drainage of Farm Land

Tile drainage is developing wonderfully in Indiana and Ohio on the high, so-called dry, but heavy and even-rolling clays. All agree that the crops on these drained lands stand the drouths better. I have been thoroughly convinced of this by observations on my own systems. It can be accounted for in part by reason of the deepened root-feeding zone, but when we find in a real drouth the soil is almost as dry as powder above the tile line, we then only can account for this successful drouth resistance by reason of an augmented moisture supply below the tile line. These premises alone would seem sufficient to justify the conclusion that there is thus created a zone of increased moisture supply below tile line.

Let us consider the well recognized effect of this decreased run-off on river-control in the way of flood prevention. Even should the soak-in merely be held back in a spongy subsoil, as must be the case for from one to five days, but still shortly finds its way into the streams, it would be about or quite as effective as retarding basins such as are being constructed in the trough of the Miami watershed to protect Dayton, Hamilton, and other cities. Then, too, it is merely an intensification of nature's way of preventing these holocausts. However, if tile drainage not only holds back an acre inch or two of precipitation for several days, but puts another acre inch or more into a subterranean zone, then its flood prevention function becomes indeed real.

Let us go to the other horn of our national dilemma —that of the constancy of our white coal supply and of improved river navigation throughout the year.

An old grist mill man explains that about 1875 his father's power supply began to fail, till for fifteen or more years prior to 1895 they were compelled to shut down each season for from four to six months by reason of water shortage; that his head of water, coincident with the extensive underdrainage installations in the watershed above him, began to return so that since about 1902 he, as successor to his father, has been vouchsafed a dependable water supply throughout the entire season. He long ago came to the conclusion that his augmented water supply was largely attributable to this tile drainage above his dam. "Why," he said to the writer in October, 1919, "you will not find a single tile now working but I am getting the increased water supply just the same and it must be because more water sinks below the tile and gradually feeds subterraneanly into the creek and its feeders above me throughout the season."

An examination of the stream, a few days later, above and below this dam and of one of its main feeders for several miles disclosed no drainage tile pouring in, but did disclose hundreds of seeps plainly visible at low water stage. The cold spots in the stream bottoms that we are always able to detect with bare feet in warm weather, and the weak springs and seeps that we can always find at low-water stage, are the main sources of dry-weather supply for all our streams. At the time of this examination, I found no water immediately below his crude and shallow, but effective, dam, but as I followed down the old stream bed, there was a slightly augmented supply at each ripple, plainly to be seen as coming from "seeps" only, till at a mile below his dam perhaps 5 cu.ft. in this creek had gathered up. A dam on White Water River each season except those of exceptional summer rainfall has for forty years, to my knowledge, demonstrated this same phenomenon, but in a much more intensified degree. In portions of at least two large feeders of White Water River, under my observation since the early eighties, there has certainly been shown some increased water supply in drouthy seasons and I know this has come from cold spots that formerly did not remain constant, but that now do.

Thus, where there is extensive tile drainage in a given watershed and a decreasing annual flowage at the tile outlets and no flowage at all therefrom in the dry season and an increasingly better dry season stage in the watershed stream, and its feeders. By reason of these conditions one is forced to the conviction that gravitation water below the tile lines is in part correspondingly increased and that from all of this there must result lower flood stage and better dry weather supply. My final conclusion is that systematic underdrainage will, more than any economic human agency, effectively contribute to physical river control by keeping down floods and by keeping up power and navigation stage throughout the season, and that, too, in nature's own way.

As such drainage is being voluntarily practiced in humid sections in an increasing progression, it seems to me that there should be governmental fostering of this most kindly aid to nature, not only from a crop production and a soil conservation, but from a river-control, viewpoint.

Approved Federal-Aid Road Projects

According to a bulletin recently issued by the United States Department of Agriculture, up to June 30, 1920, 2,985 projects, involving a total of 29,319 mi. of road, had been approved by the Secretary of Agriculture. The preliminary estimate of the cost of these projects is approximately $385,000,000, of which about $164,000,000 will be approved as Federal aid. On the same date 2,116 projects, representing approximately 15,944 mi., had either been completed or were under construction. The estimated total cost of these projects in various stages of construction, and completed, is $200,000,000. The cost of Federal aid work approved from Dec. 1, 1918, to July 1, 1920—approximately $330,000,000—exceeded by $63,000,000 the cost of all road and bridge work done by the states and counties in the United States during the year 1915.

Open Ditches Excel Tile Drains for Country Roads

Hand-Dug Ditches Constructed and Maintained at Small Cost by Village Communities Near Chicago

By Frank T. Danielson
Northwestern University, Evanston, Ill.

OPEN ditches instead of underground tiles for the removal of water from country roads have proved a great success during the past two years in New Trier Township, Cook County, Ill. This township includes the villages of Wilmette, Kenilworth, Winnetka, Hubbard Woods, and Glencoe. New Trier Township has several miles of both the tile and the open drainage construction and has had an excellent opportunity for comparing the two systems. Its roads pass over a very flat country where prompt discharging of the water from the ditches or tiles is not possible. This causes slight accumulation of water, and extra precautions must be taken in order to protect the subsoil of the roadbed.

Practically the same local conditions exist in regard to grade and outlet along the roads where underdrains are used, as along roads where there are open ditches.

FIG. 1. ARRANGEMENT OF DITCHING GANG

In every instance the open ditch system removes the water in less than one-half the time required by the underdrains and hence eliminates very quickly all danger to which the roadway is susceptible.

New Trier Township has hurried construction of open ditches during the past two years so that nearly all its roads had been ditched by the close of last season. The cost of the work is from 4 to 7c. per lineal foot, based on the average rate of wages for 1919. The work was all done by hand. No teams and slip scrapers could be used on account of the very slight grade available for flow in one direction toward an outlet.

A party of eight men, arranged as in Fig. 1, was found to work most efficiently. One man preceded the other seven, marking the location of the ditch. The next two men removed the first cut with spades. The following four men removed the bulk of the dirt with long-handle shovels and mattocks. They left the ditch at the approximate required elevation. The last man completed the work by cleaning out loose material and finishing the ditch to the grade as fixed by preliminary leveling.

The slope of the side of the ditch nearest the roadbed was made approximately 1 on 2, the far side had a slope of 1 on 1. The cross sectional area varied from 2 to 8 sq.ft. Fig. 2 shows a typical ditch after completion. It should be noticed in this connection that the roadbed may be reinforced by the removed soil, thus widening it.

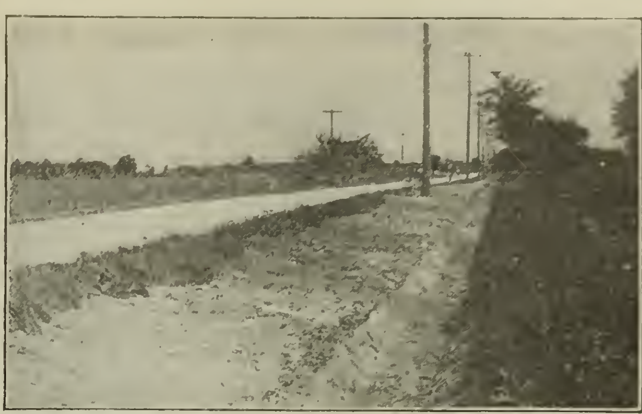


FIG. 2. COMPLETED DITCH WITH EXCAVATED MATERIAL SPREAD ON SHOULDER

Maintenance of the open ditches for the township has not cost in excess of 1c. per lineal foot per year. The essential thing in maintenance is a yearly cleaning out of weeds and, at places, of a little soil brought in by the water. By such cleaning the surface ditches may always be kept in grade and allow for the rapid discharge of water either in a large or small quantity at any time.

Summing up, the advantages of open ditch road drainage over underdrains are: (1) It provides the quickest means of removing water; (2) it eliminates the high cost of laying and replacing underdrains; (3) obstructions are more easily cleared away; and (4) it widens a roadbed by reinforcing the shoulders.

Credit Institute to Aid Italian Housing

By royal decree dated May 27, the Italian Government authorized the establishment of an institution with headquarters at Rome for the extension of credit to prospective builders of dwelling houses. This institution is designated as L'Instituto Nazionale di Credito Edilizio (National Building Credit Institute), and it will have a fully paid capital of 100,000,000 lire (lira at par of exchange=$0.193). Through its agency financial aid will be granted for the construction of dwellings which are not of a "luxury" character. Preference in the extension of building credit is to be given to undertakings for construction on the part of co-operative organizations or of groups of families.

Shares in the Building Credit Institute may be issued to would-be builders up to 10 times the paid-up capital—that is, for a total of 1,000,000,000 lire. Applicants for building credit, which is to be obtained by suscription to the shares, must put up a sum equal to one-quarter of the amount required for the proposed construction. The interest charged on the institute's loans to builders may not exceed 6 per cent. The security on the loans will be provided by first mortgages on the buildings during construction and after their completion.

The housebuilder who avails himself of the institute's assistance must file the architect's plans and estimates of the total cost when the credit is granted. In the course of construction, additions or alterations in the plans so filed cannot be made if the expenditure necessary to carry them out exceeds 10 per cent of the original estimated cost of the building. While construction is going on the institute will open a current account with the borrower, which will be converted into an amortizable share on the completion of the building operations, and which will be payable at the end of 20 yr. Payment of interest and installments of the principal will be half yearly.—*Commerce Reports.*

Building Big Eddy Dam on Spanish River, Ont.

Plant Layout and Construction Method Used on Gravity Dam Built Across Valley with Narrow Gorge Requiring Caisson Cut-Off—Work Carried on Through Northern Winter

CONSTRUCTION work on the Big Eddy dam on the Spanish River near High Falls, Ont., was carried on continuously throughout the past severe winter, and the structure, the early work on which was described in *Engineering News-Record*, July 17, 1919, p. 108, is well along toward completion. The layout of the construction plant is somewhat novel, owing to peculiarities of topography at the site, and the closure of the river most intersting.

As described in the earlier article the dam is at present intended merely to form a regulating reservoir to control the operation of a power plant of the International Nickel Co., about ¾-mile downstream. The dam will have a maximum height of 159 ft. and will be 1,100 ft. long, 512 ft. of which is in comparatively low bulkhead. A penstock section is 152 ft. long and the remainder is spillway. Throughout it is of mass concrete section. The river passes through a narrow gorge, which was closed by the use of pneumatic caissons up and downstream, as described in the previous article. Their location is shown on the accompanying layout of the site and plant.

Preliminary operations were begun in August, 1918. These were assisted by a standard-gage railroad track, 3½ miles long built at the time of constructing the original High Falls development from the Canadian Pacific R.R. into that site. The old rail was replaced with heavier steel and a number of grades considerably reduced, but in the meantime the line helped materially in starting the work. In order to reach the new dam site at Big Eddy an additional mile of railroad track had to be built. This involved some heavy cuts, fills and trestles, as follows: rock cuts 6,550 cu.yd., earth cuts, 6,100 cu.yd.; total borrow 5,000 cu.yd. and a trestle 945 ft. long with a maximum height of 50 ft.

While the four caissons in the river section (two on the upstream and two on the downstream faces) of the dam were being sunk (December, 1918, to March, 1919), a flume was excavated to take care of the river flow when the work in the natural river bed should be under way. This was dug through a slight natural depression about 100 ft. back from the east side of the river, was 550 ft. long, 25 ft. wide and necessitated the removal of 14,000 cu.yd. of rock. This rock, after being blasted, was loaded by stiff-leg derricks into 6 yd. cars and dumped in piles on the river bank for use later as plums in the concrete. That portion of the flume passing through the dam was lined on sides and bottom with concrete, provision being made for stop logs at the upstream and downstream faces. Later as the dam was built up the flume was roofed over at a height of 42 ft. above the floor.

At the time of starting work on the flume, crib cofferdams were placed at its up and downstream ends and upon completion of the excavation and concrete lining were loaded with dynamite and blown out.

The past winter the concrete was brought in the sluice sections up to El. 212, so as to be above high water in the spring. At this elevation the flume is calculated to carry away 12,000 sec.ft., so a weir had to be formed on the west side of the sluice section capable of discharging another 4,000 sec.ft. At one time the flume and weir combined passing a flood of 12,200 sec.ft. at El. 208 at the upstream face. The flume handled 10,200 sec.ft. and the weir the remainder.

LOOKING AT THE UPSTREAM FACE OF BIG EDDY DAM IN OCTOBER, 1919

Material Handled from Trestles

During the interval between the completion of the caissons and flume and before the spring break-up, the necessary trestles, derricks, mixer plant, etc., were erected ready to start operations as soon as snow and ice had sufficiently disappeared. This was not until May 5, 1919.

By the middle of June, 1919, the water in the river had subsided sufficiently to allow work to be commenced on the cofferdams which were to complete the closure of the river section previously started by the sinking of the pneumatic caissons. A templet of the size of the proposed cofferdams was constructed, placed in exact location and soundings taken at 2 ft. centers. This method gave very good results for, when unwatering was completed, the bottom of the cofferdams were found to conform very closely with the profile of the ground surface.

Since the cofferdams were securely braced and wedged between the caissons and the rock, considerably smaller coffers than usual were used. The upstream coffer on the west side was built 22 ft. wide and had a maximum

EXCAVATING FOR FOUNDATION BEHIND CAISSONS 1 AND 2.

depth of 38 ft. On the east side, where the greatest depth of water was 28 ft., it was built 15 ft. wide. The downstream coffers had a depth of 38 ft. and were 20 ft. wide. Upon completion and loading of the cribwork, sheetpiling was placed on the water face by divers, an apron of drier felt nailed to the bottom of sheetpiling and laid out in front on the river bottom. Toe fill was then deposited on top of the drier felt.

As will be noted in the sketch showing the general layout, a double-track railroad trestle was built to the mixer plant, which was conveniently situated between the flume and the east bank of the river, and all concrete material taken in cars directly to this plant. The coarse aggregates are dumped into hoppers of 300 cu.yd. capacity, while cement is unloaded above the mixers and fed to them through chutes. Stiff-leg derricks were erected on flat cars traveling on twin trestles in such a way as to be moved easily to any required position along the dam. The concrete trestles were built on the downstream side of the dam and plum derrick trestles above the upstream face.

Gravel and slag from the general hoppers of the mixer plant lead to measuring boxes over the two $1\frac{1}{4}$ yd. mixers. Cement bags are opened in the cement shed and sufficient cement for one batch placed in bulk in the chutes. An electric bell connected from the mixers to the shed notifies when cement is required. After the concrete is mixed it is dumped into elevator buckets, which are hoisted up to hoppers located just above the concrete trestle. Small flat cars, carrying one-yard buckets, are spotted under these hoppers. When loaded they are moved to the different derricks by means of an engine and cable.

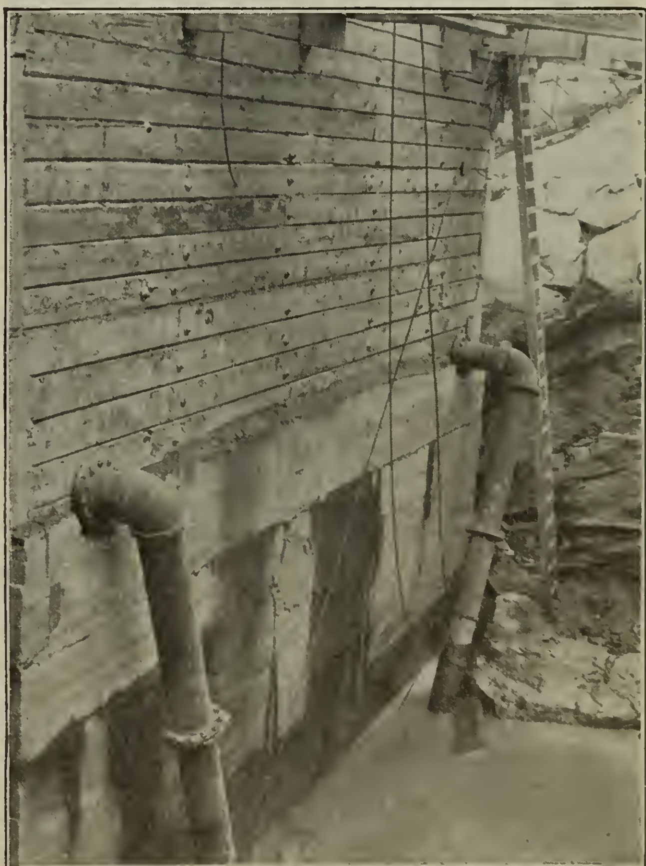
Sand, gravel and slag are used in the concrete. The slag is from the smelter at Copper Cliff and is being used in place of crusher rock. It is delivered in 35-yd. cars as required. Sand and gravel are obtained from a ballast pit alongside of the Algoma Ry., about 13 miles from the dam.

The center of the mass concrete is composed of 1 : 3 : 6 mixture, the faces of $1 : 2\text{-}\frac{1}{2} : 5$. It was figured that by substituting slag for crushed stone a much heavier concrete would be obtained—the slag concrete weighing about 17C lb. per cu.ft.

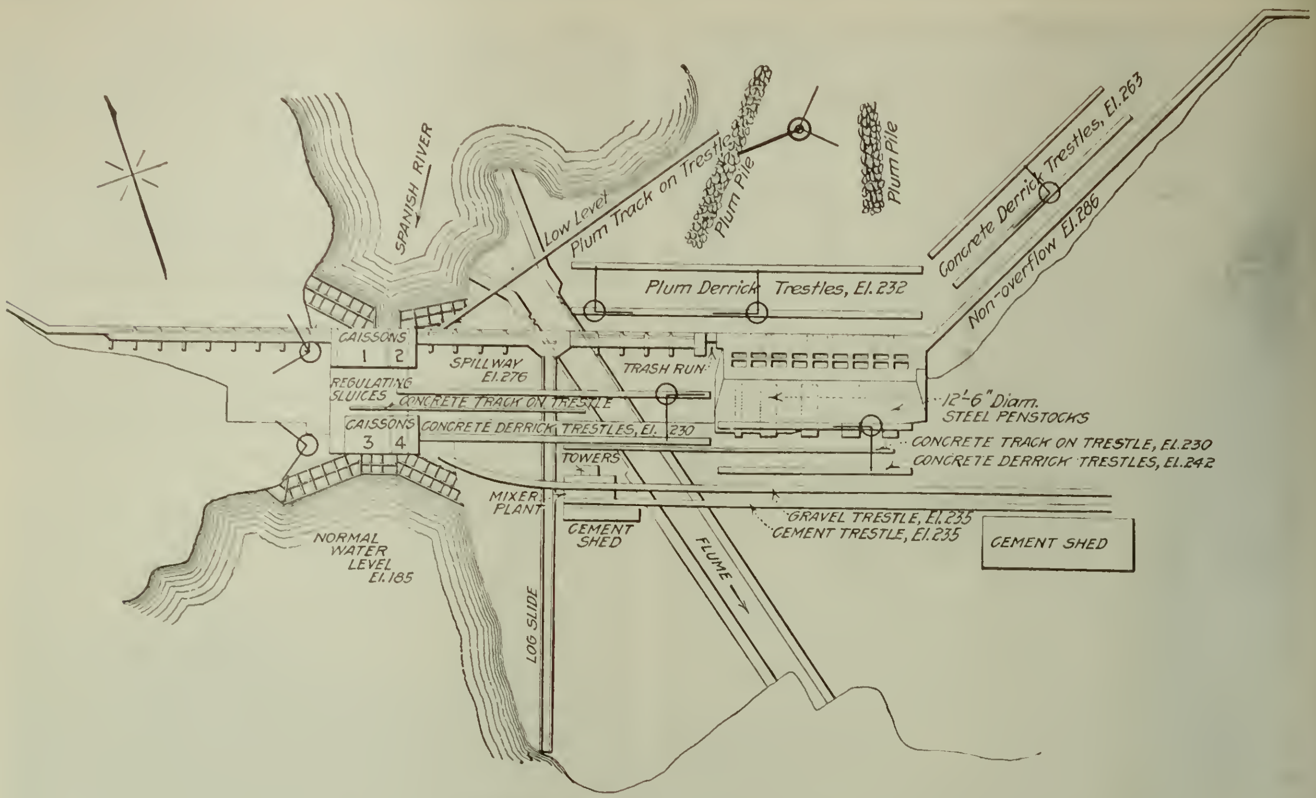
As a precaution against uplift pressure, $2\frac{1}{2}$-in. holes 20 ft. deep were drilled every 10 ft. along and 5 ft. back from the face of the dam. In these, weep pipes were inserted. When the concrete was brought up sufficiently the pipes were connected and carried out to the downstream face of the dam.

The two downstream caissons, Nos. 3 and 4, were built with concrete walls on three sides, but had timber on the upstream wall above El. 161 and 170, respectively. The caissons, after being sunk, were filled solid with concrete to these elevations, the object of this hollow space being to permit a thorough bonding of the downstream caissons with the mass concrete placed between the caisson rows. This avoided what would have been a bad shear plane along the upstream face of caissons Nos. 3 and No. 4. Advantage was taken of these openings for the main pump set-up, as it permitted two 12-in. centrifugal pumps to be placed inside of No. 3 caisson at El. 163, which is 22 ft. below normal water. The suctions of these pumps had previously been built through the wooden wall.

Pumping started Sept. 2, 1919. The general forma-



UPSTREAM FACE OF CAISSON 3 SHOWING PUMP SUCTIONS



LAYOUT OF PLANT FOR CONSTRUCTION OF BIG EDDY DAM ON SPANISH RIVER, ONT.

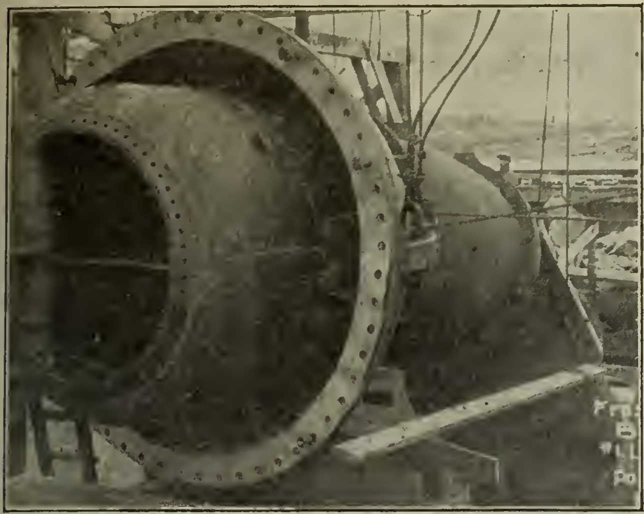
tion of the rock in the river bed sloped from east to west side. A seal was formed on the upstream side between the caisson and the east bank, and as mucking was completed, a series of bulkheads were placed and the concrete poured. No great difficulty was experienced until the west side was reached. There, considerable excavation was required between upstream caisson No. 1 and the bank before a solid foundation was reached, and as the rock rises almost perpendicularly, the working space was small. When this caisson was sunk it was known that the extreme west side of it was not resting on solid rock, and in consequence it would be necessary to get down well below the cutting edge and remove loose rock underneath a portion of the caisson. This is exactly what was experienced. The cutting edge of the caisson was at El. 142.4, and the lowest elevation found under the cutting edge was 127.4. The concrete that filled the working chamber of the caisson was found to be in perfect condition. A good bond was made between this concrete and the fresh concrete and rock. On account of the cramped position here, it was found necessary to put in a small seal about 4 ft. wide at the bottom between the west side rock and the caisson. The water pressures were allowed to equalize and the concrete was tremied. After nine days it was unwatered, and with a 20 ft. head on it, it was found to be perfectly tight.

Some special handling was required in placing the large sluiceway valves. The regulating sluice section is 60 ft. long and is located across the river. When the river is not running over the spillway the flow will be controlled by discharging through three 78-in. Larner-Johnson valves, having a combined capacity of 3,700 sec.-ft. with full head. The valves weigh 25 tons apiece, and with the intake and discharge tube connections weigh 52 tons. For erection they were suspended by rods threaded at the upper end so as to permit of easy adjustment in regard to level and grade, while horizontal adjustment was made by jacks.

The ground in the vicinity of the proposed dam, being rough and broken, did not lend itself readily to a camp site. It was necessary to erect the buildings along the hillside, with the result that no building of any size could be constructed without considerable excavation and leveling. Camps for the accommodation of 700 men were erected. The types of buildings varied from long bunk houses, 35 ft. wide by 156 ft. long to small 16 x 24 ft. shacks. The former accommodated 192 men and the latter a varying number depending upon whether used for mechanics, foremen or as married quarters. The difference in size of the buildings was necessitated by the limitations of the site. Three combined cook and mess halls were erected. These had a seating capacity of 200 men apiece. In addition there was also built a two-story storehouse, two-story office, a commissary and a root house.

The dining halls, office, part of the storehouse and most of the camps were heated from a central heating plant. The structure housing these boilers also included a general wash room for the men. In it were both basins and showers.

Near to the job are located the various work shops and power station. The machine shop contains a lathe, shaper, threading machine, drill press and a power hacksaw. At the other end of the building is a blasksmith shop with three forges. The carpenter shop is equipped with bandsaw, ripsaw, rip and butt saw, swingsaw and planer. A compressor house, used for supplying air to pneumatic caissons, rock drills, hoisting engines and small reciprocating pumps, contained one 1,200-ft. capacity low pressure, two 1,050 and one 500-ft. high pressure compressors. Immediately adjoining this is the boiler house of 500 hp., having five boilers of the



ERECTING 78-IN. JOHNSON-LARNER VALVE AT BIG EDDY DAM

bricked-in type. At the commencement of the job the compressors were all driven by steam, but later, electricity, being available, was installed and at present all machinery is driven by electric power received from the nickel company's plant at High Falls. This is delivered to a transformer house on the work at 35,000 volts, where it is stepped down to 550 volts for power and 110 volts for lighting.

The dam is being built for the International Nickel Co. of Canada, Ltd., by Fraser, Brace & Co., Ltd., of Montreal and New York. Henry Holgate, of Montreal, is the consulting engineer for the owner.

Acid Process Tried on Camp Sewage

COMPARATIVE tests of sewage disinfection with niter cake and calcium hypochlorite, made at the United States Naval Training Camp, Gulfport, Miss., show that the niter cake or "acid process is 2½ times as costly as the chlorine process using the equivalent of 10 p.p.m. of chlorine, and that results, bacteriologically speaking, were not so good." The experiments are described at some length in Bulletin No. 31, Public Works of the Navy, for April, 1920.

In his letter transmitting the detailed report mentioned below, Lieutenant Commander L. F. Bellinger, C. E. C., U. S. Navy, states that the tests were undertaken on account of what appeared to be a widely distributed letter from a firm of explosive manufacturers describing the use of niter cake for recovering grease. After the tests were well under way, Lieutenant Bellinger says, there appeared in *Engineering News-Record* of Dec. 5, 1918, an article entitled "Promising Results with Miles-Acid Process of Sewage Treatment in New Haven Tests." This article appears to have suggested to Lieutenant Bellinger the use of the title, "Miles-Acid System of Sewage Purification Compared with Chlorine Process" used by him in his letter of transmittal.

From the detailed report on the tests by Ensign W. B. McElligott it appears that the sewage of the training camp at Gulfport is normally disinfected by calcium hypochlorite after having passed through a grating of steel bars and a septic tank. The niter cake used in the tests, which Lieutenant McElligott says was produced during the war in such unprecedented quantity as to make its disposal a problem to the manufacturer, is described as consisting "of a mixture of approximately 33 per cent free sulphuric acid (H_2SO_4) and 67 per cent of sodium acid sulphate ($NaHSO_4$) and results from the treatment of Chile saltpeter ($NaNO_3$) with sulphuric acid in the manufacture of nitric acid (HNO_3)."

Eight samples were taken for test on five different days, but two samples spoiled. When using niter cake at the rate of 8 p.p.m. the bacterial count of the sewage was 9,000,000 before and 2,000,000 after treatment. In four tests in succession using 29, 22, 47, and 35 p.p.m. of niter cake the bacterial count was in each case 7,500,000 before treatment while after treatment it was 740,000, 1,331,000, 147,000, and 268,000. With 104 p.p.m. of niter cake no report is made for the bacterial count before disinfection, but the count after disinfection is reported as 40,000.

Ensign McElligott concludes from the result of the bacterial counts "that none of the effluent samples were satisfactory from a sanitary standpoint, viz., to contain not more than 10,000 bacteria per c.c. and no colon bacilli." He goes on to say: "Apparently niter cake is useless, in any reasonable amount, for the sterilization of sewage. During the addition of a stronger solution it was noticed that the sewage became markedly flocculated, and that large flocks of fat and fecal matter rose to the surface. This sticky, tarry matter might cause trouble in any practical working of the process by gumming up the screens and rakes. Another grave objection is that the large amount of free sulphuric acid makes the solution very corrosive to the tanks, pipes, fittings, and causes complaint from operators on account of destroyed clothing and shoes. During the addition of the strongest of the above solutions, 1-in. galvanized pipe and fittings were destroyed in 24 hours."

In his letter of transmittal Lieutenant Bellinger compares the cost of niter cake and calcium hypochlorite per 1,000,000 gal. of sewage as follows: Niter cake, 867 lb. at 4¾c. per lb., $41.18. Calcium hypochlorite, 250 lb. at 6¾c. per lb., less than carload lots, $16.87.

The report states that the sewage of the training camp at Gulfport passes through grease taps before going to the septic tank, so that very little grease gets into the sewer. Presumably for this reason no attempts at grease recovery were made at Gulfport. However, Lieutenant Bellinger says in his letter of transmittal: "Information from the Reclamation Division of Camp Greene, Charlotte, N. C., dated Nov. 25, 1918, states that the amount of grease recovered in the niter cake process is very small, and that this method is used more for sanitary reasons than for the actual collection of grease."

Claim Irrigation Company Is a Utility

The Bitter Root Water Co., successor to the Bitter Root Valley Irrigation Co., claims that it is a utility and that its rates to irrigators are subject to regulation by the Public Service Commission of Montana. The U. S. District Court holds that the contracts between the original company and its water users are not subject to commission control. The commission agrees with the contention of the company, maintaining that irrigation rates are subject to the joint jurisdiction of the Public Service Commission and the Irrigation Commission—which have the same members. Further litigation is expected.

New Transition Curve Based Upon the Lemniscate

BY J. E. WILLIAMS

TRANSITION curves in railway track are introduced to give a gradual change from the tangent to the main circular curve and from the level rails on tangent to the superelevation of outer rail on the main curve, the purpose being to ease the motion of trains entering and leaving curves. At the point (*P.S.*) where the transition curve leaves the tangent the curvature should be zero. At the point (*P.C.C.*) where the transition curve meets the main curve its curvature should equal that of the latter. The change in curvature between the two points should take place in such manner as to allow the elevation of the outer rail to increase uniformly with the length of th: curve, and as to be just sufficietnt at every point to balance the centrifugal force. The aquation of a curve which meets these requirements can be derived as follows:

Let $h =$ elevation of outer rail,
$l =$ gage of track,
$v =$ velocity of train,
$R =$ radius of curvature,
$s =$ length of curve from P.S.,
$W =$ weight of train.

The weight W can be resolved into two components, one perpendicular to the incline of the track and the other parallel to the incline. Since the component parallel to the incline and the centrifugal force are practically equal, we have

$$\frac{Wh}{l} = \frac{W}{g}\frac{v^2}{R} \qquad (1)$$

If h increases uniformly with s, h/s is a constant. Then since v, g, and l are constants also, we have

$$Rs = C \text{ (a constant)} \qquad (2)$$

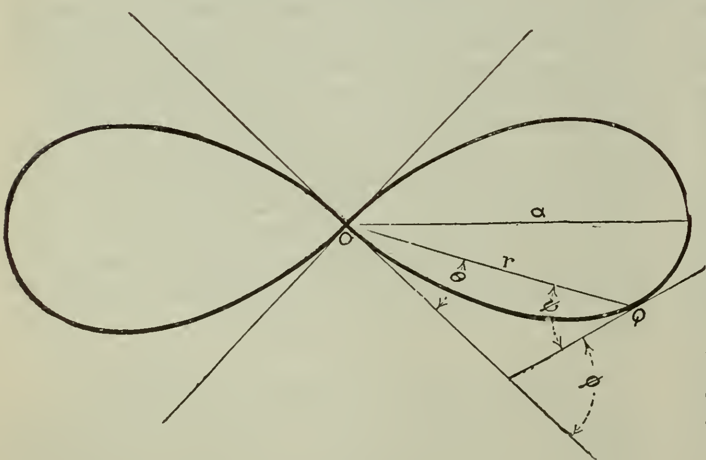


FIG. 1

Equation (2) is one form of the equation of a Cornu's spiral and represents the true transitiion curve. Points on a curve are usually located either from the tangent or by deflection angles. No easy way has been found for locating the points on the true curve by either of these methods. As a result, a number of modifications have been used. The purpose of this article is to present the lemniscate as still another modification.

The equation of the lemniscate, Fig. 1, can be written

$$r^2 = a^2 \sin 2\theta \qquad (3)$$

From the formula

$$\tan \psi = \frac{r d\theta}{dr}, \text{ we have}$$

$$\tan \psi = \tan 2\theta$$

Therefore

$$\psi = 2\theta \qquad (4)$$

This is an important property, and it holds for every point on the curve.

By using the formula

$$R = \frac{\left[r^2 + \left(\frac{dr}{d\theta}\right)^2\right]^{\frac{3}{2}}}{r^2 + 2\left(\frac{dr}{d\theta}\right)^2 - r\frac{d^2 r}{d\theta^2}},$$

the radius of curvature is found to be

$$R = \frac{a^2}{3r}, \qquad (5)$$

or

$$Rr = C' \text{ (a constant)} \qquad (6)$$

The values of θ, Fig 1, in a transition curve are never large, and it can be shown by expanding s/r that for small values θ, s does not differ greatly from r. If s is substituted for r, equation (6) becomes identically the same as equation (2).

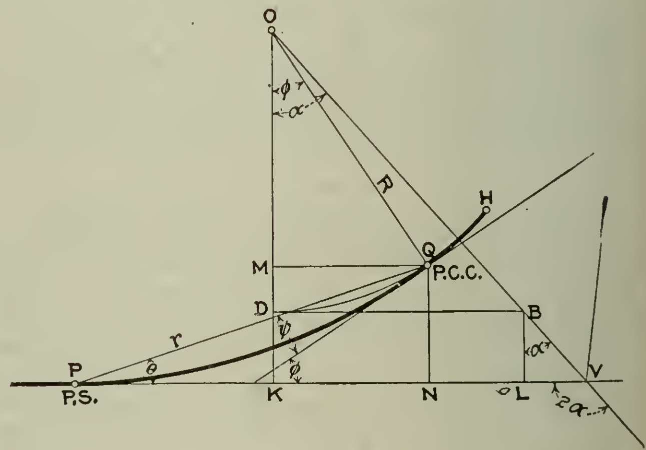


FIG. 2.

Referring to Fig. 2, QH is a part of the curcular track, and PQ is the transition curve. The curvature at P is zero. From this point the curvature gradually increases. At Q the transition curve and the circle have the same curvature, a common tangent and a common center of curvature.

Let s_c, R_c, r_c, and θ_c be the values which s, R, r and θ have at the point Q. Combining (3) and (5), and substituting s for r, we have, for calculating the deflection angles,

$$\sin 2\theta = \frac{s^2}{3R_c\, r_c} \qquad (7)$$

The next step is to find an expression for the tangent distance. Only the case in which the same curve is used at both ends of the circular part of the track will be considered here. If T is the tangent-distance, then

$$T = PK + KL + LV, \qquad (8)$$

$$PK = PN - QM = r\cos\theta - R\sin = r\cos\theta - R\sin 3\theta$$

$$KL = BD = R \tan \alpha,$$

$$BL = QN - MD = r \sin \theta - (R - R \cos 3\theta),$$

$$LV = BL \tan \alpha,$$

Substituting in (8),

$$T = r \cos \theta - R \sin 3\theta + [r \sin \theta - (R - R \cos 3\theta)] \tan \alpha + R \tan \alpha$$

$$= \frac{r \cos (\theta - \alpha) + R \sin (\alpha - 3\theta)}{\cos \alpha} \qquad (9)$$

From equations (3) and (5), $r = 3R \sin 2\theta$. If this value of r is substituted in (9), we have, after a simple trigonometric reduction,

$$T = \frac{R}{2 \cos \alpha} [3 \sin (\theta + \alpha) - \sin (\alpha - 3\theta)] \qquad (10)$$

The values of R and θ to be used in (10) are the values which they have at Q.

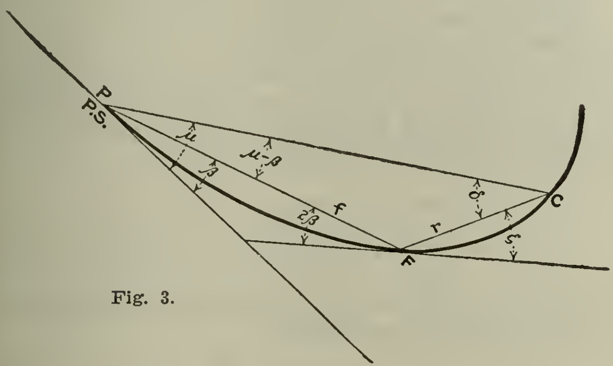


Fig. 3.

In case the curve cannot be completed from $P.S.$, the transit can be moved to some intermediate point F, Fig. 3, and a new tangent established in the usual way. Let β and μ be the deflection angles for F and C, respectively, when measured from $P.S.$ Let ξ be the deflection angle for C when measured from F. Let f and r be the lengths of the chords PF and FC, respectively, Then

$$\delta = \xi + 3\beta - \mu.$$

also

$$\frac{\sin \delta}{\sin (\mu - \beta)} = f/r$$

Substituting for δ, we have

$$\sin (\xi + 3\beta - \mu) = f/r \sin (\mu - \beta) \qquad (11)$$

The ratio $\frac{f}{r}$ is nearly equal to the ratio of the arcs PF and FC. The values of β and μ are to be calculated from (7). The value of ξ can then be calculated from (11).

When the angle δ and the angle $\mu - \beta$ are both small, quite accurate results can be gotten from the equation

$$\xi + 3\beta - \mu = f/r(\mu - \beta) \qquad (12)$$

Milk Pasteurization Ordinance Legal

The Wisconsin Supreme Court has upheld the legality of an ordinance of the city of Milwaukee requiring all milk sold in that city to be pasteurized except when certified or from tuberculin-tested cows. (Pfeffer et al. vs. City of Milwaukee et al., 177 N.W. 850.)

The True Transition Curve for Railway Problems

New Method as Simple as Methods Commonly Used in Applying Approximate Transitions to Curves and Turnout Work

By George Paaswell
Consulting Engineer, New York City

The best transition or easement curve for use in railway work is that in which the curvature varies directly as the distance measured along the curve, starting at zero at the $P.T.C.$ and attaining the proper amount of the $P.C.$ or circular curve (see Crandall's "Transition Curve"). Such a transition insures the easiest riding and agrees directly with the superelevation, but the mathematical difficulty attendant upon its use has made it hard to apply to problems in the office and the field. For this reason, other transitions are used frequently which are approximations to the true transition curve as defined above. Among these are the compound curve, the cubic parabola and the Searle's spiral.

It is the purpose of this article to place the mathematical work of the true transition curve on a clearer basis, deriving functions which, with appropriate tables, will make it easy to apply the curve in practice. These tables may be developed eventually to furnish data as complete as trigonometric tables now furnish for simple curves.

TABLES FOR THE TRUE TRANSITION CURVE

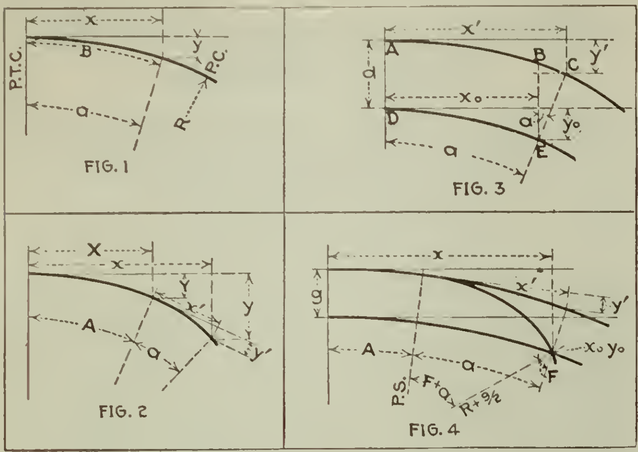
Values for the function $U\ (a)$

Deg.	0	10′	20′	30′	40′	50′
0	0.0000	0.0010	0.0019	0.0029	0.0039	0.0048
1	0.0058	0.0068	0.0078	0.0087	0.0097	0.0107
2	0.0116	0.0126	0.0136	0.0145	0.0155	0.0165
3	0.0175	0.0184	0.0194	0.0204	0.0213	0.0223
4	0.0233	0.0242	0.0252	0.0262	0.0271	0.0281
5	0.0291	0.0301	0.0310	0.0320	0.0330	0.0339
6	0.0349	0.0358	0.0368	0.0378	0.0388	0.0398
7	0.0407	0.0417	0.0427	0.0436	0.0446	0.0456
8	0.0465	0.0475	0.0485	0.0495	0.0504	0.0514
9	0.0523	0.0533	0.0543	0.0553	0.0562	0.0572
10	0.0581	0.0590	0.0600	0.0610	0.0620	0.0629
11	0.0638	0.0648	0.0657	0.0667	0.0677	0.0686
12	0.0696	0.0706	0.0716	0.0725	0.0735	0.0745
13	0.0754	0.0763	0.0773	0.0782	0.0792	0.0802
14	0.0811	0.0821	0.0831	0.0840	0.0849	0.0859
15	0.0869	0.0878	0.0887	0.0897	0.0906	0.0916

Values of the function $T\ (a)$

Deg.	0	10′	20′	30′	40′	50′
0	1.0000	1.0000	1.0000	0.9999	0.9999	0.9998
1	0.9997	0.9996	0.9995	0.9993	0.9992	0.9990
2	0.9988	0.9986	0.9983	0.9981	0.9978	0.9975
3	0.9973	0.9969	0.9966	0.9963	0.9959	0.9955
4	0.9951	0.9947	0.9943	0.9938	0.9934	0.9929
5	0.9924	0.9919	0.9913	0.9908	0.9902	0.9896
6	0.9890	0.9884	0.9878	0.9872	0.9865	0.9858
7	0.9851	0.9843	0.9836	0.9829	0.9821	0.9813
8	0.9805	0.9797	0.9789	0.9880	0.9771	0.9762
9	0.9753	0.9744	0.9735	0.9725	0.9715	0.9706
10	0.9695	0.9685	0.9675	0.9664	0.9653	0.9642
11	0.9631	0.9620	0.9609	0.9597	0.9586	0.9574
12	0.9561	0.9549	0.9536	0.9524	0.9511	0.9498
13	0.9485	0.9472	0.9459	0.9445	0.9431	0.9417
14	0.9403	0.9388	0.9374	0.9359	0.9345	0.9330
15	0.9314	0.9299	0.9284	0.9268	0.9252	0.9236

This true transition curve has been analyzed by Euler and a host of other mathematicians. It was defined by a set of Euler integrals and was also termed the Euler spiral; more lately it has been termed the clothoïde. The fundamental properties of the curve may be derived in the usual manner: Take r as radius of curvature at any point s of the curve, measured from the point of tangency, the $P.T.C.$; at the $P.C.$ the radius is R, that of the simple curve, and s becomes L, the total length of the transition. From the intrinsic relation (see Fig. 1).



$$da/ds = 2\ k\ s \tag{1}$$

$2\ k$ is a constant, which is evaluated by noting that when $s = L$ the curvature in (1) is $1/R$. Thus defined

$$k = 1/2\ RL \tag{2}$$

Integrating (1) $\quad a = k\ s^2 \quad$ (3)

From the trigonometry of the infinitesimal triangle

$$dy = ds \sin a \tag{4}$$

$$dx = ds \cos a \tag{5}$$

From (1) and (3),

$$dy = \frac{1}{2\sqrt{k}} \frac{\sin a}{\sqrt{a}} da \tag{6}$$

$$dx = \frac{1}{2\sqrt{k}} \frac{\cos a}{\sqrt{a}} da \tag{7}$$

and

$$x = \frac{1}{2\sqrt{k}} \int_0^a \frac{\sin a}{\sqrt{a}} da \tag{8}$$

$$y = \frac{1}{2\sqrt{k}} \int_0^a \frac{\cos a}{\sqrt{a}} da \tag{9}$$

These integrals define new functions and, when a is finite they can be found by expanding the integrand and integrating term by term. Performing this integration

$$x = s\ T(a) \tag{10}$$

$$y = s\ U(a) \tag{11}$$

where $T(a)$ and $U(a)$ are the new transition functions which stand for the infinite series

$$\mathrm{T}(a) = \sum_0^\infty \frac{(-1)^n\ a^{2n}}{(4n+1)\ (2n)!} \tag{12}$$

$$\mathrm{U}(a) = \sum_0^\infty \frac{(-1)^n\ a^{2n+1}}{(4n+3)\ (2n+1)!} \tag{13}$$

These are formidable looking expressions but are of but little more complexity that the analagous functions defining the sine and cosine, which may be written in the form

$$\sin x = \sum_0^\infty \frac{(-1)^n\ x^{2n+1}}{(2n+1)!}$$

$$\cos x = \sum_0^\infty \frac{(-1)^n\ x^{2n}}{(2n)!}$$

For infinite values of a:

$$\int_0^\infty \frac{\sin a}{\sqrt{a}} da = \int_0^\infty \frac{\cos a}{\sqrt{a}} da = \sqrt{\pi/2}$$

so that, as a mathematical curiosity, the co-ordinates of the terminus of the transition are

$$x = y = \frac{1}{2} \sqrt{\pi/k} = \frac{1}{2} \sqrt{2\pi RL}$$

Tables for the values of the T and U functions are given here and it is hoped will eventually be carried out to a full range of the angle values. The deflection of the curve is given by

$$\tan d = y/x = U(a)/T(a)$$

The transition curve has now been rigorously defined. The application to specific problems will emphasize the fact that such a definition is far superior to the use of approximations and corrections in that a clear view is had at all times of the curve properties.

PROBLEM 1—*Tangent Offsets.* To determine the offsets from the tangent at any point X, Y, on the transition, see Fig. 2. By the principles of the transformation of co-ordinates the new co-ordinates x', y', referred to the points X, Y as origin are related to the old coordinates referred to the *P.T.C.* as origin:

$$x' = (x - X) \cos A + (y - Y) \sin A \tag{14}$$

$$y' = (y - Y) \cos A - (x - X) \sin A \tag{15}$$

Refer these functions back to the functions as defined in (10) and (11), and there is,

$$x' = Js - IS \tag{16}$$

$$y' = Ms + NS \tag{17}$$

$J = T(A + a) \cos A + U(A + a) \sin A$; $I = T(A) \cos A + U(A) \sin A$

$M = U(A + a) \cos A - T(A + a) \sin A$; $N = T(A) \sin A - U(A) \cos A$

The angle a is measured from the point of tangency, the point X,Y. Note in (16) and (17) that for any fixed point IS and NS are constant and to determine the offsets it is necessary to compute J and M for each point. It must be remembered that s is measured from *P.T.C.* each time.

In similar fashion, when it is desired to get the offsets running back on the transition toward the *P.T.C.*

$$x' = IS - s\ P \tag{18}$$

$$y' = NS - s\ Q \tag{19}$$

$P = T(A - a) \cos A + U(A - a) \sin A$; $Q = T(A - a) \sin A - U(A - a) \cos A$

Those who have had occasion to compute offsets from odd points along the transition will appreciate the comparative simplicity of these expressions, when a table of the new functions is available. The deflections may be computed from the offsets in the same manner as before.

PROBLEM 2—*Curves Parallel to Transition.* See Fig. 3. It is to be noted that the transition curve is the center line of the track. The rails are parallel curves

separated by a distance $\frac{1}{2}g$, where g is the gage of track. To make the problem general the distance is noted here as d. The definition of parallel in this sense is that a normal to the transition is also normal to the parallel curve and that the distance intercepted on this normal between the two parallel curves is the distance d. Thus defined the co-ordinates on the curve AC at the point C are related to the corresponding co-ordinates on the transition DE

$$x' = x_0 + d \sin a \qquad (20)$$

$$y' = y_0 + d(1 - \cos a) \qquad (22)$$

It may also be assumed as a property of parallel curves that the distance AB on the curve is equal to the distance DE on the transition. Calling DE, s and AC, s',

$BC = s' - s$. From (20) and (10)

$$BC = d \sin a / T(a) \qquad (22)$$

PROBLEM 3—*Turnouts.* To locate a turnout from a transition curve involves generally a long office computation. The following should illustrate the simplification of this problem using the new function and the tables based upon them (see Fig. 4). The point of switch is assumed to be given and is located as shown. In all that follows the converse may be taken; the point of frog being assumed and the point of switch to be located. In this work the theoretical switch layout is assumed with point intersections and not the actual stub intersections with tangent throws and frogs. To apply the practical layouts would needlessly complicate the problems and introduce useless refinements. The frog angle is F. The co-ordinates of the frog referred to the circular turnout, x_0 y_0 are

$$y_0 = (R + g/2)\ (1 - \cos\ (F + a)\ )$$

$$x_0 = (R + g/2)\ \sin\ (F + a)$$

$$y_c / x_0 = \tan \frac{F + a}{2}$$

These co-ordinates may be referred back to x', y' as defined by (20) and (21) and in turn to co-ordinates referred to the $P.T.C.$ as origin as given in (14) and (15). There is then

$$\tan \frac{F + a}{2} = \frac{sM + SN - g(l - \cos a)}{sJ - SI - g \sin a} \qquad (23)$$

A few trials will suffice to determine the proper value of s to use to give the value of a to satisfy this condition. Having found this, the value of the radius of the turnout may be taken from one of the equations above. Remember that here s is measured all the way from the $P.T.C.$ along the outer rail while a is measured from the $P.S.$ only.

The problem may, of course be extended to include cases where the $P.S.$ is on the tangent, or on the circular curve and the frog point on the transition. There should be no difficulty in deriving the condition equations as above shown for these cases.

An arithmetical problem may render the above literal work a little clearer. Take a length of transition of 300 ft. and a radius of simple curve, 1,500 ft. Let the station of the $P.T.C.$ measured along the center line of track be 0 + 00 and let the point of switch be at the point 1 + 00. The central angle a at this point is, from (3), 0.0111 in circular measure or 0°40′. The switch turnout is to be as shown in Fig. 4. The gage of the track is taken as 4.708 ft. The length S for the outer rail must have the correction for stationing as given in (22). The correction is

$$\frac{\frac{1}{2}g \sin 0^\circ 40'}{T(0^\circ 40')} = 0.03$$

which may or may not be neglected, depending upon the requisite refinement of the work at hand.

In the condition equation for this case, the quantities $S\ N$ and $I\ S$ remain constant. From the previous equations

$$N = T(0^\circ 40') \sin 0^\circ 40' - U(0^\circ 40') \cos 0^\circ 40' = 0.0077$$

$$I = T(0^\circ 40') \cos 0^\circ 40' + U(0^\circ 40') \sin 0^\circ 40_0 = 0.9998$$

$$NS = 0.770 \qquad IS = 100.01$$

A No. 7 frog is to be used with frog angle $F = 8^\circ\ 10'$. As a first trial, the lead on tangent track may be used, which is about 65 ft.; s will then be 165 ft. and accordingly the total angle $A + a$ is 0.0303 or 1° 45′.

$$M = U(1^\circ 45') \quad \cos \quad 0^\circ 40' \quad - \quad T(1^\circ 45') \quad \sin \quad 0^\circ 40' = -0.0015$$

$$J = T(1^\circ 45') \quad \cos \quad 0^\circ 40' + U(1^\circ 45') \quad \sin \quad 0^\circ 40' = 0.9993$$

$$sM = -0.248 \qquad sJ = 164.88$$

The left hand member of the condition equation (using the value 1°5′ for a) is 0.0810. The right hand member, using the above values, is 0.0803. By assuming the lead value 64.5 the right hand member is 0.0809 and the left hand member 0.0810. This should suffice and the proper stationing may be found for the frog point by applying the parallel curve correction. The radius is found from the equations given above.

Changes in Configuration Revealed by Superposing Photographs

A method used during the war for detecting military construction, camouflage and other operations through airplane observation, and also used to some extent in astronomy and physics, is described by M. H. Stillman in a scientific paper of the Bureau of Standards, soon to be issued, under the title "Photographic Method of Detecting Changes in a Complicated Group of Oobjects." Under this method, photographs are taken of the place or group under observation, both before and after the period during which a change may have occurred; the exposures are taken as nearly as possible from the same position, and the same camera and the same kind of plate should be used. Superposing a positive made from one of the exposures upon a negative made from the other (the two being made as nearly as possible of the same density), the two plates when held to light will show a field of practically uniform density where no change has occurred. The dark portion of the negative adds to the transparent portion of the positive in the same way as the transparent portion of the negative adds to the black portion of the positive. Where a change has taken place, however, the opposing depth of positive and negative will not match or balance exactly, and there will be a distinct departure from uniform density of the field.

Relining a Leaky Park Lake With Gunite

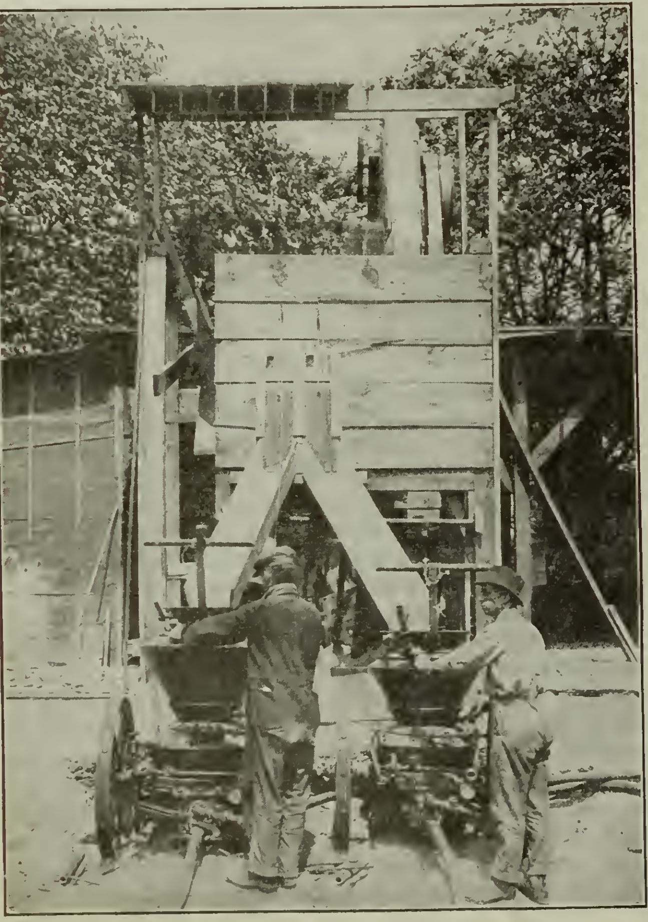
Mixing Plant Set Up on Shore and Concrete Applied As Far As 400 Ft. Distant—High Pressure Used

By Donald J. Baker
Wilkinsburg, Pa.

TWO inches of concrete applied with the cement gun and reinforced with a heavy wire mesh was used to reline the floor and sides of Lake Elizabeth, in West Park on the north side of Pittsburgh, Pa. The lake, which is a recreational center for boating, bathing and skating, has been leaking for some time through the 6-in. solid concrete base, though the depth of water is only 4½ ft.

The original bottom of the 200 x 550 ft. pond was a 6-in. concrete slab without reinforcement; three sides are on easy slopes with the same thickness lining and the fourth side was a low concrete wall. On this latter side, a new wall 10 ft. inside the old has been added in order to provide planting space for a shrubbery screen against a paralleling railroad.

When the water was drained off preparatory to relining the bottom, the exposed surface showed quite clearly that it was in an advanced stage of degradation. Cracks were numerous and in many places the concrete had worn away leaving small holes. Before the cement guns could be used, it was necessary to fill these cavities so that an approximately level surface would be provided for the placing of the wire reinforcement.



MIXED CONCRETE MORTAR CHUTED TO TWO CEMENT GUNS

APPLYING GUNITE UNDER HEAVY PRESSURE TO PITTSBURGH LAKE BOTTOM

Over 150 cu.yd. of mass concrete was used in this work, at the conclusion of which the bottom was thoroughly cleaned by brushing which removed all extraneous material.

It was desirable that this equipment be located as near the center of one side of the lake as possible so that the shortest hose lines could be utilized in reaching all portions of the bed. By reason of the nearness of the fence on the southwest bank, there was no space there available for setting up the guns and concrete mixer. A combination boathouse and rest room is situated in the center and near the bank on the north side so it was impossible to install the mixer at this point, which would have been the ideal location. Further, by reason of the flower gardens surrounding the building it was not feasible to situate the guns and other equipment in the immediate vicinity. A spot was finally chosen on the northeastern wall near the eastern extremity of the lake. Here two cement guns were installed as well as the concrete mixer and other storage piles.

No. 12 gage wire mesh was laid over the entire bottom in double layers, one being stretched over the other at right angles. In order to have the bed, slope and curbing one solid piece of concrete, the wire was laid not only over the floor but up the sides and over the curb.

After the wire had been placed over the bottom, the guns were brought into operation and hose lines extended from them to the nozzles, located some 400 ft. distant at the farthest point. The concrete used was a 1 : 3 mixture. This was delivered to the nozzles by air under a compression of 40 lb. per square inch. Water was delivered to the nozzles at a pressure of 160 lb. per square inch, which is considerably in excess of the pressure required for most efficient operation. A 2-in. thickness of gunite was applied.

That the completed surface might be relatively level and contain the grate desired to the outlet line near the southwestern corner, nails were dr'ven in the floor at frequent intervals. These lacked 2 in. of being driven home, and provided a grade to shoot to. Of the three men stationed at the nozzles but one had previous experience with the cement gun; the other two were enlisted from laboring details, yet their work was quite up to the standard maintained by the experienced nozzleman.

After the curbing had been shot with gunite on both sides, a trowel was employed in producing a smoother finish, the stipple finish left by the gun being more or less rough.

Inclement weather delayed the work to some extent. Although the sand and cement was under cover in a roughly constructed building that housed the mixer at the guns, the dampness of the air penetrated these aggregates to such a degree that clogging of the hose to the nozzle often resulted. When this occurred, there was some delay before the long lines could be cleared, which was accomplished by shaking and pounding the rubber. Despite the handicap imposed by the weather, the nozzlemen averaged 1,000 sq.ft. of surface each per day of 8 hours. Over 2,800 bbl. of cement was required to gunite the 80,000 sq.ft. of lake bottom and sides while 175,000 sq.ft. of wire was employed in the reinforcing.

The work was done under the direction of the Bureau of Engineering of the Department of Public Works, N. Y. by A. V. Purnell, a Pittsburgh contractor.

Storing Coal at St. Louis Water-Works

WITH proper care practically all grades of bituminous coal can be stored indefinitely without material loss of heat value. This is the experience at the water-works of St. Louis, Mo., according to a statement made by L. A. Day, Engineer-in-charge, Operating Section, Division of Water, in a paper before the recent convention of the American Water Works Association. Continuing Mr. Day said:

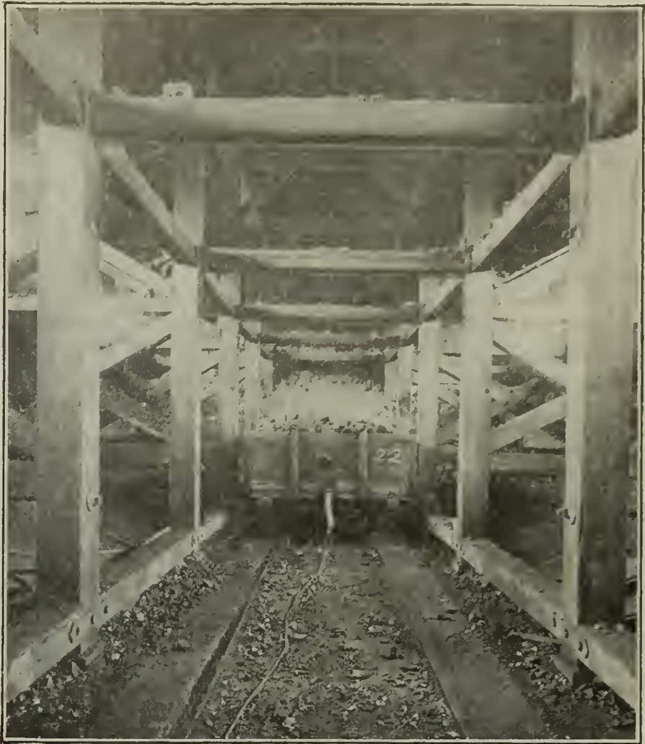
The water department is provided with a coal storage capacity of 15,400 tons, or enough for 60 days. Although we are close to the Illinois coal fields the wisdom of maintaining this liberal supply for emergency use has manifested itself on several occasions since the beginning of the war.

The coal stored is known as 6-in. screened lump. It is piled 16 to 18 ft. high in sheds.

We do not attempt to store Illinois screenings for any length of time but have stored for a year Illinois screenings that contained about 45 per cent of duff coal that will pass thr·ugh a screen having ¼-in. circular perforations. This coal showed no signs of heating after being placed in a pile about 6 ft. high in the open air, with no protection from rain or snow. In general, it has been our experience that all bituminous coal free from fines or duff can be stored for an indefinite period without appreciable heat loss. Heat value determinations show no appreciable heat loss due to storing for ten years. Naturally coal loses some of its moisture. This tends to compensate for the heat loss due to some of the volatile gases being set free.

It is preferable to choose sized lump coal for storing and the coal should be placed with the idea of minimizing breakage.

EXTERIOR VIEW OF CHAIN OF ROCKS COAL SHED



TYPICAL INTERIOR VIEW OF ST. LOUIS COAL SHED

The accompanying views give an idea of the type of coal storage sheds used at St. Louis.

Six Months of American Shipping

During the six months ending June 30, 1920, a total of 15,558 vessels, aggregating 86,931,700 dead-weight tons, entered and cleared United States ports. They carried 37,398,184 long tons of cargo. About 60 per cent of both vessels and cargo tonnage was chargeable to American registry. It appears from the figures that many of the American vessels carry return cargoes to American ports, while most of the foreign vessels enter in ballast. The latter, however, clear with relatively larger cargo. About half the total tonnage of vessels, and 60 per cent of the freight tonnage, was in export trade; here again over 50 per cent is credited to vessels sailing under the American flag. It is computed that the average export load of all vessels was 2,800 long tons, and the average import load 1,972 long tons, representing 52 and 34 per cent of the average dead-weight capacity per vessel. For 1919, a recent bulletin of the U. S. Shipping Board states, the shipping in export trade included only 46 per cent American and 54 per cent foreign bottoms.

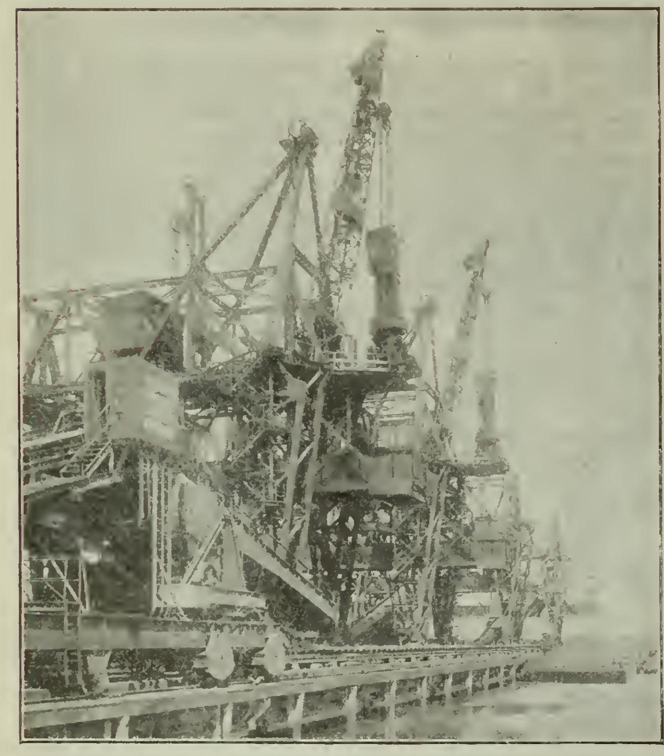
Mechanical Coal Trimmers Solve Ship Loading Problem

Installation at Curtis Bay Pier, Baltimore & Ohio Railroad, Increases Plant Capacity and Reduces Labor

By Philip George Lang, Jr.
Assistant Engineer of Bridges, Baltimore & Ohio R.R.

TO PROVIDE the last step in the transfer of coal from cars to boats at the export coal pier of the Baltimore & Ohio R.R. at Curtis Bay, Md., the engineering department of the railroad has evloved and put into operation mechanical trimmers, resulting in a material increase in the handling capacity of the pier and a very large decrease in necessary labor. Hand trimming of boats having numerous small hatches and two or more decks involved the employment of large numbers of men, and when the labor situation became serious, upon the entry of this country into the World War, the impaired capacity of the pier and the high cost of trimming led to an investigation being made by the engineering department which resulted in the conviction that a machine could be designed and built which would satisfactorily supplant hand trimming.

The Curtis Bay coal pier, which was described in



MECHANICAL COAL TRIMMERS RAISED AND LOWERED BY BOOM SUPPORTS

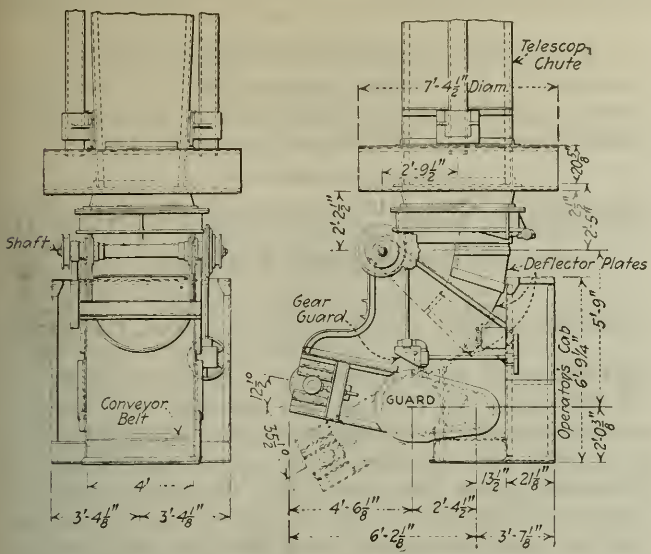
Engineering Record of March 17, 1917, p. 421, and in *Engineering News*, April 6, 1916, p. 656, is unique in that long conveyor belts are used for effecting the transfer of coal from ordinary cars to vessels. It was built in 1916 and supplanted a gravity coal pier, constructed by the Baltimore & Ohio during the '70's, which was outgrown by the demands of traffic. On the new pier two special McMyler car dumpers discharged coal upon four main conveyor belts. Four movable coal-loading towers carry transverse belts which receive the coal from the main 60-in. conveyor belt and discharge

TRIMMER LOWERED TO OPERATING POSITION IN HOLD OF SHIP

it into vessels, the transverse belts being capable of movement longitudinally of the pier to accommodate the various hatches of vessels, transversely to accommodate boats of varying beam, and vertically to compensate for varying drafts of vessels. Two years' operation has demonstrated a very large capacity as instanced by the recent loading of the SS Malden for the New England Coal & Coke Co., in which 7,222 tons of bituminous coal, which had been contained in 151 cars, were received in 1 hr. 58 min., which is believed to be a world's record for rapid loading.

The pier was highly satisfactory when so-called "open" boats, requiring little or no trimming, were to be loaded; but with boats having numerous small hatches and two or more decks it became necessary to resort to hand trimming involving the employment of a large number of men to shovel the coal by hand between decks to the more or less remote parts of the vessel. This condition caused the cost of loading per ton of coal to rise very rapidly and materially decreased the capacity of the pier, for the reason that, while the boats were being trimmed by hand when berthed, the plant was idle. Experience at Curtis Bay and at other ocean terminals has clearly demonstrated the inadequacy of manual trimming as an adjunct to mechanical coal delivery, and has shown that it involves long and costly delays to vessels.

The mechanical trimmers, developed by the engineering department of the railroad company during 1918, embody the principle of an endless belt to which bulk material is delivered through a telescopic chute of four sections, and distributed by the movement of the belt at high speed. Coal is delivered at the top of the telescopic chute by the shuttle belt of the transverse coal pier unit. In the design of the trimmers it was attempted to secure a speed of the continuous belt which would give the maximum throw and at the same time correspond approximately with the velocity attained by the coal in its descent from the shuttle belt



DETAILS OF NEW COAL TRIMMER

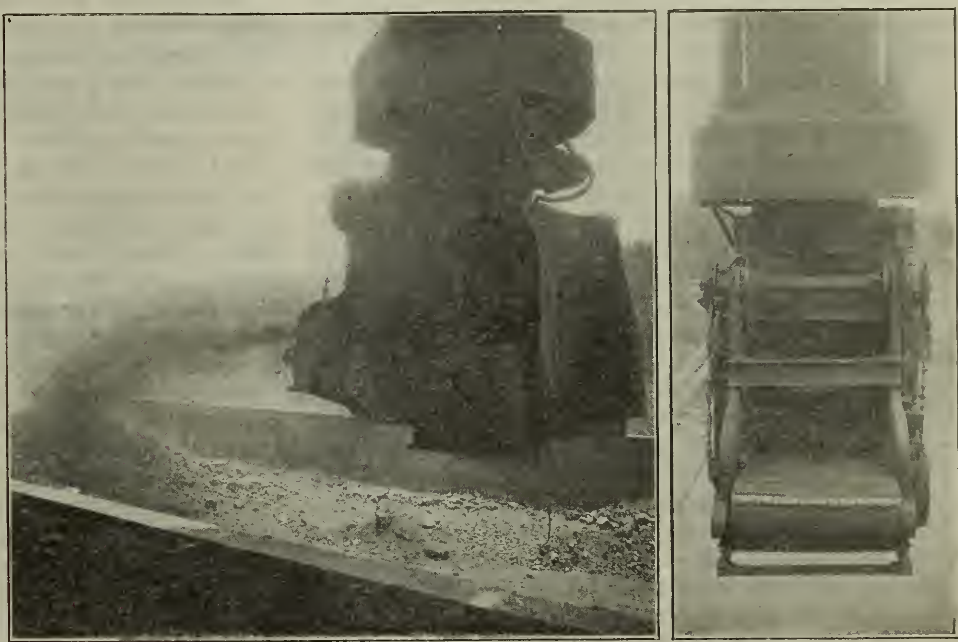
when directed by properly placed deflecting plates to the endless belt.

The telescopic chute has a minimum cross-sectional area of 2 ft. 9¾ in. x 3 ft. 2¾ in. The greatest distance from the top of the cross belt delivering coal to the chute to the top of high-speed trimmer belt is 44 ft. 3 in., and the minimum, 23 ft. 6 in. with the chute completely telescoped, so that allowance is made for varying drafts of vessels and more than one deck in trimming.

The angle of the trimmer belt may be elevated by means of a mechanism consisting of a ratchet wrench driving a worm wheel through a shaft and meshing with a gear segment on a lever arm carrying the belt frame. The endless belt is also capable of rotation through a complete circle accomplished by a 13-hp. direct-current motor driving a motor pinion, engaging gear, which drives a worm and worm wheel and pinion engaging a rack.

A limiting factor which presented a serious obstacle in the development of the design was the restricted hatch areas of oceangoing vessels. The machine as built has an extreme horizontal dimension of 7 ft. 6 in. x 10 ft. 0 in. In this small space a mechanism had to be developed capable of imparting to the material handled an initial velocity adequate to the proper discharge. The distance to which bulk material must be thrown in order properly to fill the holds of various types of oceangoing vessels became the object of consideration and much time and study were devoted to plotting the trajectories of material thrown at different angles and various speeds. To attain the desired range in the throw of coal it was found necessary to attach cross cleats to belts, in spite of the fact that coal is delivered to the end of trimmer belts at comparatively high velocity. These cleats are thoroughly protected by metal to reduce wear, as indicated in the photograph. The belt has a width of 48 in. and a distance center to center of the 18-in. pulleys of 3 ft. 9 in., running at a velocity of approximately 2,700 ft. per minute. The power for operating the trimmer belt is provided by a 40-hp. direct-current motor connected to the endless chain pulley by a chain drive, protected by metal housing. Elaborate provision is made throughout the trimmer to protect all mechanism from dust.

It was necessary to give careful attention to the method of supporting the trimmers since their weight is approximately 22 tons each. The trimmer had to be movable so that it would not interfere with the movement of boats alongside the pier and had to be held steady in heavy winds, as well as being capable of being quickly lowered to operating position, securely attached to the loading tower. The accompanying photograph shows one machine in the housed position, and another in operation in the hatch of a vessel. Vertical pipes which resist the reaction of the flow of coal and the lateral wind forces are used to support the trimmer from the cables passing over the boom. In a loading position, the weight of the lower portion of the machine is held by the boom through the ropes and vertical pipes, while the telescopic chute section is held by brackets placed on top of the cross girder. The lower brackets on the end of the cross girder are so designed that they do not take vertical loads, but prevent lateral movement. It is possible to move from the completely housed position into loading position, in the hatch of a vessel, in approximately 3½ min. The operator is stationed at the rear of the trimmer itself and is so able to closely guide its operation, accompanying it into the hold of a ship.



LEFT, TRIMMER DISTRIBUTING COAL IN BARGE. RIGHT, BELT WITH CROSS CLEATS THROWS COAL OUTWARD

The first of the trimmers was placed in operation Dec. 27, 1919, when 1,000 tons of petroleum coke were delivered to the SS Victorious. The last of the four trimmers was installed April 9, 1920. Up to the present time the four machines have handled over 1,000,000 tons

of coal under practically incessant operation and the most severe demands.

The practicability of the trimmers has been established by investigation and analysis of cost elements. On March 21 and 22, 1920, the SS Scotsburg, a ship with five hatches and four 'tween decks, was loaded with 9,600 tons of coal in 9 hr. and 30 min. It is estimated that 25 hr. would have been required if hand trimming had been employed.

The accompanying photograph, which was taken in the open on a barge for the reason that it is impossible to obtain a photograph of the trimmer when working within the hold of a vessel, shows the machine throwing coal at the rate of approximately 17 tons per minute.

The result of the successful operation of the four mechanical trimmers, two on each side of the pier, has been to change this pier from a four-boat pier to a two-boat pier, the most efficient operation being obtained when the mechanical trimmers are used to their fullest extent in one boat on each side of the pier; that is, the material is deposited in the vessel as fast as it is conveyed to the mechanical trimmers.

Undoubtedly, the most important element for consideration in connection with the cost of trimming coal by the use of mechanical trimmers, both from the standpoint of expense and of efficient operation, is that of the service or life which is obtained from belts. Service tests of various types of belt have been made, and the data obtained are well worth the effort. A material reduction in the cost of belt per ton of coal handled, the largest of the mechanical trimming cost elements, has been effected, but the accumulation and analysis of belt data have not as yet reached the point where the writer feels that the full possibilities of this portion of the device have been realized. The general results so far obtained, however, have demonstrated beyond all doubt that the trimmers now in use at Curtis Bay are far superior to any device previously evolved.

One of the most severe tests which these machines have encountered in actual service has been the occasional and accidental introduction of foreign bodies into the chute, with the coal, and their passage through the trimmers. In addition to car knuckles and springs, these articles include a piece of iron 2 ft. wide by 3 ft. long, weighing approximately 500 lbs., and, in two other instances, large pieces of stone, weighing respectively 500 and 600 lbs., which passed through the machine without causing damage. On another occasion, a steel car strut, approximately 8 ft. long, 10 inches wide and 4 inches thick, found its way to the trimmer belt and passed over the machine.

While every possible precaution is observed to prevent the intrusion of such material into the chute, the fact that the trimmer has, on several occasions, discharged objects of this nature without damage to itself is a striking illustration of the sturdiness of these machines and their ability to withstand hard usage.

The development of the machine was carried out by the engineering department of the Baltimore & Ohio R.R. under the immediate direction of the writer, including the preparation of general plans and supervision of the structural and mechanical details as these were developed by the engineering department of the McMyler Interstate Co. which fabricated and erected the trimmers. The device, patents for which are now being secured, will be known by the trade name of the "Lane-Galloway" trimmer. The installation of a machine of this nature was recommended by C. W. Galloway, vice-president of the railroad company, and the work was placed under the general direction of H. A. Lane, chief engineer, and W. S. Bouton, engineer of bridges.

Syracuse Uses Tar-Sand Cushion in Wood-Block Paving

By John Stanley Crandell
Consulting Engineer, General Tarvia Department, the Barrett Company, New York City

THE wood block pavement on East Water Street, Syracuse, N. Y., was laid recently in a manner somewhat different from that usually followed. In place of a plain sand cushion, or a cement-sand cushion, a tar-sand cushion was spread and the blocks were laid thereon. While this method has been used to same extent by street car companies it has not been given an extensive try-out in city work.

The concrete base was given the finish usually employed when a cushion coat is to be laid over it. It was evident that a number of people had walked through it before it had set, and therefore there were areas where it had to be smoothed up with a pickax before the cushion could be laid.

The cushion consisted of dry sand and light refined tar, in the proportion of about 90 per cent sand and 10 per cent tar. These were mixed cold in a local asphalt plant. The mix was brought to the job in the regular bottom dump wagon, spread and raked as if it were binder course for a sheet asphalt pavement, except that the raking was easier, and there was no need to hurry to prevent setting up or cooling.

The specification called for a depth of cushion of ¾ in. Owing to the irregularities of the base, mentioned above, the depth varied from ½ in. to 1½ in., but on the whole it probably was close to specification. The blocks were laid on the unrolled cushion. After they were in place, and the culls had been removed and replaced, the pavement was rolled with a light tandem roller. The joints were filled with coal-tar pitch, and the surface was sanded. It was not possible to roll the cushion; the tarred sand stuck to the roller.

There are some decided advantages about this method of construction. First of all, an absolutely waterproof cushion is provided for the blocks. Water can neither find its way up through the cushion nor can it seep through from the surface. With a pitch filler in the joints there should be no danger of any bulges or blow-ups from moisture causes. There can be no shifting of the cushion from entrance of water or other causes. This cushion of tar and sand sets up after a while into a firm but resilient mat. The cost is low.

The amount of tar will vary with the quality of the sand. The writer made an extended series of tests in 1912, 1913, 1914, and 1915 to determine the right amount of tar to use. In all he tested over 1,200 briquets of tar and sand mixtures and the strongest were those that contained between 7.5 and 11 per cent of tar, by weight. The coarser the sand the less tar necessary, but a minimum of 7.5 per cent should be set. Less than this amount produces a mix that will not hold together. At the present writing there are no recommendations to make as to how to determine the correct amount to use other than to state that a fine asphalt sand will require about 10 per cent of tar, while a coarse building sand will require less.

The History of Engineering

By C. Matschoss
Professor of Engineering History at the Charlottenburg Technical College

In an article published in this journal Feb. 12, p. 322, R. Fleming urged the importance of compiling a history of engineering. Many of the data for such a history, in this country more so than elsewhere, are rapidly becoming lost. Over twenty years ago the same thoughts stirred a young German engineer, Conrad Matschoss, to attack the problem singlehanded. His first historical monograph gained the interest and help of the national engineering society, and later led the Charlottenburg Technical College to found a chair of Engineering History, of which he is the first incumbent. In order to acquaint those who will write America's engineering history with what has been done elsewhere, Engineering News-Record *asked Prof. Matschoss to tell briefly of the development of his historical work. The present article is his response. In transmitting it he says: "Every step of progress in this field made in the United States will tend to further our own endeavors. We European engineers can wish for nothing better than to see the excellent suggestions of Mr. Fleming put into effect."* —Editor

Whoever should attempt, 5,000 years hence, to reconstruct our present age by the help of our present day historical records, would find only stories of presidents and kings, of the mistakes of our diplomats and of the deeds of our great generals. Of the real essence of our age, of engineering, which has revolutionized our life and by means of which the United States of America has acquired its dominating position in the world, the seeker after truth would learn very little.

The great men of engineering science have molded the history of their age, but in doing so they found no time to write this history. Our historians know too little about engineering to comprehend our age or do it justice. Therein lies a reason for the remarkable fact that our scientists know a great deal about the tools of the stone age, but very little about modern tools, and yet no greater proof of the glory of American engineering during the last fifty years could be adduced than the history of American toolmaking.

It will be necessary for engineers to write their own history, but this history will in reality be nothing less than the history of a nation of workers. If that history were written we would be able to recognize plainly how much we owe today to whole generations of inventors and engineers in all countries. Often these great pioneers of engineering would appear to us more deserving of praise than the modern statesmen and warriors, upon whom history is wont to lavish its laurels.

The vast amount of research work to be done in the field of engineering can only be realized by one who has selected historical research work as his special study. It has been my privilege to be engaged in this work since 1895, and in 1901 I published a history of the steam engine, in which I endeavored to treat this important subject in a manner which would appeal to everybody. When I had finished this work I found that it was only a beginning, and that a systematic study of this matter was only possible after I succeeded in obtaining the assistance of the Institute of German Engineers. This great engineering institution opened for me the archives of the government and of the great engineering factories; it gave me introductions to prominent engineering firms, and allowed me to travel extensively. Everyone I came in contact with evinced an intense interest in my work, and many thousands of original drawings were willingly placed at my disposal, dating back to the beginning of the 18th century. In this manner, in 1908, I completed my book on the "Development of the Steam Engine," in two volumes, being a history of the stationary steam engine, the locomobile, the marine engine and the locomotive.

This work was so favorably received that the Institute of German Engineers decided to entrust to me the task of historical research and the regular publication of a periodical under the title *Contributions to the History of Engineering and Industry.* This publication, which is devoted exclusively to the history of engineering, first appeared in 1909, and since that time has been published regularly. Up to the present there are nine volumes, containing important contributions referring to all ages and to the most varied countries and topics. The biographies of prominent engineers and the history of industrial and engineering enterprise have been fully treated. In the same year I received a call for filling the newly created chair of Engineering History at the engineering university of Charlottenburg.

Sources of Information

Doubtless the history of the engineering science of bygone ages is very fascinating and important. It is more important for us, however, to discover the sources of the history of engineering of our present age and to keep a systematic record of them. Whatever we neglect to do in this respect now will be irretrievably lost. Those of our great engineers, still living amongst us today, who have been the creators and pioneers of the particular branch of engineering they represent, are sources of information which we cannot dispense with. The great engineering societies should stimulate these men through the medium of the great engineering press to leave their memoirs to posterity.

What a vast store of historical engineering information is contained in the autobiographies of Werner Siemens, Henry Bessemer, Charles T. Porter and many others! In Germany we are at present endeavoring to work systematically in this direction. Long historical conversations with prominent engineers are taken down by shorthand writers and supply much important material which, entrusted to the archives of the Institute of German Engineers, forms a valuable contribution to the history of engineering. There are many industrial concerns which, on the occasion of a jubilee celebration, happen to remember that they have a history to be proud of, and then proceed to write an account of the historical development of their works, based on the data contained in their own archives. In this manner historical works have been produced that are a mine of information for the historian specializing in the history of engineering and industry.

Engineering Museum Established

Such endeavors received an extraordinary stimulus in 1903 through the establishment of the "Deutsche Museum," the German museum for masterpieces of natural science and engineering in Munich. Oscar von

Miller, the well-known electrical engineer, a friend of the famous inventor Thomas A. Edison and honorary member of the American Society of Mechanical Engineers, succeeded in an incredibly short time in compiling a collection of historically remarkable productions of engineering, which were admired by the whole world. This collection was received with such widespread approval that the necessary funds were quickly placed at the disposal of Mr. von Miller. When it became my privilege to visit the Munich Museum with 200 American engineers I found among them the fullest possible understanding of the importance of the history of engineering. They pointed out to me in what high degree such a museum is adapted for stimulating interest in great engineering work amongst the masses of the people. In this museum the portraits of the great engineers and scientists are placed close to their masterpieces, thus inspiring the onlooker with that enthusiasm which alone is productive of great accomplishments.

When will the great Museum of Engineering be started in America? For anyone who knows the importance of engineering it is a great pleasure to see that in the National Museum in Washington the famous Stevens marine engines and many other masterpieces of engineering are accorded equal prominence with other exhibits. What Paris can boast of in its Conservatoire des Arts et Métiers, London in its Kensington Museum, and Munich in its German Museum will surely in no distant future be emulated by a country which has risen into prominence with steamships and railways and through engineers who are famous throughout the world.

The science of engineering is not confined to the boundaries of any one country, and as in Munich the masterpieces of the different nationalities are placed peacefully side by side, so the future great American Engineering Museum will no doubt bear testimony to the fellowship of all engineering and scientific research workers. This museum would be destined to become the center, in America, of all systematic historical research work, and to the great and influential enginering institutions this will be a gigantic common task for the common good of the profession.

If the enterprising spirit of American engineers is once directed into channels for systematically furthering the history of engineering we shall all benefit enormously in every other country. Nowhere is competition more desirable than in this field, for it aims at bearing testimony to the work of our great engineers and arousing enthusiasm in those who wish to become engineers. Without this enthusiasm in the growing generation of engineers we shall never succeed in rebuilding this world and making it better than it has been before.

Philadelphia Municipal Pension System

A pension system for all municipal employees has been in effect in Philadelphia since July 1, 1915, following a legislative act of the year named. Employees who have reached the age of 60 years and have been 20 years in the service of the city are entitled to a pension equal to one half their average salary or wages received during their term of service. Employees contributed 2 per cent of their wages or salary to the pension fund, but not to exceed $4 a month. This pension scheme does not include policemen and firemen, who have a separate pension fund.

Lumber Depletion in the United States

In a report to the United States issued under date of June 1, 1920, the Forest Service of the United States Department of Agriculture comes to certain conclusions regarding the present status of the timber supply in this country. The outstanding facts are that three-fourths of the original timber of the United States is gone and that we are using timber four times as fast as we are growing it. The forests remaining are so localized as greatly to reduce their national utility. The bulk of the population of manufacturing industries is dependent upon distant supplies of timber as a result of the depletion of the principal forest areas east of the Great Plains. The depletion of timber is not the sole cause of the recent high prices of forest products, but it is an important contributing cause whose effect will increase steadily as depletion continues.

The Present Problem

The fundamental problem today, according to the bulletin, is to increase production of timber by stopping forest devastation. At one time the virgin forests of the United States covered 822,000,000 acres. They are now shrunk to one-sixth that area. All classes of forest land now aggregate 463,000,000 arces. Of the land remaining not utilized for farming approximately 81,000,000 acres have been so severely cut and burned as to become an unproductive waste. New timber remaining in the United States is estimated roughly at 2,215 billion board ft., three-fourths of which is in virgin forest: the rest is the second growth of relatively inferior quality. About one-half the timber left is in the three Pacific Coast states, and over 61 per cent is west of the Great Plains. A little over one-fifth of the timber left in this country, or 460 billion board ft., is hard wood. There is now consumed or destroyed annually 56 billion board ft. of material of saw timber size. The total yearly consumption of all classes of timber is about 26 billion cu.ft., and the depleted forests are growing less than one-fourth of this amount.

According to the report of the Secretary of Agriculture the solution of the problem presented by this forest situation is a national policy of reforestration. Increase of widely distributed production of wood is the most effective attack upon excessive prices and monopolistic tendencies. Depletion has not resulted from the use of forests but from their devastation. It is recommended, therefore, that legislation be enacted which will permit effective co-operation between the Federal government and the several states in preventing forest fires and growing timber on cutover land, and which will greatly extend the national forests.

A statement is made that can be construed as giving as the opinion of the Department that profiteering has been rampant in lumber selling. "A study of prices and increased production and distribution costs during the pre-war and post-war periods substantiates the statement that prices during the end of 1919 and the beginning of 1920 reached costs unjustified by production and distribution costs. Irrespective of the distribution of excessive profits, which by and large unquestionably varied with relative advantages held and with relative abilities to dominate situations, lumber prices are excessive and yield profits bearing no reasonable relation to increased cost of lumber production and distribution."

Testing Rock Bearing By Leverage Loading Machine

Device Used at New Sacramento River Dam by Reclamation Service Engineers Proves Successful

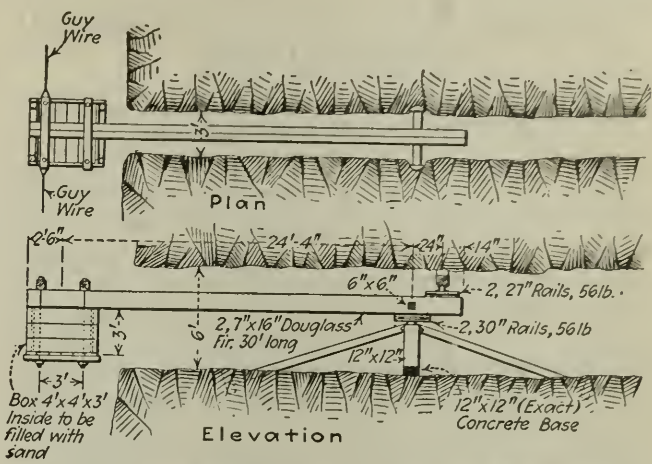
Bearing capacity of rock is as a rule most difficult to measure by any simple field testing machine. In the investigations for a new dam at Iron Canyon, on the Sacramento River, however, the engineers of the Reclamation Service used such a machine with success. Its details and the results of the tests are described as follows by H. J. Gavit, Engineer, U. S. Reclamation Service in the August, 1920, number of the *Reclamation Record.*

The site for the dam is in a region where the rock formations are all of volcanic origin. These include tuffs, breccias, agglomerates, and basalts. Of these classes the one most suitable for foundations for a dam is the agglomerate, and the location of the dam site was governed mainly by the consideration of finding a place in the canyon where this formation is of sufficient thickness under the river to provide a safe foundation. At the site selected the agglomerate lies in a nearly horizontal sheet or bed about 140 ft. thick, of which about 110 ft. is beneath the river bed.

This rock is composed of volcanic sands, ash, and large and small fragments of lava, mixed and cemented to form a sort of natural concrete of varying hardness. In drilling this material with a core drill few samples were obtained except from the lava blocks, the body of the mass being generally too soft to produce solid cores. There is no stratification or regularity in the formation, the softer parts occurring in irregular masses or pockets. For the purpose of examining this rock more closely a drift or tunnel was excavated into a cliff near the dam site. This tunnel was about 3 x 6 ft. in size and 35 ft. in length. It penetrated both hard and soft material, the latter in places being soft enough to be excavated by a pick without blasting.

Before planning a high masonry dam to rest upon this agglomerate rock it was desirable to know its bearing capacity or supporting power, and to this end a test was made in the tunnel by applying varying degrees of pressure upon an area of 1 sq.ft. on the floor of the tunnel at a point where the softest material was found. The apparatus for making the test consisted of a simple beam or level 30 ft. long bearing on the roof at one end, with a weight applied at the other. The short arm was 2 ft. and the long arm 24.4 ft. Concrete blocks 12 in. square and 3 or 4 in. in depth were molded on the roof and floor at the points of bearing. The beam was of Oregon fir, 14 x 16 in., formed by two pieces 7 x 16 in. bolted together. The weight used was a wooden box 4 x 4 x 3 ft. inside, filled with sand. Short sections of 56-lb. steel T-rail were used in combination with 12 x 12 in. pine blocks to concentrate the pressure at the proper points on the beam. In the joints between the wood and concrete blocks at the roof and floor steel pointers were inserted, extending about 3 in. to a vertical graduated scale attached to a frame fastened to posts which were set farther back in the tunnel so as to be unaffected by the application of pressure. By this arrangement a movement of the pointers along the scales would indicate the yielding or compression of the rock.

As a check on the results levels were carefully taken on both roof and floor blocks before and after the test. Five readings were taken on each block and referred to two bench marks before the test and another set of readings at the same points was taken after the test. These level readings showed no measurable settlement or compression at either block. The indicator at the floor block, however, showed a settlement on the scale of ⅛ in. This result was discredited for the reason that the arrangement of the indicator was such that the progressive pressure may have caused a slight twist in the pointer, and the results of the level readings were considered much more reliable.



DETAILS OF ROCK BEARING TESTING MACHINE

Following is the record of the pressures and corresponding gage readings:

Test Conditions	Roof Block Pressure Tons	Roof Block Gage Inches	Floor Block Pressure Tons	Floor Block Gage Inches
At start, before applying pressure.....	....	15.25	....	2.375
With beam and empty box..........	7.6	15.25	8.8	2.325
Weight box partly filled..............	20.0	15.25	22.0	2.310
Weight box filled....................	33.3	15.25	36.5	2.250
With extra weights added...........	36.0	15.25	39.5	2.252

The limit of pressure for the apparatus was reached at 39.5 tons. What additional pressure the rock would have supported is not known.

The level readings showed no actual settlement of the floor block as a whole, but indicated a slight tilting of the block which was accounted for by the small movement of the beam and post during the process of loading. The conclusion therefore was that there was no measurable yielding at either the roof or floor block.

Applying the result of the test to the design of the dam it is recognized that the conditions are not quite similar for the reason that in the test the load is applied at the top of a pyramid of pressure, whereas under the dam it is applied at the top of a theoretical column of uniform thickness. Taking into account this difference in conditions, since the material stood under nearly 40 tons per square foot without yielding it is considered safe to design the dam with pressure on the foundation not to exceed 10 tons per square foot. All pockets of soft material exposed in preparing the foundations should, however, be excavated so as to leave a surface of the harder rock.

Duluth Plans Crossing of Canal

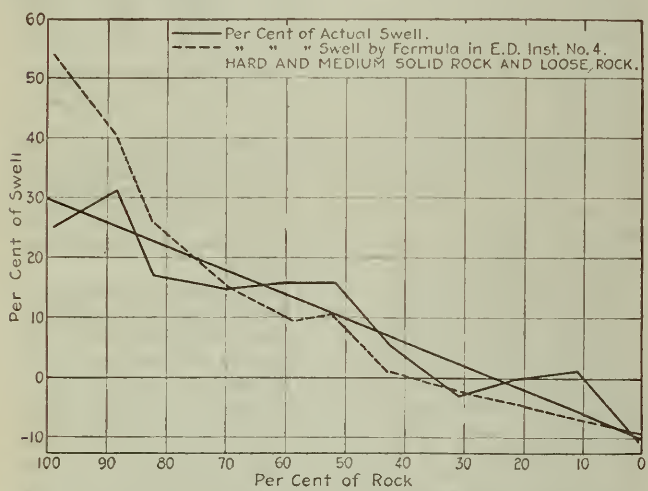
Traffic over the aerial bridge which spans the ship canal across Park Point and forms the entrance to the inner harbor at Duluth, Minn., has increased to such an extent that alternative plans have been made by E. K. Coe, city engineer, for drawbridge and tunnel projects to afford adequate facilities for passengers, street cars and roadway vehicles, and possibly for railway tracks also. Any kind of bridge is opposed by the Lake Carrier Association and the U. S. War Department. A tunnel would require a steep approach and its cost is estimated roundly at 72,000,000. No action has been taken, but an improved crossing is needed on account of the traffic and to enable the six miles of waterfront on Park Point to be developed for docks and warehouses. This district is said to be well able to sustain reasonable expense to provide communication. The aerial bridge or ferry bridge was built in 1904 and was designed for trips at intervals of 20 to 30 minutes for the car suspended from a 393-ft. span high enough to clear vessels. The contract price was $100,000, but this included the design. The operating and maintenance cost has been $193,000 during 15 years of service.

Shrinkage and Swell of Materials In Railway Fills

Carriers' Report Includes Results, Covering Many Rock and Earth Materials, Obtained from Actual Measurement

Abstract of Subcommittee Report, Presidents' Conference Committee, Federal Valuation of the Railroads of the United States, heretofore unpublished.

A SHRINKAGE in railway embankments composed entirely of earth approximating 10.4 per cent of the original volume in cut, and, in embankments composed entirely of rock, an average swell of 30 per cent are indicated in the conclusions of a report recently made to the engineering committee of the Railway Presidents' Conference Committee by a subcommittee consisting of D. J. Brumley, chairman; H. E. Hale and Charles Silliman. The report states that the allowance for shrinkage in earth embankments should not be less than 10 per cent and the results obtained indicate that, with increasing proportions of rock, shrinkage decreases rapidly and swell takes place in material of more than 40 per cent rock.



SWELL OF ROCK AS MEASURED BY CARRIERS AND AS CALCULATED BY INTERSTATE COMMERCE COMMISSION

The subcommittee was appointed to investigate and report on the subject of shrinkage and swell of material in embankments with respect to the instruction issued by the eastern district of the Valuation Bureau of the Interstate Commerce Commission, as follows:

"Where grading involves classified materials the ratio of measured volume of embankment to that in excavation, where better evidence is lacking shall be used on the following swell factors applied to the excavation measurement. For hard solid rock and loose rock (boulders or detached masses), 60 per cent; for medium rock and loose rock other than boulders or detached masses, 45 per cent; for soft rock, loose of the same character as to hardness and hardpan, 10 to 25 per cent; earth or common excavation, 10 per cent shrinkage."

Accompanying this instruction quoted above were charts showing the swell or shrinkage for fills composed of varying proportions of rock and earth, the latter filling to some extent the voids of the former. It seemed to the committee that the best way of testing the accuracy of the charts was to compare results obtained by its use with the swell determined by measurements of various combinations of material encountered in actual construction. Railways were requested to furnish information as to swell of rock and to make cross section surveys of embankments, preferably those abandoned at the time of construction, where the quantities from which they were built could be identified in the records. This applied only to ten jobs out of all those reported. Eight of these lines were the Vermont Central and two were Illinois Central jobs. These ten jobs were cross sectioned on lines which were abandoned during construction. All of the others were on operated lines. The total returns represented 12,000,000 cu. yd. of excavation and the general results are shown in Table I taken from the report, which was compiled from the accompanying chart.

TABLE I. SWELL AND SHRINKAGE OF MATERIAL IN RAILWAY FILLS OF EARTH AND ROCK

Proportion Rock Per Cent	Proportion Earth Per Cent	Swell or Shrinkage	Result by Measurement, Per Cent	Result by Valuation Rule Per Cent
100	0	Swell	25	54
90	10	Swell	31	40
80	20	Swell	17	26
70	30	Swell	15	15
60	40	Swell	16	10
50	50	Swell	16	11
40	60	Swell	6	1
30	70	Shrink	3	2
20	80	Shrink	0.1	4
10	90	Shrink	1.2*	7
0	100	Shrink	10.4	9

* Swell.

In connection with this table the report points out that where the proportion of rock is more than 60 per cent the instruction from the Bureau of Valuation provides a greater swell than that indicated by the measurement of known cases, but that where the proportion is less than 60 per cent the rule gives a smaller swell than that indicated by the measurements. From a study of the records covering about 12,000,000 cu. yd. it appears that a maximum allowance of 30 per cent for swell is representative of actual experience where the banks are comparatively new, the allowance decreasing with the decreasing proportions of rock.

The committee reports that the rock fill records consist largely of cases where the measurements were taken during or shortly after the completion of construction. It expresses the opinion that with some kinds of rock in the course of years disintegration will take place, filling the voids and thus reducing the volume of the mass. This opinion is confirmed by the few cases of measurements of old fills. For this reason the committee considers that with old embankments containing 40 per cent or more of rock great care should be exercised in determining the percentage, as with many materials the actual swell will be less than the percentage given in Table 1. In Table II are shown some of the individual records of shrinkage in rock and earth of different kinds.

As to shrinkage of earth embankments, the report states that the records obtained show that such embankments "shrink in all cases from the dimensions of the original excavations," the average shrinkage in the cases reported being 10.4 per cent as indicated by the 12,000,000 cu. yds. involved. This matter has been given prominence by the brief of the Public Utilities Commission of Illinois (in connection with the valuation of the Elgin, Joliet & Eastern Ry.) that no allowance should be made for shrinkage in earth embankments. On the other hand, the practice of the Bureau of Valuation of the Interstate Commerce Commission has

TABLE II. SHRINKAGE OF EARTH AND SWELL OF ROCK IN RAILWAY FILLS AS DETERMINED BY ACTUAL MEASUREMENTS AND BY THE RULE OF THE BUREAU OF VALUATION

Railway	State	Material	Shrinkage by Measurement, per Cent	Shrinkage by Rule, per Cent	Method of Construction	Quantities Involved—(Excavation) Cu.Yd.
Cen. Vt.	R. I.	Fine, dry, sand	7.77	9.1	A	96,767
Cen. Vt.	R. I.	Stiff blue clay	12.27	9.1	A	3,047
Ill. Cen.	Ill.	Dune sand, fine and dry	8.81	9.1	A	358,408
So. Pac.	Ore.	Borrow earth, very clayey	1.8	9.1	B	11,016
So. Pac.	Ore.	Silt and coarse, hard gravel, mostly borrow; bottom of large fill	10.3	9.1	B, C, D	64,160
So. Pac.	Ore.	Clayey silt	11.1	8.7	A, C	9,648
So. Pac.	Ore.	Clayey silt, gravelly in spots, half cuts and half borrow	10.1	9.1	B	31,660
So. Pac.	Ore.	Very clayey, mostly cuts	3.5	9.1	C, D	5,572
So. Pac.	Ore.	Cemented material, clayey in character; mostly cuts; 2.5% rock in fill	15.1	8.6	E, F	26,781
No. & West.	....	Light clay with considerable sand and some mica	8.8 to 9.7	9.1	C, D	124,059
No. & West.	....	60 per cent dry sand	6.1	9.1	C, D	44,360
No. & West.	....	Some quicksand	10.3	9.1	C, D	77,120
		ROCK FILLS	Swell by Measurement	Swell by Rule		
L. & N.	Ala.	Hard limestone	55.9	60	....	13,782
L. & N.	Ala.	Shale and sandstone	20.6	45	....	155,000
Un. Pac.	Utah	Hard rock	21.0	60	A, C	30,862
Un. Pac.	Wyo.	Medium hard rock	9.9	45	A, C	6,215
Cen. Vt.	Mass.	Granite	31.9	60	D	8,762
Colo. So.	Colo.	Granite	48.4	60	E	3,596
Mo. Pac.	Ark.	Hard limestone	24.8	60	B	23,053
Mo. Pac.	Ark.	Very tough limestone	32.6	60	B	25,955
Mo. Pac.	Ark.	Hard slate, disintegrating on exposure	10.2	44.4	B	69,211
So. Pac.	Ore.	Very hard trap in tunnel	90.1	60	....	9,444
So. Pac.	Ore.*	Trap and other rock, mostly tunnel; 1.1% earth in fill	45.5	58.2	....	41,405
C., M. & St. P.	Wash.*	Hard basalt; 2% earth in fill	46.0	56.8	F	10,660
C., M. & St. P.	Wash.*	Hard basalt, 2.5% earth in fill	66.6	56.0	F	31,205
Ch. & O.	W. Va.	Hard sandstone	35.1 to 45.3	60.0	....	54,211
Ch. & O.	W. Va.	Hard sandstone and shale	23.3	57.8	....	190,582

* Earth is included with rock in small proportions in these three cases.

NOTE—Methods of construction (see last column): (A) Unloaded from temporary trestle; (B) Teams and scrapers; (C) Steam shovel; (D) Dump wagons; (E) Carts and horse-drawn cars dumped from sides and ends of fills; (F) Station men.

been to add an allowance of 10 per cent to the measured embankment quantities in computing pay quantities, which is the equivalent of assuming that the shrinkage from the excavated quantities is 9.1 per cent, as compared with a shrinkage of 10.4 per cent indicated by actual measurements of railroad construction.

Railroad grading is paid for usually by measurements of excavation (one way method) or by an allowance of the quantities within the dimensions of the standard roadbed section, both cut and fill (two way method). In the construction of embankments, allowance is made for shrinkage. But as the pay quantities are otherwise determined, accuracy of a shrinkage allowance has not been deemed important.

An entirely different situation has arisen in the valuation work. The fills, as well as the cuts, must be measured, and the problem presented is what should be added to the measured embankment quantities as developed by the Bureau of Valuation to be equivalent to the yardage required to construct the embankment, where the borrow pits cannot be located. The studies submitted amply and clearly show that shrinkage always does exist, doubtless varying in quantity, and the committee suggests that as a practical matter and in the interest of economical and prompt prosecution of the work of valuation an average allowance of not less than 10 per cent is fully warranted.

TABLE III. COMPARISON RAILWAY RECORDS OF EARTHWORK WITH FIELD MEASUREMENTS MADE BY INTERSTATE COMMERCE COMMISSION

Railway	State	Fill Built	Miles of Fill	Cubic Yds from Railway Records	Cu. Yds. Meas. I. C. C.	Difference Per Cent of Col. 6
O. W. Ry. & N.	Wash.	1886	2.7	23,160	20,673	13.03
L. A. & S. L.	Utah	1902–03	116.0	3,861,567	3,333,237	15.85
Gt. Nor.	No. Dak.	1905	13.0	137,418	124,991	9.94
Gt. Nor.	No. Dak.	1904	5.0	80,871	70,634	14.49
Gt. Nor.	No. Dak.	1904	0.34	5,571	4,692	18.73
Gt. Nor.	No. Dak.	1906	42.0	578,942	537,662	7.68
Gt. Nor.	So. Dak.	1888	14.5	89,527	81,527	9.81
No. Pac.	No. Dak.	1903–05	40.0	458,766	407,481	12.59
No. Pac.	No. Dak.	1909–10	91.0	1,824,058	1,644,760	10.90
C. & N. W.	Minn.	1899	195.0	2,856,724	2,412,624	18.41
C. & N. W.	So. Dak.	1882	13.0	170,348	158,097	7.75
C. & N. W.	Iowa	1910	29.0	875,255	767,588	14.03
C. & N. W.	Wis.	1900	166.0	1,093,172	1,028,752	6.26
C. & N. W.	Wis.	1891	40.0	550,630	515,187	6.88
C. & N. W.	Ill.	1912	86.5	3,052,397	2,850,280	7.09
Soo Line	Mont. & Dak.	....	......	8,438,134	7,813,704	7.97
Ill. Cent.	Ill.	1907–08	1.13	358,408	311,977	14.88
Ill. Cent.	Ill.	1903	17.0	811,342	681,958	18.97
Ill. Cent.	Iowa	1898–1900	131.0	5,131,184	4,101,532	25.10
Ill. Cent.	Miss.	1907–08	27.5	407,072	287,304	41.69
Ill. Cent.	La.	1907–08	65.0	765,814	542,571	41.15
Wabash	Ohio	1902	11.0	153,761	119,007	29.20
Penna.	Md.	1870+	48.7	1,266,491	886,682	42.83

NOTE—The percentages in the last column may be modified by allowances based on later information in regard to subsidence.

It was suggested to some of the railways, therefore, that they should compare the figures developed by the field measurements of the Bureau of Valuation with the actual figures from their records. Such a study was made covering nearly 40,000,000 cu. yd. and the average difference in original and present quantities thus developed was 14.4 per cent. As most of the measurements in this particular study were made several years after the construction of the fills the committee considers that 14.4 per cent is a more correct allowance than the 9.1 per cent allowance now made by the Bureau of Valuation. Table III gives a portion of this tabulated comparison, showing the relatively low figures obtained by the rule of the Bureau of Valuation. The report closes with the following statement:

"The committee suggests that judgment and care should be exercised in determining the percentage of swell and shrinkage to be applied in different cases, giving due consideration to the varying character of the materials encountered, and that as an approximate method (except in some special cases) a swell of 30 per cent for rock should not be exceeded, even in comparatively new banks, nor should the shrinkage allowed for earth be less than 10 per cent."

Directory of City Health Officers

A directory of health officers in cities and counties having an estimated population of more than 10,000 is given in U. S. Public Health Reports for July 2, 1920. An asterisk denotes "full-time" officers. Such an officer is defined as "one who does not engage in the practice of medicine or in any other business, but devotes all his time to official business."

Check of Immigration Requires Labor Conservation

ON returning from a survey of industrial conditions in Europe, Frances A. Kellor, vice-chairman of the Inter-Racial Council, New York City, proposed the following statement regarding the need for labor conservation in America due to the check of immigration:

The time has passed when the American employer could count upon an unlimited supply of labor from abroad. Emigration from the countries of Europe will be strictly regulated by the governments in the near future, and is already being directed in some of the Old World nations, which have begun to realize the value of their workers.

This is the case in Italy, for instance, which has supplied us with such vast numbers of unskilled and semi-skilled laborers. The French Government has offered Italy six tons of coal per month for each Italian miner induced to go to France, and the Commissioner of Emigration of Italy is advising his people to emigrate to France. It is asserted that opportunities are better there than in America, both for steady work and high wages. Other countries are making efforts to keep their citizens at home. Greece is offering inducements of farms to the people, having passed an act by which large land owners may retain only one-third of their estates, while surrendering two-thirds to the peasants. If this offer should not be sufficiently persuasive, emigration from Greece may be prohibited at any time by law. Conditions in that country are being studied at present to determine what action may be necessary to prevent an undue exodus of the population. The extension of Greek territory is a powerful reason for keeping these people in their own country. Similar conditions are found in Finland, where areas have been set aside for settlement, and farm implements and supplies are offered to small cultivators on liberal terms.

Attitude of Foreign Governments

These instances show the attitude of foreign governments toward their nationals. Instead of permitting their men and women to leave at will and select their own destinations, as in our port, emigration will be curtailed, by many governments, to the extent deemed expedient for their own interests. Instead of the emigrant selecting his own future home, the governments will advise him where to go, and in some cases will retain him as a citizen, with voting rights, even while living abroad. At present the Lithuanians in America have three deputies to represent them at the next meeting of the Constituent Assembly of Lithuania, while Italy has under consideration a plan to give its nationals throughout the world elective representation in its home government.

This means that the immigrants who do come here will have less tendency to make America their permanent home and become citizens, hence we will have to make greater efforts to assimilate them than we have done in the past. It indicates a policy opposed to the best interests of America, and which should be opposed by our people before it becomes an accomplished fact.

Some of the foreign nations are planning to do the things which America should have done long ago; to protect immigrants from fraud, to establish official information bureaus, to take care of their savings through branch banks and generally to look after their welfare. International agreements are being made between Old World countries regarding immigration. Diplomats of Hungary, Poland, Greece, Italy, France, Lithuania, Spain, Portugal and the Balkan countries have taken the lead in such conferences, but the United States, which has so much at stake in the matter, has shown indifference. If our supply of coal, iron, oil or cotton were threatened, the whole nation would be aroused, but with the imminent curtailment of our labor supply, even at this time of acute labor shortage, the Government and the business men who should be interested are remaining quite apathetic.

The new era of world-wide business requires an international view of conditions if American interests are to be adequately cared for. To help meet this need, the Inter-racial Council has planned a series of bulletins reflecting the world movements and endeavoring to interpret them.

These are no longer mere academic questions, but matters of direct concern to the American business man. When the manifesto of a leader in Russia can react with greater force upon the workers than the words of the plant executives, or when a stream of literature in foreign languages can counteract utterances in the American press or in plant organs, it is essential to the self-interest of the American business man that he should know about these things and act with information on the facts.

Meanwhile it is to the interest of every industry to conserve the present inadequate labor supply and make the best use of it. The tendency of the foreign-born workers to return to their old homes should be checked by every legitimate means. The most powerful inducement to them to remain is of course just and humane treatment, with no discrimination in wages, housing, living and working conditions between them and the native born. Efforts should be made to establish closer relations with the foreign born workers. If they have legitimate causes for discontent, the grievances should be understood and removed. The same spirit of co-operation that is being secured through enlightened employers and their English-speaking workers should be developed into relation to the foreign born laborers.

This is not "coddling," not philanthropy, but labor conservation. As in the early days of America we were wasteful of our resources, coal and oil, natural gas and timber, until we saw the results of extravagance, so at present we are as wasteful of our man-power as if the supply were inexhaustible.

We should not be deceived by the temporary increase in immigration. The figures that indicate a large number of arrivals at Ellis Island fail to show the fact that the proportion of women, children, professional and clerical workers is so great as to afford little relief to our labor shortage. Of the manual laborers coming in, a large percentage are men who went abroad to fight and are now returning to their old jobs. Of new workers, to do the essential work of America, there is an exceedingly small percentage, while recent correspondence from all parts of the United States indicates serious shortage of labor.

The course of action for the employer is therefore, first, to conserve labor as carefully as he conserves his raw material; second, to regard immigration problems with the same interest that he gives to international commerce, realizing that America is no longer isolated and that what happens in the Old World today will be reflected in his own business tomorrow.

An international conference on immigration is planned for 1921, in which the United States should play a leading part. Business men who are interested may obtain further details through The Inter-racial Council, Woolworth Building, New York City.

Use of Peat on Swedish Railways

Interesting trials to test the possibilities of peat as fuel for locomotives have been in progress for some months on several railways in Sweden. The reports so far show favorable results. One privately owned railroad in southern Sweden, 256 mi. in length, has found peat so practical for steam purposes that the management believes the road can dispense entirely with coal. The State Railways have likewise been testing peat for steam purposes, with good results, and have on a limited scale adopted it for fuel. For some years the State Railways have been operating a factory for the production of peat powder, which is said to make an excellent fuel. In Sweden, where there are 10,000,000 acres of peat bogs, with an average depth of 6.6 ft., the substitution of peat for coal would add enormously to the national wealth. Every acre of peat bog yields nearly 1,000 tons of prepared peat.—*Commerce Reports.*

Notes from Foreign Fields

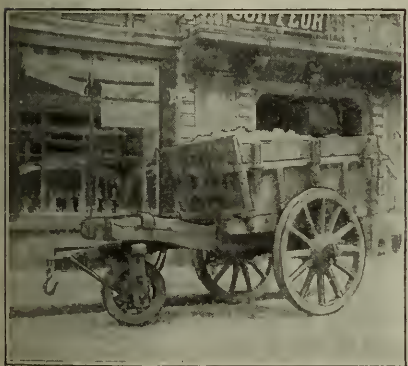
BRUSSELS—THE CITY BEAUTIFUL

BY E. J. Mehren
EDITOR ENGINEERING NEWS-RECORD

AFTER a voyge of more than a week one expects to find on this side of the Atlantic a different country. So England is. But after a month in England one is astonished at the marked difference one finds after the three-hour ride across the Channel—from Dover to Ostend.

We leave a land of brick and of narrow streets, cities of dun hue, and arrive in a community of broad avenues, sparkling with the brightness of the white and cream-colored houses, houses which give the impression of being built of stone even when the walls are of stucco. After a week in Brussels one still walks along enchanted by the delightful vistas afforded by its city planners. In England one's thoughts are occupied with the utilitarian—the pavements, the transportation facilities, the traffic. Here one revels in those features which go to make a city beautiful.

Yet Brussels is but a foretaste of Paris. Here there are two rings of boulevards, the inner one around the



THREE TYPES OF CART SEEN IN BELGIAN CITIES

older part of the city. From these run broad radial avenues in every direction. Rectangular planning is conspicuous by its absence. Many of the avenues are tree-planted. The boulevards have grass plots, generally with four lines of trees, a central driveway for passenger vehicles and two side carriageways for the commercial vehicles and the street railways. Street widths naturally vary with the character and location of the street. Some new streets are as narrow as 14 m. between property (fence) lines, with carriageways of 7 m. On the other hand, some new residence streets may be as much as 25 m. wide between property lines, with 12-m. carriageways. Main arterial ways are wider, while the boulevards are as much as 77 m. between property lines. That is the width in large part of the inner ring of boulevards.

This inner ring has a maximum diameter of only about 2 km. (1.2 miles) and in the course of an ordinary business day one is constantly crossing it. The effect is most favorable.

CLOSE-JOINTED SANDSTONE BLOCK PAVEMENT

STATE PLANTED FOREST NEAR BRUSSELS

Nor are the broad avenues and the boulevards the only features that impress the visitor. Squares are common, not merely the stone-paved spaces for the accommodation of traffic at important cross-routes, but the park squares. They, too, elbow close to the business quarter. In them, tucked away in nooks of shrubbery, are beautiful statues, not merely of the commemorative sort, but of a subject befitting the location. Of commemorative statuary there is a great deal—as is the case in England also—but it stands rather in the paved squares where the multitudes circulate and the great can receive the attention their achievements merit.

Paving—From the paving standpoint Brussels is a city of stone. Such pavements are found even in the residential districts, though for such neighborhoods tar-macadam and asphalt are coming into use. For the heaviest traffic porphyry is used; for lighter traffic and on grades, a sandstone, called *grès* is favored. Most of the stone paving is on old macadam foundation, using a 3-in. cushion of sand. Sand is used exclusively for jointing. The blocks vary in size, but the most common is 10 cm. wide, 15 cm. long and either 12 or 14 cm. deep (4 x 6 in. by 4.8 to 5.6 in. deep). Where a concrete foundation has been used the thickness has been only 10 cm. (4 in.) but the recent specifications call for 15 cm. (6 in.). The proportions are 1 : 2½ : 5.

The Brussels experience, however, is of relatively small value for us, because the traffic is light. There are but few motor-trucks.

One feature of their stone-block experience should be emphasized—the success they have had with sandstone. It reminds one of the fine medina sandstone one formerly saw in Cleveland. *Grès*, the sandstone used here, wears very evenly. For grades it has a grittiness that the porphyry lacks. Its life, naturally, is shorter than that of volcanic rock. The life of porphyry under the traffic of the business center is from 25 to 30 years; on residence streets, from 40 to 50 years. Good maintenance is, of course, necessary to get these terms of service.

Before the war these pavements on old macadam foundations cost from about $2.20 to $2.75 per square yard. The cost now is from three to four times as much.

Brussels, June 9.

BELGIUM'S RECOVERY—YPRES

IN BELGIUM one realizes that he is at the seat of war. In going from London to Brussels one first sees war destruction at Ostend. The "Vindictive" still lies in the harbor entrance, though its removal is under way; the dock buildings are being reconstructed, while houses along the shore are damaged. One quickly leaves these evidence of destruction, but other reminders of the war are always at hand. Along the railroads German rolling stock is to be seen; minor coins of a zinc composition largely replace the nickel coinage, while paper one-franc notes are the most common medium of exchange. These 2 x 3½-in. bits of paper, issued by two of the leading banks, one of them the Banque Nationale, cost Americans about 8 cents each, against a normal value of about 19 cents.

COVERED DRAIN FOR BROOK AT YPRES TORN BY SHELLS

Costs have gone up 350 per cent and therefore one pays what sound like abnormal prices. A luncheon bill for four totaling 90 or 100 francs is at first a great shock, but the use of the 8-cent factor restores one's composure.

In talking to engineers and business men here one catches a tone of confidence that is very gratifying. We remember the difficulty of getting the Belgian people back to work. Even now production per man is not up to pre-war levels, but it has improved so much since the middle of last year that Belgians are quite optimistic. The rate of increase of the unfavorable trade balance is decreasing every month. Unemployment has practically disappeared.

Labor costs have naturally gone up. Men who received from 4 to 6 francs per day before the war receive 20 to 25 francs now. Their efficiency, one qualified business man stated, had risen from exceedingly low figures last year to probably 80 per cent now, based on pre-war production. Remembering that the Belgian has always been a faithful and hard worker, he is today more nearly earning his wages than the American or the British worker.

With these high labor costs, contractors and manufacturers are looking into the possibility of using labor-saving machinery. Among the larger contractors the performance of American construction machinery is well understood, but just now there is practically no market for it, principally because the rate of exchange makes its cost prohibitive. Moreover, the Belgian contractor, noting the increase in efficiency during the last year and hoping that the cost of living will soon begin to fall, is inclined to defer buying, believing that there is a possibility of having again cheap construction labor in Belgium.

Before the war the Germans dominated the market for what equipment, such as steam shovels, cranes, hoists, etc., was sold. The prejudice against the Germans is still strong and with the readjustment of exchange there should be a field here for the American builder of construction plant. The Belgian worker has no prejudice against the use of machinery, so that one of the difficulties encountered in England at least, is not here present.

YPRES

While the industries are busy, the restoration of the destroyed region in the neighborhood of Ypres is not proceeding rapidly. In going to Ypres from Brussels one sees an astonishing contrast—between a marvelously farmed countryside and chaos. Until one reaches Coutrai one would not know that the land had for four years been in the hands of an invader, but in the trainshed there no glass remains, while bullet and shell-splinter marks show that here was military action. Gradually other signs of war appear, here a house in ruins, there a huge heap of jetsam of war—piles of barbed wire, some scrapped concrete mixers, a road roller or two. Near Menin the zone of severe destruction is reached, but even there the fields are again under cultivation. In the town, much damaged, little houses with concrete foundations and semicircular roofs of corrugated iron fill some of the gaps.

At Comines the fullness of destruction is reached. Barbed-wire entanglements in process of removal, trenches, shell holes are everywhere. In an occasional dugout a Belgian has re-established his home.

Round about as far as the eye can reach, "No Man's Land"—and it looks it; the ground broken into a hopeless series of pits and hollows; the forests reduced to dead sticks; no sign of houses or land lives, save when at great intervals the red roof of a new house serves only to emphasize the desolation.

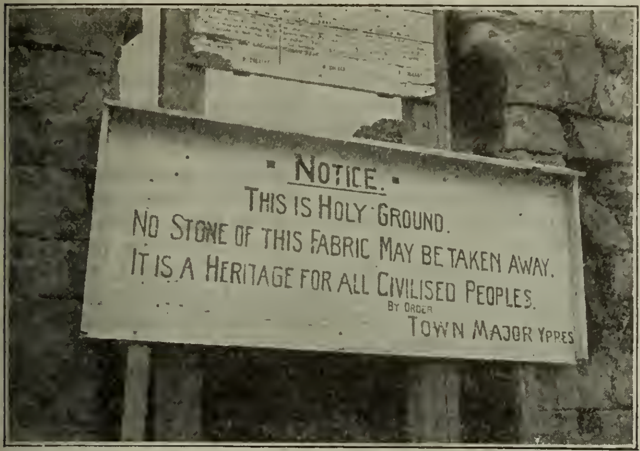
Ruin—the land swept as if by an avenging hand. I can think of nothing to liken it to but our American deserts. Only those dead silences can convey the impression of lonesomeness, of desertion. There, though, we have sand and sage and greasewood. Here it is green, the pock-marked earth grown up with burdock and chick-weed and thistles. There is no relief, no emphasis, save for that of the gas-killed trees.

In Ypres there is nothing but ruin. Not a single house remains intact. Most of them are heaps of brick and mortar. The imposing buildings—the cathedral and the Cloth Hall—still fling high their shell-torn walls, while to emphasize what happened here the council of Ypres has put up at intervals this sign:

The Burgomaster and the City Council of Ypres urge you to remember that the ground on which you walk is hallowed by the sacrifice of 250,000 British officers and men, who were killed or wounded in four terrible years of battle endured in the salient of Ypres, and whose heroism Belgium can never forget.

Another sign found in different parts of the town is shown in one of the photos.

The city, so the Belgian government has decided, will not be rebuilt but will be kept as a national memorial.



A SIGN BOARD AT YPRES

Round about new houses are springing up and the people are busy cleaning up the wreckage.

Except in Ypres and a few other towns, however, progress has been slow. The barbed wire has largely disappeared, but the trenches and shell holes are still there. Occasionally a little patch of land has been newly plowed. Effort seems to have been concentrated on restoring the village life and the farms in the less severely damaged area. Soon probably the other areas will be taken in hand.

For the remainder of this year, however, one can get at Ypres some conception of No Man's Land. It is not a pleasant place—nor a place for the merely curious. It is for those who want to appreciate to the full the horrors—and the accompanying heroism—of war.

Brussels, June 11, 1920.

Shipping Board to Sell Steel Vessels

MINIMUM selling prices for different types of Shipping Board vessels have been fixed by the board as follows: Lake and Submarine Boat Corp. types, $160; Hog Island, Skinner & Eddy, and all types over 10,000 tons, except combination cargo and passenger vessels, oil tankers and refrigerator vessels, $175. These prices are per ton deadweight rating, and for ships equipped to burn coal. Where they are fitted for oil burning the prices are $10 per ton higher. Part payment terms are offered by the board, under which 10 per cent of the purchase price must be paid in cash on delivery of the vessel and the remainder in installments covering a period of 12 years, deferred payments carrying interest at 5 per cent. Control of a certain part of the earnings of the vessel is maintained by the board until 50 per cent of the purchase price has been paid. These selling offers are made under the terms of the 1920 Merchant Marine Act.

Asphalt Maintenance Costs in Columbus

FROM its local representatives at Columbus, Ohio, the Barber Asphalt Paving Co. has received a report on maintenance costs of asphalt pavement in that city, from which the following data are taken:

Columbus has 1,320,628 sq.yd. of asphalt pavement, of which 1,002,990 sq.yd. are laid with native lake asphalt. On thirteen streets, comprising a yardage of 101,502, the average life of the asphalt pavement has been 28.77 years. For eleven of the streets the average cost of maintenance per square yard per year has been 3.3c. Figures for the other two pavements have not been kept.

Bryden Road from Parsons Avenue to Twenty-second Street, an area of 12,573 sq.yd., was laid in 1888, or 32 years ago. The cost for maintenance per square yard per year has been 2.1c. The cost of maintaining King Avenue from High Street to Neil Avenue laid 30 years ago and covering 8,683 sq.yd. has been 2.2c. figured on the same basis; 14,612 sq.yd. on Franklin Avenue from Parsons Avenue to Wilson Avenue, also laid in 1890, have required 3.2c. per sq. yd. per year. Washington Avenue, with 10,646 sq.yd. from Broad to Buckingham Street, paved in 1891, has proved slightly more expensive to maintain, the figure being 4.9c. This, however, is the highest figure in the list of the thirteen streets more than 23 yr. old.

The following table gives the maintenance figures for the old streets:

Streets	Year Laid	Square Yards	Maintenance Cost per Square Yard per Year
Champion Ave., Broad St. to Mt. Vernon Ave.	1889	8,448	$0.038
Cleveland Ave., Broad St. to Long St.	1896	3,820	0.023
18th Street, Bryden Rd. to Main St.	1892	2,985	0.032
Hamilton Ave., Broad St. to Long St.	1897	4,377	0.029
High St., Poplar Ave. to Fifth Ave.	1895	13,700	.....
Ohio Ave., Broad St. to Main St.	1889	9,878	0.044
Parsons Ave., Broad St. to Main St.	1891	7,248	0.039
17th Street, Main St. to Bryden Road	1890	3,181	0.039
State Street, High St. to Pearl St.	1888	1,351	.

All of these streets were paved with Trinidad Lake asphalt. Of the total yardage of asphalt streets in Columbus, 999,782 sq.yd. or approximately 76 per cent, were laid with Trinidad Lake asphalt. Bermudez Lake asphalt was used for 3,208 sq.yd.

The foregoing figures were submitted to Henry Maetzel, chief engineer of the division of engineering and construction of the Department of Public Service, who makes the following comment:

"The figures are correct as shown by our records. However, the following explanation will be in order.

"Prior to 1907 our maintenance work was done by contract. Since then the city has operated an asphalt repair plant and made all repairs. Figures of cost given do not include interest on outlay for asphalt plant or any depreciation. This would increase the cost perhaps 10 per cent. The cost is averaged over the entire life of the pavement, though very little was spent during the first ten years."

Erie R.R. Uses the Chicago River

Operation of two local freight yards on the Chicago River at Erie St. and Webster Ave. has been commenced by the Erie R.R., cars being transferred on barges between these yards and the main Chicago freight yard at 18th St. This is a resumption of local freight service which was abandoned during the war.

Letters to the Editor

Effect of Increased Rates on Railroad Construction

[The following letters are in reply to inquiry from the "Engineering News-Record" in regard to the probable effect of the recent increase in railroad rates on railroad construction.—Editor]

Sir—Replying to your recent letter regarding effect on railroad construction due to the increase in railroad rates. I will answer your questions in order as follows:

1.—The railroads will not be able to launch programs of construction until it is possible to secure the necessary funds with which to make improvements which is dependent upon the restoration of the credit of the railroads.

2.—It is likely that it will be some time next year before the additions and betterments program can be undertaken on a large scale.

3.—The transportation of materials is now affecting the construction the same as it is with other industries.

4.—(a) The first consideration for expansion of facilities is more locomotives and cars, (b) engine terminals and shops to take care of the equipment, (c) yards and terminals to provide facilities for the more expeditious handling of traffic, (d) double tracking to expedite the movement between terminals.

This is about the order in which the transportation facilities of the country today require expansion.

5.—It is likely there will be an expansion in the engineering departments and personnel to meet the new situation. This is due to requirement that the railroads of the country must be honestly, efficiently and economically managed and this can best be done through a thorough reorganization of the departments.

6.—The railroad facilities of the country are today from three to five years behind in their normal development and it will require that length of time to put the transportation business in proper condition to handle the traffic offered.

L. C. Fritch,
Chicago. Vice-President, Chicago, Rock Island and Pacific Railway Co.

Sir—Now that substantial increases in rates have been granted the railroads, it is expected that the surplus earnings will enable the roads to make large expenditures in improvements. This is a matter of great interest to the public in general; for, when railroads spend large sums of money, general prosperity results therefrom.

Just at present the railroads are waiting to find out what the advance in rates and wages will mean in earnings before deciding what should be done. It is natural to suppose, therefore, that if the results of these earnings are what may be expected, work on a large scale will follow.

At the present time the railroads are hampered by the want of equipment, and this is largely due to need of repairs, to bad order cars and to scarcity of engines, and while this continues the lack of transportation facilities will naturally hamper the progress of the work. So before much can be done, it will be necessary greatly to increase the number of cars by building new ones and repairing those in bad order, and the number of engines must be increased materially.

It must be remembered that just previous to the war and during Government control it was almost impossible to get materials and labor for repairs to keep the tracks up to the standard, and the first work to be done would be largely that of renewal of ballast, ties, and rails, but as there is still a scarcity of labor and materials for carrying on work, progress in these lines of work will be slow.

The season of the year is so far advanced that no immediate construction will be done by the railroads, and the outlook has been so gloomy that no important construction programs have been made. In all probability extensive plans for additions and betterments will be made during the winter months so that work may be started in the Spring.

Because of the difficulty of getting materials, a great deal will not be accomplished during the coming year to relieve the shortage of transportation facilities of the railroads, and until steel mills are able to turn out a greater tonnage than at present it will not be possible for the railroads to accomplish much.

From this it is plain it will be one to two years before the railroads will be able to start on any extensive plans for necessary enlargements to keep up with the times. Engine terminals, double-tracking and yards will undoubtedly receive first attention in order to shorten division runs so as to cut down overtime, and consequently very little line revision will be made until some time in the future.

On account of the valuation of railroads the surplus engineers of the country are generally employed, so that no large expansion in engineering departments can take place.

It must be remembered that as soon as the railroads start work on a large scale, the factories which supply the materials will take a great deal of the labor of the country. This will mean that labor will be very scarce and work will naturally progress very slowly. Therefore, while the outlook is favorable, yet the scarcity of materials and labor will largely control the money that can be expended by the railroads in future work.

A. O. Cunningham,
St. Louis. Chief Engineer, Wabash Railway Co.

Engineers in Railroad Wage Award

Sir—I have noted the letter published in your issue of Aug. 5, p. 279, by W. J. Sykes in which it is intimated that the engineering societies were largely responsible for the lack of technical recognition in the recent railroad wage award. It appears to many of us that discrimination was used against the engineering profession by the board and that the technical societies have been equally guilty in not protesting *en masse.*

Judge Barton, chairman of the award board, was quoted on the subject as follows: "Civil engineers as such had no submission presented for them and hence no question as to them decided. In all the argumentative debate of the board in executive session, civil engineers (broadly speaking, professional engineers) were not considered because they had not been properly before the board in hearing." Judge Barton further made plain the proper procedure by explaining that the board cannot and will not entertain or receive for hearing any case until it can be shown and evidence produced to substantiate that a reasonable amount of effort has been expended by the professional engineers to seek or hold a conference with the managment of the carrier in an attempt to settle any dispute involving salaries.

This is a perfect argument for unionism. Yet the technical societies have always frowned down on any such suggestions. If we are not to unionize, have we not the right to expect these societies to protect the individual members from financial losses in consequence of such a decision? Judge Barton and the only one of the "57 societies" making any attempts along this line except the individuals or at least the local groups in the different railroad offices to make these efforts and forward proof of same. Was proof offered that each individual member or each individual local of the different unions made such attempts? If the unions were permitted to make demands through national organizations and thus be considered as complying with the law, why would not a similar demand by a national engineering society have equal weight, and if not, why did not the national society protect against such discrimination?

Probably there will never be another opportunity to benefit the profession as a whole in such a widespread manner. The trade unions have demonstrated beyond question that to benefit one benefits all. This is not a question which concerns railroad engineers only or even primarily. It is manifestly unfair to expect unorganized engineers to comply with the same legal technicalities as unions hav-

ing paid officials unless the paid officials of the various technical societies deign to represent their members. Conditions are different from those of even five years ago, and in answer to Mr. Sykes' last question, it is most certainly not improper to expect these paid officials of the societies to keep abreast of the times, to quit dreaming abstract problems long enough to recognize an opportunity to elevate the profession as a whole, and above all, to quit passing the buck to the individual engineers who have no paid representatives but them to look to in times of adverse discrimination.

W. H. HOBBS.

Danville, Ill.

Sir—Why were the technical engineers left out of the railroad wage award?

Primarily because the wage board was a political machine element quickly thrown together as a stop gap to fend off a strike which would have taken place.

The board did not consider the technical engineer because the "57 varieties" of engineering societies mentioned by Mr. Sykes are not affiliated with any of the labor bodies who get their demands because they are enabled to enforce them.

The wage board visualized the engineers in terms of transits, levels, drafting boards and blueprints just the same as the public does.

The employer of the engineer regards him as a necessary evil; hires him under protest; charges him up to profit and loss and fires him with glee.

The engineering societies have their heads in the clouds, engaged in dry and dusty discussions—abstruse discussions of ethics, problems, etc.—and hold their professional standing so close to their eyes they can't see the rest of the big world: To the total neglect of the actual wants and necessities of themselves as a body. And money is everything today with a fifty-cent dollar.

One notable exception is the American Association of Engineers which has done more for the engineering profession, or trade, or occupation in five years than the rest put together in fifty years. If the engineers get anything out of this wage award it will be through their efforts as a body and not through individual wails.

ROBT. H. BALDWIN,
Constructing Engineer,
Chicago Northwestern Railway Co.

Chicago.

Shear in Reinforced Concrete; Mr. Godfrey Issues a Challenge

Sir—A new Joint Committee on Concrete and Reinforced Concrete is at work preparing standards of design. Presumably it will include in those standards provisions for shear in reinforced-concrete beams, a subject on which the writer has been in controversy with the accepted authorities for many years. The progress in this detail of design, however, has been so slow and the dangers of present accepted standards so great that I would like once more to call attention to the inadequacies and inaccuracies of present practice in the hope of provoking a defense of that practice which will hold water.

The writer will admit that some little progress has been made in shear provisions. Quite recently the American Concrete Institute adopted as standard the Building Regulations for the Use of Reinforced-Concrete. In the preliminary draft of that report it was provided that tension rods in beams bent up at an angle to provide against shear would have to make an angle of 60 deg. or less with the vertical. The writer opposed this provision in a discussion sent to the committee in advance and the final report changed the angle to be 0 to 90 deg., thus permitting the flat slope anchored diagonal rods advocated by the writer. In these same standards anchorage of the main steel rods into the supports is recommended, but only in special cases. These cases are where the shear on the concrete is so excessively high that it is past the initial point of web failure. These standards allow 12 per cent of the ultimate compressive strength in shears on a beam, if the main rods reach into the supports for anchorage. With 2,500-lb.

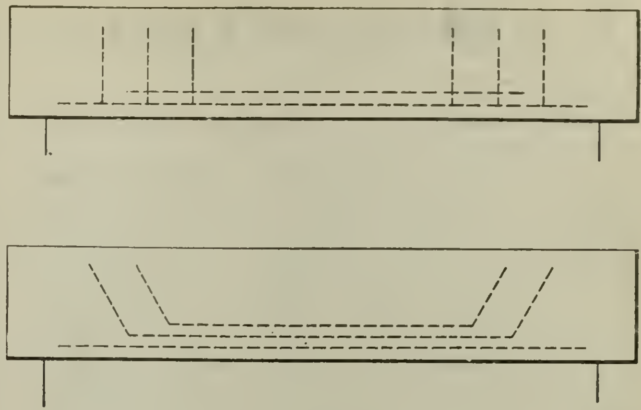


FIG. 1. STANDARD REINFORCED-CONCRETE BEAMS

concrete this would be 300 lb. per square inch. This excessive confidence in the shearing strength of reinforced-concrete beams is apparently based on tests of some extraordinary beams of I-shape where the initial point of failure of the web was between 200 and 300 lb. per square inch. These regulations allow an optional web reinforcement in the shape of bent-up and anchored main reinforcing rods as recommended by the writer.

How many engineers know that these same standards of the American Concrete Institute, in any beam or girder where the shear is not greater than 6 per cent of the ultimate compressive strength, do not require that any steel whatever cross the plane of the face of the wall or column supporting that beam or girder. Nor does the present Joint Committee report require any such tying steel, except in a vague and ambiguous reference on the subject of

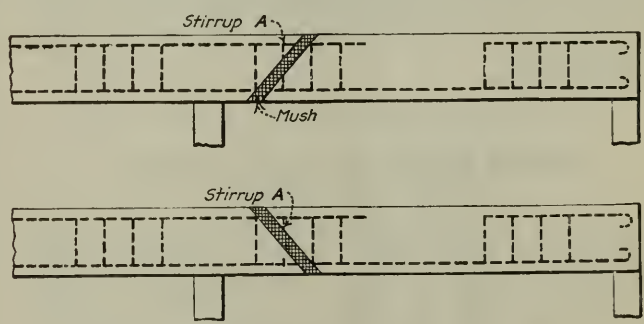


FIG. 2. WHAT STRESS IS IN STIRRUP "A"

shrinkage to connecting floor and wall members in an articulated structure. This is decidedly worthy of study. Possibly no seasoned designer would take advantage of this, but regulations are not made for seasoned designers. The beams shown in Fig. 1 are standard under the ruling of the American Concrete Institute and of the Joint Committee on Concrete and Reinforced Concrete. Stirrups are required in the beam—to hold it together for fear that it might break in two if it should fall away from the supports; but holding a beam to the support appears to be no concern of the writers of standards. Some designers are now making some of the main reinforcing rods shorter than the span of the beam. It is interesting to observe how designers discover the loopholes that allow them to save a few pounds of steel.

It seems to the writer that the basis on which rests this utter lack of provision for uniting the beam and the support by reinforcement is the action of most beams in laboratory tests. The writers of standards are blinded by the behavior of test beams. Because of the lack of shrinkage tension in the isolated specimen and because of the arch action on immovable supports, precluding tension near the supports, and because the rods do extend over the supports in test pieces, it is scarcely possible for a laboratory test beam to break close to the supports. No large tension can possibly be developed there. The shear or diagonal

tension breaks develop a short distance from the supports in these artificial tests, which are made as unlike a building as they can be. Is that why, in standards, stirrups are not required closer to the supports than a half a beam depth or so away from them? Let us forget the laboratory tests and look at wrecks of concrete buildings. When buildings fail, beams and girders break close to the supports, and stirrups or short shear members are frequently of no more value than if they were painted on the side of the beam. Shrinkage of the entire building produces a tension and standard designs make no allowance for this whatever.

It seems to the writer that there is a simple demonstration of the claim that he has often made that there is no force in a whole beam tending to elongate a stirrup. Given two beams, as per the sketch in Fig. 2, identically designed; assume a layer of mush in the first as indicated, stirrup A will be in tension; assume a layer of mush in the second, stirrup A will be in compression. This surely does not need other proof than engineering common sense. Furthermore, stirrup A will take *all* of the shear of the beam and *not* a portion, depending on the spacing of the stirrups. It will take the shear apportioned in standards to the concrete as well as that apportioned to the stirrups. It is only in a crippled web that a stirrup can take any stress, and it depends somewhat on how the mush may be laid which way that stress is going to jump.

The writer has frequently endeavored to induce, persuade, banter, challenge, coax, shame, and provoke some one to produce an analysis of the stress in the stirrup or short shear member. That analysis is yet to come. A new Joint Committee is at work. Here is something for them to consider. Reinforced-concrete standards of design will not be on a sound basis until one of three things occus: (1) The writer's statements are shown to be false; (2) his arguments are shown to be fallacious; (3) the standards are revised to agree with those statements and arguments. This condition calls for something more than silence on the part of the men responsible for the present standards, and something sounder than ridicule of one who criticises them.

EDWARD GODFREY.

Pittsburgh, Pa.

Marine Railway at Astoria, Oregon, Not Yet Completed

Sir—In an article appearing in *Engineering News-Record* of June 10, p. 1156, entitled, "Marine Railway for 5,000-Ton Ships at Astoria, Oregon," the impression was given that the marine railway which was under construction was a completed railway and was in operation. In order that the shipping interests and others may be correctly informed, I believe it would be advisable to state that the marine railway has not as yet been completed, and further, that construction work has been suspended for some time.

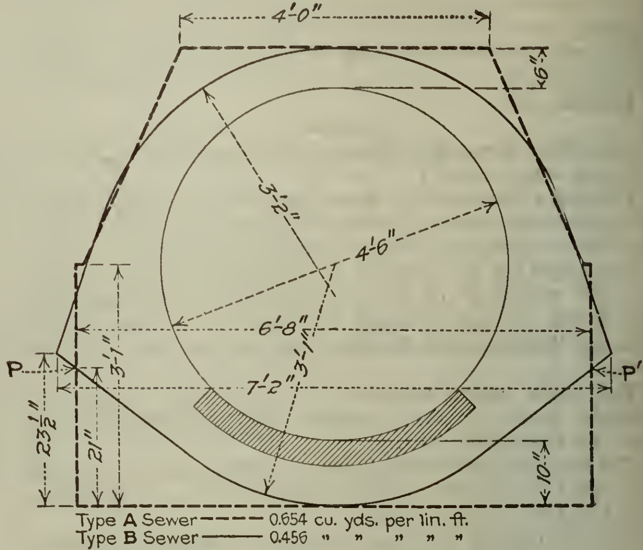
Jasper, Wyo. C. O. CRISMAN.

Composite Design for Sewer Section

Sir—The article by John P. Wentworth in your issue of July 22, p. 148, on "Sewer Cost Lowered by Increasing Concrete Yardage in Section," emphasizes a real vital point in economical concrete design in calling attention to the need of reducing labor and form costs even though quantity of concrete be thereby increased.

The enclosed diagram shows Mr. Wentworth's Type A and Type B sewer cross-section superimposed, and brings out clearly the advantages of Type A in form work and labor, as against the advantages of Type B in concrete. It rather suggests, however, a composite design, utilizing the advantages of Type A above points *P* and *P'*, while using Type B below, in order to eliminate the excess concrete in the lower corners of Type A. This design would call for 0.500 cu.yd. of concrete per linear foot of sewer, nearly 25 per cent less than Type A, and but 10 per cent more than Type B.

Comparing Type A and the composite design from the viewpoint of the contractor, the extra cost of shaping the bottom of the trench should be balanced by the saving in material to be excavated. Form work would be the same. Overhead charges would be unchanged, unless the saving in concrete permitted speeding the work up somewhat. This would leave a net saving equal to the cost of materials and



COMPOSITE SEWER SECTION PROPOSED

Design utilizes Type B below points P and P¹ and Type A above. Composite design calls for 0.500 cu.yd. of concrete per linear foot of sewer.

labor to mix and place 0.15 cu.yd. of concrete per linear foot of sewer, amounting to possibly a dollar and a half.

I would be interested to hear from Mr. Wentworth whether this type was suggested, and whether any practical difficulties were brought up against it.

M. F. SAYER,
Assistant Professor of Applied Mechanics, Union College.
Schenectady, N. Y.

[Copy of Prof. Sayer's letter was submitted to Mr. Wentworth, whose reply follows.—EDITOR.]

Sir—Several types of sewers, in addition to Types A and B, were considered. A cross-section very similar to the composite cross-section suggested by Professor Sayer was studied, but it was not thought advisable to adopt it. With such a section the contractor would be obliged to use greater care in excavation, in placing the lower inside forms and in pouring and spading the concrete in the lower portion of the sewer to prevent foreign material from rolling into the bottom of the trench under the forms. In my opinion, the extra cost of shaping the bottom of the trench would exceed the saving in material excavated. The material at the bottom of the trench is gravel and sand (some of the sand is being used for concrete) which can be excavated cheaply, but which could not be as easily shaped for a Type B or composite type as could other materials.

Last year a small sewer designed with a cross-section similar to Type B was constructed under the writer's direction. The contractor, rather than construct such a section, excavated deeper at the sides of the trench and used more concrete, although he did not quite go to the limit shown in Type A. For this extra excavation and concrete he received no compensation. This contractor was a very capable man and had done a large amount of sewer work. His method of doing the work showed that he believed a heavy section was more economical to construct than a light one.

JOHN P. WENTWORTH,
Boston. Metcalf & Eddy, Consulting Engineers.

Hints for the Contractor

Improvised Cart Hauls 3,200-Lb. Sections of Precast Concrete Pipe

TWO-WHEEL carts with cradle bodies hung low on gooseneck axles are being used to advantage in hauling precast concrete pipe for the Parley's high line conduit being built to extend the water supply of Salt Lake City. The pipe, produced at a central casting plant, are 4 ft. long and 48-in. in diameter and weigh approximately 3,200 lb. The carts, as indicated by the illustration, are simple; using old dump cart wheels, they cost not to exceed $50 apiece. The pipe line, 17,100 ft

CRADLE BODY TAKES ONE 4 x 4-FT. PIPE

long, is being laid at the rate of 275 to 300 ft. in an 8-hr. day, and six carts and two low trucks are used for hauling, the average haul per day being 14 to 17 mi. for each team. Two men and the teamster, using skids, load the pipe. The pipe is unloaded along the line at stations from 300 to 700 ft. apart and four men are required to unload the pipe and distribute it between stations by rolling. The contractor for the pipe line is P. J. Moran and the engineering work is handled under the direction of Sylvester Q. Cannon, city engineer.

Wall Form Saves Labor and Lumber

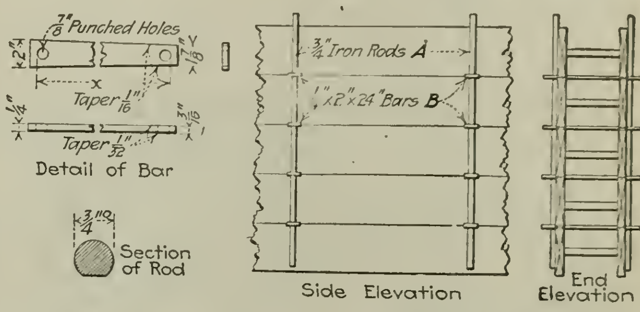
By F. W. Hodson

Inspection Engineer, Sinclair Refining Co., East Chicago, Ind.

THE life of form lumber has been lengthened and labor has been reduced in erecting and dismantling wall forms by adopting the construction indicated by the drawings. This construction is not original with the company but it has been found exceptionally useful in recent construction.

The material required consists of: 2 x 12-in. planks, ¼ x 2-in. steel straps, and ¾-in. diameter rods. The planks are notched ¼ in. deep by 2 in. long every 6 ft. on one edge. The straps are cut from ¼ x 2-in. steel in the length desired. They are then tapered 1/16 in. on each long edge and 1/32 in. on the flat faces on a grindstone. Two ⅞-in. holes are punched on centers equal to the width of wall desired plus twice the thickness of the planks used plus the diameter of one hole. The rods are cut from ¾-in. round steel and are 7 ft. long. They are flattened on a grindstone about 1/16 in., as indicated by the drawing.

In erecting the forms the bottom planks are set on



FORM PLANKS FREED BY WITHDRAWING RODS

edge with the notched edges up. The steel straps *B* are placed in the notches and the rods *A* are inserted in the holes in the straps. The second layer of planks is then laid on top of the first with notched edges up and the straps are slid down over the rods into place. This is repeated until the desired height is reached. The rods are then turned so that the long diameter is parallel to the steel strap. In wrecking the rods are turned so the flat sides are next to the planks and are then pulled out. The planks can be readily removed. Then by tapping the smaller end of the steel straps lightly with a hammer they may be easily pulled from the opposite side. Staggering the planks and coating the straps with oil will facilitate removal. The holes left by the steel straps may be pointed up after completion.

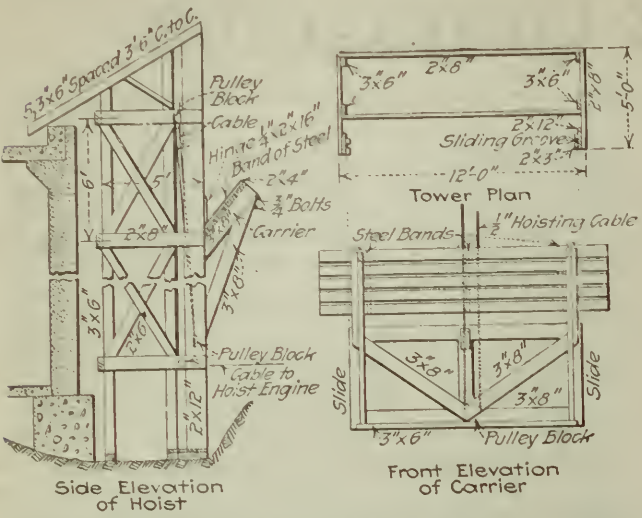
Steel and Lumber Hoist Equipment

THE horizontal struts of a small tower extended far enough to support 2 x 12-in. timbers form the skeleton of a hoist used for elevating steel and lumber to the various stories of a reinforced concrete factory building being constructed at Johnson City, N. Y., by Thompson & Binger, Inc., engineers and contractors, New York. The hoist was devised by C. M. Geupel, construction manager for the contractors.

The horizontal pieces of the tower support two 2 x 12-in. timbers upon which were placed vertically two pair of 2 x 3-in. pieces forming a groove in which the runners of the carrier slide. The runners of the carrier consists of 3 x 8-in. pieces, which form the sides of the carrier frame. Strap hinges are placed on the carrier, one end of which slides on the edge of the vertical 2 x 12-in. piece. When the carrier reaches the top of the tower this portion of the hinge falls down, releasing the bars from the carrier to the sloping 3 x 6-in. pieces on top of the tower, the bars rolling outside on these to the floor of the building. These flat iron bands placed on the platform of the carrier aid in the unloading.

The carrier, as indicated in the accompanying sketch, is elevated by means of a cable running over two pulley blocks, one placed at a point below the carrier platform so that when the carrier is hoisted to near the top pulley block the platform will have reached the top of the frame and will have automatically deposited its load.

Steel for the first supported floor was carried up a runway instead of being hoisted. For the remaining floors and the roof of the five-story building all rein-



DETAILS OF EASILY CONSTRUCTED MATERIAL HOIST

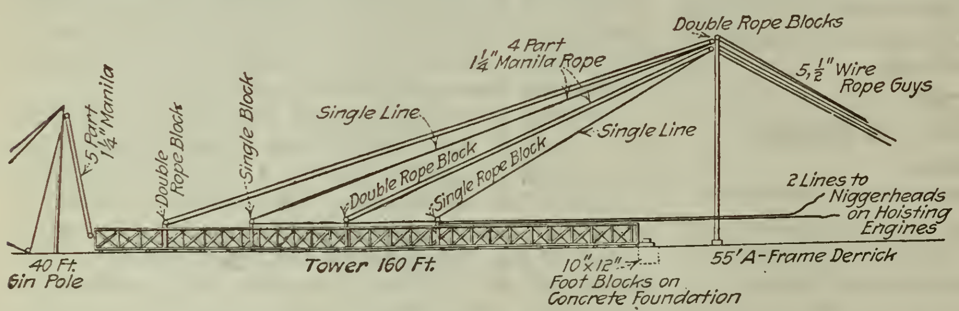
forcing steel was hoisted to the proper floor on this hoist. In addition the hoist was used for elevating form lumber, under-flooring or maple flooring and sleepers. Over 500 tons of reinforcing steel and 200,000 ft. of lumber were handled by the hoist.

[Material for this article was secured from the *Contractors' Atlas.*]

Rigging for Raising a Concreting Tower

DETAILS of the method of rigging the tackle for raising intact the 160-ft. concrete chute towers for the new Dunlop Tire buildings at Buffalo, N. Y., by the Foundation Co. are given in a recent installation sheet of the Lakewood Engineering Co. This contractor has used the same method for towers as high as 200 ft. and finds some economy, due to the greater speed with which carpenters work on the ground and the difficulty of getting any but high-priced men to go up with a tower which is erected in place.

The towers in question were entirely completed on



RIGGING FOR RAISING A 160-FT. CONCRETING TOWER

the ground, even to installing the catheads and top-sheaves and attaching the guys. They were nailed together, not bolted. Eight sets of diagonal braces were evenly distributed throughout the length of the tower on the inside to stiffen it during erection, but on future work it is planned to use oak corner posts on the lower section of the tower on the side which carries the erecting weight.

The method of rigging the tower is shown in the sketch. The hoisting blocks are attached with wire rope, several turns being taken around the entire tower. Two foot-blocks are fastened to the top of the concrete tower foundation to prevent the tower from slipping while being raised. The two main hoisting lines are carried to separate riggerheads on the hoist as the amount of pull required on the line varies.

The line to the gin pole may be handled by the same hoist, but in this case there was another hoist closer at hand to which the line was run. The guy lines are attached to deadmen with blocks and tackle, and five or six laborers with a rigger as foreman are put on each line to take up or let out the slack as the tower goes up.

The upper end of the tower is raised about 35 ft. by the gin pole. Two main hoisting lines take up the slack up to this point. From this point on the main lines raise the tower to its vertical position. The line to the gin pole is not detached but acts as guy. Skillful manipulation of the hoist guy lines prevents any kinks from forming in the tower, and the body of the tower was kept straight all through erection.

On this particular job, from the time a tower was fully rigged on the ground until it was in its vertical position with the guys fastened varied from one hour and fifteen minutes to three hours.

Tractors Replace Teams for Scrapers

TWO 5-ton tractors, each hauling three wheeled scrapers, are used for grading work by the American Cement Plaster Co. at its plant at Acme, Tex. The scrapers are of 16 cu.ft. capacity and there are two men to each train, one operating the tractor and the other loading and dumping the scrapers.

Inability to get men who knew how to drive and care for teams, extremely high wages for drivers and high cost of feed were the main reasons for using tractors. The two tractors are doing as much work as twelve wheeler teams could do, according to C. H. Newby, superintendent for the company. When the first machine was purchased it was worked in competition with one of the best teams, the horses weighing 1,400 lb. each and handling a wheeled scraper without the aid of a snatch team. The tractor pulling three larger scrapers would make about four trips to three by the team, both having the same length of haul.

Four men, as above, are now handling as much material as was handled formerly by twelve men, which makes a saving of about 25 per cent, after taking both horses and engines into consideration. With a maximum haul of about 1,200 ft. the two machine outfits are moving about 400 cu.yd. per day. The excavation is 12 ft. in depth and the dump is on the surface of the ground, so that the machines run up hill and down hill all day. The tractors load the scrapers on low gear, haul them to the dump on direct gear and return to the pit on high gear when the ground is sufficiently level. Each machine uses an average of 25 gal. of gasoline per 10-hour day and about a gallon of lubricating oil, besides cup grease. The maintenance on the machines has been very small.

NEWS OF THE WEEK

New York, August 26, 1920

E. J. Mehren Returns from Europe

E. J. Mehren, editor of *Engineering News-Record*, returned to this country on the *Aquitania* Aug. 21, after a four-months' European trip devoted to a study of engineering conditions. He left the United States April 24 and after spending about a month in England visited France, Belgium, Switzerland, Germany and Holland. For several months this journal has been publishing Mr. Mehren's observations abroad in the form of special articles and also under the heading "Notes from Foreign Fields."

Hetch Hetchy Tunnel Work Let to Sub-Contractors

The entire 18 miles of Hetch Hetchy tunnels for the water supply of San Francisco, recently let to the Construction Company of North America, has just been sublet to two well known tunnel men. A. C. Dennis has contracted for 10 miles of the work on the west or Priest portal end and Rex C. Starr has the 8 miles on the Early Intake end.

Mr. Dennis, who has been practising as a consulting engineer for several years, was in personal charge of construction on the 5-mile Rogers Pass tunnel for the Canadian Pacific Railway, where exceptional progress records were made. Mr. Starr is construction engineer for the San Joaquin Light & Power Corporation and has had charge of construction work continuously for a number of years in which he has gained a reputation for speedy work in tunnel driving.

Joint Water Supply Proposed for Seven Cleveland Suburbs

The Suburban Water Commission, composed of the mayors of seven municipalities in Cuyahoga County, west of Cleveland, Ohio, has been organized, with E. A. Fisher, city engineer of Lakewood, as secretary. The communities other than the city of Lakewood are the villages of West Park, Rocky River, Fairview, North Olmsted, Dover and Bay. Lakewood and West Park now take water from the Cleveland works. Rocky Park has an independent supply which is inadequate in quantity and unsatisfactory in quality. The other villages have no public water supply. The seven municipalities, it is reported, feel that they can secure an adequate water supply by joint action sooner than if they wait for extensions of the Cleveland works. A report on the project is to be made by Morris Knowles, Inc.

Federated Societies Sentiment in Control At Civil Engineers' Convention

Portland Meeting Asks Quick Vote on Federation—Conference of Local Representatives Favored—Opposing Amendments Referred to Committee

PRO-FEDERATION sentiment was prominently in evidence at the annual convention of the American Society of Civil Engineers, held in Portland, Ore., Aug. 10 to 12, 1920. Those who held this sentiment proved to have the necessary voting strength to control the proceedings, and, accordingly, action on the five groups of amendments to the society's constitution, which had been proposed for discussion at the convention, was favorable to the federation. A resolution requesting the Board of Direction to issue at once a referendum ballot on the subject of joining the Federated American Engineering Societies expressed the attitude of the convention majority still more clearly.

The more radical amendments were ordered to letter ballot of the society either unchanged or with but minor modifications, while final action on others was delayed. The proposal to establish an annual conference of representatives of local sections, fathered by a Philadelphia group of members, some of whom had been known as strong federation men, was accepted by the meeting, and the representation of District No. 1 on the Board of Direction was cut sharply, though the original proposal to allow the district only two directors was changed to give it three, making a total of directors (other than officers and past presidents) of fifteen. On the other hand, the amendments proposed by the Questionnaire Committee, providing in a slightly different way for the nomination of officers by the local sections and omitting to establish an annual conference that would discuss the general welfare of the society, were referred to a committee of the Board of Direction, and they will, therefore, not come up for action until next January. Another proposal of this committee, however, was passed to immediate vote, this being an increase of membership dues with reduction of the extra dues paid by resident members. An independent amendment which would have raised the dues so as to abolish all extra charges to resident members was deferred by reference to a committee of the board.

Two individual amendments, one reforming the election of honorary members by requiring a favorable vote of two less than the total membership of the Board of Direction (in place of unanimous vote) and the other making the members of the nominating committee ineligible to office during service, were acted upon favorably, being passed to immediate letter ballot.

Discussion of the five groups of amendments (designated as A, B, C, D and E in *Engineering News-Record* of July 29, p. 235, where their provisions are summarized) was the principal business of the convention. To facilitate action upon them, the convention divided them into fourteen parts, the proposed amendments to each separate article being considered by themselves.

Address of President Davis

Before the work of the convention proceeded, President Arthur P. Davis delivered the annual address, after welcome had been given to the convention by the mayor of Portland, George L. Baker and by F. H. Murphy, secretary of the Oregon Technical Council, an organization consisting of the Portland sections of the civil engineers, the mechanical engineers, the electrical engineers, the architects and the National Electric Light Association.

President Davis sounded the keynote of the convention. His address was, in effect, a severe indictment of the "small, but very active minority" in the American Society of Civil Engineers, which, it was charged, opposed each and every step tending to co-ordination and co-operation of the Founder Societies. "The real issue in the contest now going on, and especially in the election of directors which will take place next fall," said Mr. Davis, "is whether or not the society is to take its proper place among human activities or gradually decay and become an obstruction to progress, pretending to fill a niche which it does not fill and wasting the prestige and history of this glorious society which ought to be devoted to some end more useful than individual benefits to a small circle of its membership."

President Davis asserted that Engineering Council is not a satisfactory organization for producing results, as

it lacks in democracy and in power to raise funds, and recommended the substitution of a league of engineering socieites. Referring to the plan of organizing such a society with individual membership, he pointed to the American Association of Engineers and expressed the view that it lacks the necessary prestige to become an all-inclusive society and attain the broader ends that have been aimed at in the federation movement. Under present conditions, he said, the countrywide demand for broader activity by the society cannot be met because of the existence of a strong conservative element in a few large cities, backed by an antiquated constitution. The main issues before the society were summarized as "progress versus stagnation, and democracy versus centralized domination."

Coming to other subjects, Mr. Davis expressed himself in favor of license laws and in favor of centralizing the engineering activities of the government in one department. License laws, if properly directed, he said, can be of great benefit.

The address of President Davis, practically in full, will be published in next week's issue.

Amendments Discussed

Following this stimulating address, the meeting referred the various constitutional amendments for digesting to a committee of five—George B. Mason, J. C. Ralston, Roger C. Rice, E. E. Wall and A. A. Northrup. This committee reported that six of the fourteen proposed amendments should be referred to a committee of the Board of Direction for revision and resubmission at the annual meeting of the society in January; the other eight were recommended for favorable action. The vote of the meeting was substantially in accordance with this recommendation.

In summary, four of the amendments were ordered sent to letter ballot in the form originally proposed, four were slightly revised and thereupon ordered sent to letter ballot, while six were referred to a committee of the Board of Direction for report at the annual meeting.

Passed to Ballot Unchanged—The amendments passed to letter ballot unchanged are:

Part of amendment B (see *Engineering News-Record*, July 29, 1920, p. 236), changing Art. I, Sec. 3, to broaden the stated objects of the society so as to include co-operation in economic, industrial and civic movements.

Part of amendment C, changing Art. III, Sec. 1, referring to election of honorary members by the Board of Direction so that two less than the total membership of the board will elect.

Part of amendments B, amending Art. IV, Secs. 2 and 3, so as to increase the dues of corporate members and associates by $5 and reduce the additional dues for resident members to $5 (except for associates).

Amendment D, changing Art. VII, Sec. 2, so as to make members of the Nominating Committee ineligible for election to office during service.

Amendments Modified by Convention—Detail changes were made in four of the proposed amendments as follows:

The local-section amendment in Group B, changing Art. II, Sec. 9, was modified by eliminating the last paragraph, which stated ways in which local sections would stimulate active interest of the members.

Decrease of the number of directors to fourteen, as proposed in one of amendments E, was modified by providing for fifteen directors, three (instead of two as proposed) representing District 1. A provision was also added that all officers of the society at the time of adopting the amendment should continue to serve out the term for which they were elected.

Nomination of officers at an annual conference of representatives of local sections, as proposed in another amendment of group E, was modified by providing in Sec. 3, for voting power in proportion to the memberships of the local sections, and requiring the secretary upon receipt of the report of the conference to notify the nominees and ascertain their acceptance or declination, the Board of Direction to fill vacancies caused by declinations.

In the Group E amendment establishing this annual conference (amendment to Art. VIII, Sec. 8), the principle of proportional voting was also added, and traveling expenses allowed to one representative from each section (instead of to all).

Referred to Committee of Board—Amendments affecting six sections of the constitution were put off until next January by being referred to a special committee of the Board of Direction. They are:

Abolition of the resident membership extra dues (Amendment A) by increasing the annual dues of members more than provided for in amendment B.

Nomination of officers by the local sections as proposed in three amendments of Group B conflicted with an amendment of Group E, already noted, by which the work of nomination was allotted to an annual conference of representatives of local sections. The provision of Amendments B was referred to a committee of the board.

Part of Amendment C relating to the election of honorary members proposed to strike out the clause of the present constitution which provides that all past presidents shall be members of the Board of Direction for the purpose of electing honorary members. This proposal was referred to the Board of Direction.

One of Amendments B providing for the establishment of local sections in a slightly different way from that provided for in Group E was also referred to the board.

Subsequently the following committee was appointed by the Board of Direction to consider the amendments referred back: Peter Junkersfeld, Boston; Paul H. Norcross, Atlanta; L. L. Hidinger, Memphis; J. F. Coleman, New Orleans; A. S. Baldwin, Chicago; L. R. Ash, Kansas City; E. J. Schneider, San Francisco; F. R. Fuller, Portland.

Convention Disagrees With Board

In a meeting held just before the convention the Board of Direction had decided to refer the legal questions involved in the society's joining the Federated American Engineering Societies to its legal counsel, and to issue a referendum ballot to the membership of the society only after receiving a favorable opinion from counsel. The convention took issue with this decision, however, by adopting the following resolution, moved by J. C. Ralston:

"First, that the action of the board relative to joining the Federated American Engineering Societies, taken at its meeting of Aug. 9, 1920, should be reconsidered;

"Second, that the board be directed to submit at once the question of the society's becoming a charter member of the Federated American Engineering Societies to referendum vote of the corporate membership as recommended by the Joint Conference Committee, the ballot to be accompanied by a copy of the constitution and bylaws of the Federation;

"Third, that the board be instructed in the event of a favorable vote on the referendum to proceed at once to take such steps as may be necessary for the society to become affiliated with the Federation."

At a subsequent meeting the Board of Direction took action substantially in accord with the view expressed in the resolution just quoted, as fully reported in these columns last week (Aug. 19, p. 380).

Various entertainment and special features marked the convention. About 400 members participated in a trip up the Columbia River Highway by automobile on Aug. 11, made under almost perfect weather conditions. Stops at several of the cascades along the road, a visit to the state fish hatchery at Bonneville, and a trout and salmon dinner at a long table under the trees on the shore of Eagle Creek were parts of the trip. A smoker was held the same evening, with participation of members of the Oregon Technical Council and of the American Association of Engineers. A harbor trip was made the following morning (Aug. 12) including visits to the municipal terminals, the Interstate Bridge, and the Standifer steel shipyard at Vancouver, Wash. Other parties visited the Cazadero power plants of the Portland Railway, Light & Power Co. and the Oregon City paper mill of the Hawley Pulp & Paper Co.

On the return trip from Portland, many of the convention visitors made stops at Seattle, Yakima, and Spokane, where local engineering delegations received and entertained them.

Competition Speeds Up Rate of Driving Kerckhoff Tunnels

In driving the tunnels for the Kerckhoff hydro-electric project, which was described on p. 314 of *Engineering News-Record*, Feb. 12, the contractors on different headings were encouraged to compete with one another. Prizes or bonuses were offered for the longest round pulled, the greatest progress on a weekly basis and the first hole through to the opposing side. The keenest competition occurred on the 8,400-ft. tangent of Tunnel No. 1, which could be worked from the two portals only, and which was the controlling factor in the completion of the entire project.

The tunnels were started and holed through in the following order: On July 9, 1920, South Portal, or Tunnel No. 4 (started Aug. 25, 1919) holed through into Tunnel No. 3 South (started July 27, 1919). Tunnel No. 4 drove a distance of 3,282 ft. and Tunnel No. 3 South, a distance of 2,901 ft.

On July 9, 1920, Tunnel No. 3 North (started Aug. 23, 1919) holed through into a 7-ft. x 17-ft. heading which was started south from Adit No. 1 on April 27, 1920. The crew in Tunnel No. 3 North removed the bench in Adit No. 1 South, finishing a total of 3,144 ft. on July 23, 1920.

Tunnel No. 1, or North Portal (started June 6, 1919) and tunnel No. 2, or Adit No. 1 (started June 30, 1919) holed through on the night of July 27, 1920, after an interesting race between crews, thus completing the 8,400-ft. tangent. The record for distance in the last eight days on this tunnel was closely contested, the North Portal crew driving in this time 125 ft., an average of 15.63 ft. per day, and Adit No. 1 crew pushing them hard with 123 ft., or an average of 15.38 ft. per day. The record pull, or break, jumped from one crew to the other. The North Portal, on July 21, made a pull of 18.3 ft., followed on July 25 by a pull of 18.8 ft. from Adit No. 1. The North Portal crew were not to be outdone and on the same night made a pull of 19.3 feet.

These measurements were checked by an engineer not particularly connected with the tunnel work so that no partiality could be claimed by either crew. The North Portal crew also won the honor of driving the first drill hole through to the opposing side. North Portal drove a total distance of 4,033 ft. and Adit No. 1 a total distance of 4,370 ft.

These records for long breaks in a 17-ft. x 17-ft. tunnel and the record made by the crew in Adit No. 1 by driving 1,343 ft. in three months, March, April and May, are believed by the company's engineers to constitute "if not a world's record, at least a record for the United States which will be hard to beat."

Rex C. Starr, construction engineer for the San Joaquin Light & Power Co., was in charge of the work from its inception.

Col. Walker to Command Engineer School at Camp Humphreys

The important assignment as commander of Camp Humphreys and commandant of its engineer school has been given to Colonel Merriweather L. Walker. During the war Colonel Walker was a brigadier-general overseas, where he was director of the Motor Transport Corps. Since his return to this country, he has served as instructor at the General Staff College, and at the time of this last appointment he was serving as division engineer at Cincinnati.

COL. M. L. WALKER

Ohio To Speed Federal-Aid Highway Work

Following the return of Highway Commissioner A. R. Taylor and Senator W. A. Alsdorf, secretary of the Ohio Good Roads Federation, from a trip to Washington, where they were in conference with officials of the Bureau of Public Roads, it was announced that all Federal-Aid projects in Ohio had been approved and that work upon them would go forward. This will mean the award of a large number of road improvement contracts during the remainder of the year.

16-Story Concrete Office Building for New York

A reinforced concrete building 16 stories high is to be built in the leather district of New York City, just below Brooklyn Bridge. This is a record height for such a structure on Manhattan Island, where concrete has been used sparingly and only for lofts and factories. The new building is to be at the corner of Gold and Frankfort Streets, on a plot 69 x 74 ft., and will be 189 ft. high. It is to be built for the Hide & Leather Realty Co., Inc., by Thompson Binger, Inc., as general contractor.

Chicago to Begin Lake Front Work

As a first step in creating the new lake-front park in Chicago, which is to be formed by filling along the present shore line south of Twelfth St., the South Park Commissioners have decided to place contracts for a section of the bulkhead wall which eventually will form the west bank of the inner waterway or lagoon (see *Engineering News-Record*, Aug. 21, 1919, p. 360). This section will extend south to Twenty-fourth St. The bulkhead will be of wood piles and rock filling, capped with a concrete wall in some parts. At other parts the bulkhead will be cut off near the water line, after the filling has been placed, the shore being dressed to a flat slope and finished with earth or riprap. With the construction of this first section of bulkhead there will be an enclosed space for depositing the city waste and rubbish as filling, which material averages from 750,000 to 1,000,000 cu.yd. annually. The work is under the direction of Linn White, chief engineer for the South Park Commissioners.

Port Authorities Will Meet

Announcement has just been made that the American Association of Port Authorities will hold its annual convention in Chicago, Oct. 4, 5 and 6, 1920. Special attention at the meeting will be paid to the port and harbor problems of the Middle West, and the Great Lakes and St. Lawrence River Navigation projects. Among the papers to be presented are descriptions of the new port works at Vancouver, Portland, Ore., and Toronto.

Indiana Road Contractors Use Liberty Bonds as Deposits

Road and street contractors of Indiana are making profitable use of Liberty Bonds instead of cash as deposits to guarantee their work. Under the Indiana law all street and road work that is done under the so-called Barrett law, a law providing that the property owner abutting the improvement may be allowed twenty years in which to pay for the improvement, shall be accompanied by a 10 per cent deposit on the part of the contractor to insure the guarantee of the improvement and to insure his making any repairs needed during the life of the guarantee.

In former years the contractors generally deposited cash. This year they are buying Liberty Bonds, which have been about fifteen points below par for the past several months, and are depositing them as security on the completed contracts. Regularly they go to the city or county treasurer's office and clip their coupons. They expect the bonds to reach par at the expiration of the five-year period which, according to law, the securities must be held. Incidently the different municipalities are being deprived of considerable interest on the money formerly deposited.

Gen. Carson Heads Construction Service of Q. M. Corps

Brigadier General J. M. Carson has been placed in charge of the construction service, now a part of the Quartermaster Corps of the Army. Much of his term of service has been spent in constructional activities, including practically all of the newer buildings at the U. S. Military Academy at West Point.

General Carson was born in Pennsylvania, June 26, 1864. He was graduated from West Point in 1885 and was immediately put on construction duty. He was engaged in building operations at Fort Hamilton, N. Y., until the war with Spain. From the close of that war until 1903, he was in charge of construction and repair activities for the Quartermaster Corps. He spent the next eight years on the building construction work at West Point.

In 1911, General Carson was sent to the Philippines to take charge of construction, other than fortification work, on Corregidor Island. During the three years that he was engaged in that work, he disbursed $8,000,000. In addition to the erection of the necessary buildings, he put in the water and sewerage systems and built the necessary streets and roads.

Having reached the grade of colonel, in 1914, he was ordered to depot duty and was assigned to the New York depot. In 1917, in addition to his duties as depot quartermaster at New York, he was charged with preparing plans for handling the embarkation of troops at that port.

In November, 1917, General Carson was sent to France as chief quartermaster of the line of communications. He served in that capacity until March, 1918, when he became deputy chief quartermaster of the A. E. F. With the return of General Rogers to the United States, in January, 1919, General Carson became chief quartermaster of the American forces in France. On Sept. 1, 1919, he was made zone supply officer at New York and, in addition, since January, 1920, served as depot quartermaster at New York, which post he is relinquishing to become chief of the construction service.

Four Divisions for General Staff

Under the provisions of the Army Reorganization bill, the General Staff has been reorganized and will include four divisions, as follows: Operations; military intelligence; war plans; and supply. The military intelligence division, in which civil engineers are most interested, is charged with the collection, evaluation and dissemination of military information for the use of the Secretary of War, the Chief of Staff and the War Department General Staff. It is specifically charged with (a) formulation of policies with reference to military topographical surveys and maps, including their reproduction and distribution; (b) supervision and training of military attaches, observers and foreign language students; (c) formulation of policies affecting the supervision of intelligence personnel for all units; (d) use of codes and ciphers; (e) translation of foreign documents; (f) establishment and maintenance of contact with other intelligence agencies of the government and with duly accredited foreign military attaches and military missions; (g) construction and reproduction of special maps required for intelligence purposes, including the procuring of maps from foreign sources; (h) custody of the General Staff map and photograph collection. In the event of the establishment of a military censorship, the director of this division shall act as chief military censor.

Kerckhoff Hydro-Electric Plant Put in Service

The 50,000-hp. Kerckhoff hydro-electric plant has been completed by the San Joaquin Light & Power Co., and was put in service on the generating system of that company on Aug. 15. This plant, on which work has been rushed from start to finish, was completed in a 15-month construction period, 60 days ahead of schedule, and is said to be the first hydro-electric project to be started and finished since the war was over. The haste was caused by the urgent need for power on the San Joaquin Valley, which will be somewhat relieved by this additional block.

Electrical Engineers Join Federation

At the meeting of the Board of Directors of the American Institute of Electrical Engineers held in New York Aug. 12, 1920, the following resolution to become a charter member of the Federated American Engineering Societies was unanimously adopted.

> "*Resolved,* That the American Institute of Electrical Engineers accepts the invitation to it to become a Charter Member of the Federated American Engineering Societies, and pledges its hearty co-operation in the work thereof."

Federal Power Commission Busy on Regulations

After having heard criticisms and suggestions at two public hearings, officials of the Federal Power Commission and a committee appointed by outside interests are engaged in whipping into final shape the rules and regulations for use in connection with the waterpower act. The principal changes which have been agreed upon eliminate much detail from the information required with the application. It is believed that this data can be furnished more intelligently when the project will have been completed. Financial interests have asked those drafting the regulations not to add to the hardships already imposed by the law.

Detail of Regimental and Coast Defense Commanders

The War Department has instructed the Chiefs of Infantry, Cavalry, Field Artillery, Coast Artillery and Engineers that with a view of development and maintenance of the highest efficiency among combat regiments and coast defense commands of the Army, the policy will be that regimental and coast defense commanders who are rated as "superior" and "above the average" will be retained with their commands for a tour of duty of at least two years and will not be changed except for exceptional reasons.

Activities of the A. A. E.

The San Diego Chapter has elected the following officers: President, George F. Hayler; vice-president, Fred Grumm; recording secretary, V. Elmendorf; treasurer, S. A. Evans; member of executive committee, George Cromwell.

The Nevada Chapter has elected the following officers: President, H. M. Loy; first vice-president, H. F. Holley; second vice-president, G. W. Borden; third vice-president, C. C. Cottrell; corresponding secretary, L. V. Campbell; recording secretary, Dale B. Pruett; treasurer, H. M. Payne.

The San Francisco Chapter, at its July meeting, was addressed by Prof. C. D. Marx, head of the Department of Civil Engineering at Stanford University, who explained the proposed National Department of Public Works and gave a progress report of what has been done to promote this new department. Walter D. Cole, manager of the Marchant Calculating Machine Co. and president of the Oakland Chamber of Commerce, was the speaker at the August meeting. His subject was "The Relation of the Chapter to Civic Organizations."

The Akron Chapter, at its meeting of Aug. 17, was addressed by Senator F. E. Whittemore, of Ohio, who introduced Hon. Carl H. Kimball, Speaker of the State House of Representatives. Mr. Kimball spoke on "The Engineer in Politics." L. E. Barkheims, formerly of the 29th Engineers, A. E. F., gave a talk on "Sound Ranging in France," illustrated with specially drawn diagrams. H. G. McGee, acting president of the chapter, explained some charts which he had prepared showing graphically the present financial and economic conditions in the United States and Europe with relation to conditions following the Civil War.

Columbia Starts 3-Year Course in Industrial Engineering

A three-year course leading to the degree of master of science and industrial engineering has been organized at Columbia University according to the announcement of Dean George B.

Pegram of the School of Mines, Engineering and Chemistry. It is not intended that the new course constitute a short cut to professional success but rather afford a rigid training to meet what is described as a very general need and growing demand for executives of manufacturing and other industrial and commercial enterprises who are instructed in both engineering and business principles and practices. The departmental representative for the course will be Prof. Walter Rautenstrauch.

Civil Service Examinations United States

For the United States civil service examination listed below apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the Civil Service Commission, for Form 1312.

Junior Civil Engineer, Bureau of Public Roads, $1,500 a year. File application not later than Sept. 28.

Canada

Application forms may be obtained from the office of the Employment Service of Canada, or from the Secretary of the Civil Service Commission, Ottawa.

Assistant to Director of Technical Education, $3,480 to $3,840 a year. File application not later than Sept. 3.

Bridge and Structural Engineer, $2,820 to $3,420 a year. File application not later than Aug. 31.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston; Holyoke, Mass., Sept. 7-10.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Sept. 13-17.

SOUTHWEST WATER WORKS ASSOCIATION, Waco, Tex.; New Orleans, La., Sept, 20-23.

AMERICAN ASSOCIATION OF PORT AUTHORITIES, Montreal; Chicago, Sept. 30-Oct. 2.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Valparaiso, Ind.; St. Louis, Oct. 10-15.

The Duluth (Minn.) Engineers' Club, at its annual meeting Aug. 2, received the report of its committee appointed to investigate the question whether or not the club should become a member of the Federated American Engineering Societies. The decision of the committee was that further study by the club membership was advisable and that several points should be investigated and cleared up. The report was accepted, the committee discharged and the secretary instructed to get the information desired.

Personal Notes

A. N. JOHNSON has severed his connection with the Portland Cement Association to assume his new duties as dean of the Engineering School of the University of Maryland and director of engineering research. The latter work is to be particularly along lines of highway construction and engineering, in co-operation with the U. S. Bureau of Public Roads and the State Highway Department of Maryland.

JOHN W. MEREDITH has been appointed city engineer of Antioch, Cal., succeeding R. P. Easler, who has resigned to become manager of the West Coast Dredging Co., with offices in Antioch.

LEROY K. SHERMAN, who recently resigned as president of the U. S. Housing Corporation, has been made vice-president of the Edmund T. Perkins Engineering Co., Chicago.

COL. EDWARD WALTON has been placed in charge of the district office for the Eastern District of the U. S. Construction Service, with headquarters at Washington, D. C.

CLARENCE E. RIDLEY, city engineer of Port Arthur, Tex., has tendered his resignation. He will go to New York to take an eight months' course in the New York School of Public Service. Mr. Ridley was selected from a long list of candidates as one of those to take the course. Under his supervision Port Arthur has just finished a street improvement campaign costing in excess of $200,000. He will specialize in public administration and city management in his studies.

JAMES W. ROUTH, director and chief engineer, Rochester Bureau of Municipal Research, Inc., announces that he is available for service as consulting municipal engineer and is prepared to conduct investigations, prepare plans, specifications and reports, and supervise operations in connection with all municipal engineering activities. Special service can be rendered municipalities interested in improving the organization and administrative procedure of their departments of government.

CHARLES E. SIFFERLEN, junior engineer assigned to the valuation of the street railway system of Syracuse in the prospective adjustment of city car fares, has been made instructor in forest engineering at the New York State College of Forestry at Syracuse, N. Y.

WALTER E. MILLER has resigned from the staff of the Railroad Commission of Wisconsin, with which he was connected for nearly fourteen years, to engage in private practice as a consulting engineer. His practice will include investigations and studies of steam and electric railway and public utility problems, especially the valuation of such properties, rate-making therefor, reports on efficiency of operation, designing, estimating and supervising construction of new properties and improvements of existing plants. His office, temporarily, is in the Pioneer Block, Madison, Wis.

ARTHUR H. BLANCHARD, professor of highway engineering and highway transport at the University of Michigan, has recently been appointed consulting engineer to the Michigan State Highway Department.

J. R. MCDERMOTT has resigned as assistant highway engineer of Harrison County, Ohio, to accept a position with the West Virginia State Road Commission as assistant division engineer, with headquarters at Keyser, W. Va.

B. B. MILNER has tendered his resignation, soon to become effective, as engineer of motive power and rolling stock of the New York Central R.R., at New York City. He will go to Tokio to take a similar position with a Japanese concern.

BRIGADIER GENERAL C. H. MITCHELL, consulting engineer, Toronto, has been made a member of the commission of the Ontario Government appointed to investigate the hydro-radial situation.

A. F. MACALLUM, commissioner of works of Ottawa, has been made a member of the Ontario Government's commission appointed to investigate the hydro-radial situation.

CAPTAIN W. S. LAWSON, formerly a member of the Militia Headquarters Staff, Ottawa, is now inspecting bridge engineer of the Canadian Northern Ry., Eastern Lines, covering the territory between Port Arthur and Lake St. John.

N. W. MCCALLUM, electrical supervisor of bridges and buildings of the New York Central R.R., at New York, has been promoted to the position of division engineer, with headquarters at Oswego, N. Y.

S. H. BONAR has been appointed city engineer of Moundsville, W. Va.

THE MCCLURE, GREENE ENGINEERING CO. has been organized at Worcester, Mass., by FREDERICK A. MCCLURE, former city engineer of Worcester; EARLE W. GREENE, who was engaged by Mr. McClure while city engineer to assist him in the preparation of plans for the Imhoff sewer purification plant to be built by the city at a cost of $2,000,000, and who recently resigned to join Mr. McClure, and GEORGE M. WRIGHT, former mayor and former head of the Wright Wire Co., now merged with the Wickwire-Spencer Steel Corp. The firm will specialize in municipal engineering, including the designing and building of water-works, sewers, sewage disposal

plants, street paving, concrete construction, bridges, dams, hydro-electric development. This branch of the work, as well as general consulting engineering, will be under the direct supervision of Mr. McClure. Mr. Wright will have charge of the department of designing, wire mills, heating and annealing furnaces and the supervision of the building and the installation of the same.

A. E. DYATT has been appointed resident engineer of Kansas Federal Aid Project 7 in Douglas County, with headquarters in Lawrence, Kan., succeeding A. C. Lagerwall, resigned. For the past year Mr. Dyatt has been chief engineer of the Kansas Engineering Co., of Topeka, Kan.

Obituary

R. E. HARWOOD, civil engineer and contractor, for the past thirty years engaged in road construction in the South, died at Springfield, Ohio, his birthplace, Aug. 4, at 63 years of age.

SAMUEL MITCHELL, contractor, of Ottawa, Ont., died Aug. 13, in that city. He had lived in Ottawa for about forty years and most of that time was in the contracting business.

ROBERT PARKER STAATS, president of R. P. & J. K. Staats, building contractors, of New York City, died Aug. 8, at Great Barrington, Mass. He was 69 years old and a descendant of one of the first Dutch families in New Amsterdam. His firm has built many of the largest piers in New York Harbor.

N. F. THOMPSON, district engineer of the Western District of the New York Central R.R., at Buffalo, N. Y., died July 26, at Roswell, N. M. He was born at Lansingburgh (now Troy), N. Y., Oct. 16, 1884. He graduated in civil engineering from Rensselaer Polytechnic Institute in 1907 and soon afterward entered the service of the New York Central as draftsman in its engineering department. He was subsequently made assistant engineer of grade crossings and, in 1912, appointed engineer of grade crossings. He was made district engineer of the Middle District in March, 1917, with headquarters at Albany, N. Y., and was transferred to the Western District in January, 1918.

AARON H. WRIGHT, engaged for more than 70 years in bridge and railroad construction in New England, died at Springfield, Mass., Aug. 16, at 89 years of age. He was born in Norwich (now Huntington), Mass. Mr. Wright was for years associated with the late Daniel L. Harris of Springfield in the firm of Harris & Wright, bridge builders, and before Civil War days was engaged in railroad work in Tennessee. He was later associated with the late George F. Lyons, of Greenfield, and his son, Herbert W. Wright, under the firm name of Wright, Lyons & Co., in a general railroad contracting business. On the death of Mr. Lyons the business was continued under the name of A. H. Wright & Son until 1906, when Mr. Wright retired.

BRIG. GEN. CHARLES RUSSELL SUTER, U. S. Army, retired, died at Brookline, Mass., Aug. 7, at 78 years of age. He was born in Brooklyn, N. Y. and graduated from the U. S. Military Academy in 1862. He was commissioned in the Corps of Engineers, U. S. Army, and remained in the corps throughout his active life. During the Civil War he served with the Army of the Potomac, at the siege of Charleston, S. C., and elsewhere in the South. After the war he was assigned to the work of the improvement of the Mississippi River and its tributaries, stationed at St. Paul, Cincinnati and, for many years, at St. Louis. He was an original member of the Mississippi River Commission (1879 to 1896) and the first president of the Missouri River Commission (1884 to 1896). In 1896 he went to San Francisco as division engineer of the Pacific Division and president of the California Debris Commission. He was in charge of fortification and river and harbor work in the vicinity of Boston, from 1898 to 1901, and division engineer of the North Eastern Division and president of the Board of Engineers and of the board to report on the harbor lines of New York Harbor and adjacent waters, with station in New York, from 1901 to 1906. He was retired, by operation of law, as a brigadier-general, May 5, 1906.

Business Notes

THE SHOURDS-STONER CO., INC., architects and engineers, Terre Haute, Ind., announces the opening of an office at Chicago. The Terre Haute office will be retained. The company maintains separate departments in architecture, and civil, mining, mechanical electrical and structural engineering, as well as an appraisal and valuation department.

EXUM M. HAAS, railroad specialist, has been appointed manager of the railroad department of the H. K. Ferguson Co., Cleveland. From 1912 to 1917 he was Western editor of the *Electric Railway Journal*, and for the past three years sales engineer for the Austin Co.

THE T. L. SMITH CO., Chicago, has opened an office and warehouse, through its agents, Norman B. Livermore & Co., at San Francisco, Cal. A complete stock of Smith tilting and non-tilting mixers, paving mixers, excavators and loaders, pumps, engines and boilers will be carried there, as well as a stock of repair parts, for immediate shipment to the company's agencies in Western territory. R. Bowen has been appointed Eastern district manager, in charge of the company's offices and warehouse at New York, succeeding W. S. Walker, who has resigned to take up other work in the Middle West. Mr. Bowen was formerly associated as sales manager with the Worthington Pump Co., the Allis-Chalmers Co. and the Prescott Steam Pump Co.

THE PENNSYLVANIA PUMP & COMPRESSOR CO., Easton, Pa., announces the opening of additional sales offices in the following cities: Buffalo, J. B. Baird, manager; Cleveland, agent, L. J. Wakefield; St. Louis, agent, Corby Supply Co.; Minneapolis and Omaha, agent, L. E. Pollard Co.

G. BRONSON PHILHOWER, JR., during the war attached to the aviation and submarine chaser divisions of the Mechanical Division of the Navy, and since February of this year an apprentice in the various plants of the Reading Iron Co., has been appointed salesman in the company's railroad sales department, with headquarters at the New York office.

THE H. K. FERGUSON CO., Cleveland, has appointed MAJOR RICHARD W. ALGER manager of its Southern department, with headquarters at Atlanta, Ga. Previous to the war he practiced architectural engineering in Chattanooga, Tenn. During the war he was detailed to the Construction Division of the Army, from which commission he resigned in March of this year to become assistant chief engineer of the Ferguson Co. CAPTAIN RICHARD E. J. SUMMERS, who has been with the company since December, 1919, has been appointed assistant chief engineer. He was formerly with McClintic-Marshall Co., Pittsburgh. During the war he served for nearly a year as engineer officer in responsible charge of all construction in the Western Division of Great Gievres Depot for the A. E. F.

Telescoping Concrete Pile Forms

A patent (U. S. 1,342,424) has been issued S. M. Cotten, of Phoenix, Ariz., on a telescoping steel form for cast-in-place concrete piles. The form consists of a driving point, and a central driving shaft, with nested shells of diminishing diameter. In driving, lugs on the outside of the outer shell stop that shell at a determined depth and the impact of driving shears pins which hold the next smaller shell, so that the whole form continues to descend with smaller diameter shells successively taking their position. The advantage claimed is the reduction in skin friction due to the fact that only one section is ever in driving contact with the ground at one time.

A Consolidation of Engineering News and Engineering Record   McGraw-Hill Company, Inc.—JAMES H. MCGRAW, *President*

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN *Editor*

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The Coming Water-Works Convention

A LONG and varied program has been provided for the annual convention of the New England Water Works Association at Holyoke, Mass., next week. In recognition of the meeting much of our space this week is given to water-works and allied subjects.

Adventures in New Fields

THE symposium on the shrinkage of filter sands, the studies of the Venturi flume, the examination of water consumption in three wholly metered cities in relation to the size of distributing reservoirs, each the subject of an article in this issue, exhibit the engineer as an eager adventurer in new fields.

Man Power for Pumping

PRIMITIVE methods of lifting water still prevail in the Far East, as may be seen from the view on our front cover and the notes from a much-travelled engineer on p. 448. In many other respects Asia and Africa are still dependent on man power. Slowly but surely this is bound to change. The resulting effect on the machinery markets of the world, as well as upon the lives and comfort and uplift of vast populations, will be of great significance.

Pumping Station Economies

FROM the crude man-driven water lifts of industrially stagnant Korean countrymen to the triple expansion pumping engines and steam-turbine-driven pumps of an up-to-date water-works plant is a long leap. It suggests an essay or a book. Neither can be attempted here, but the opportunity may be seized to call attention to the remarkable essay written some years ago by one of our foremost engineers, the late George S. Morison, "The New Epoch as Developed by the Manufacture of Power." Coming back to the practical questions of the present time: The successful efforts to get higher efficiencies from the boilers and pumps at St. Louis, recounted in the abstract of Mr. Day's paper on p. 441, should and doubtless will stimulate other water-works men to work for increased efficiency in the application of manufactured power.

Railway Water Supplies

DESIGN and operating conditions of railway water stations and pumping plants differ from those of municipal plants in that there is much less definite organization and centralizing of responsibility. Besides this, instead of one unit system under the continual supervision of an engineer or superintendent who gives it all his attention, there are numerous scattered and relatively small plants which are in local charge of foremen who have many other matters under their care. Similarly, the water systems on a railway or a division are only items in the work of the assistant engineer who has more or less responsibility for the water-supply plants in addition to bridges, bulidings, track maintenance and other lines of railway work and equipment. For these reasons, the railway engineers and foremen are likely to be less well informed on water-supply matters than are the men in charge of municipal water-works. These conditions were suggested in *Engineering News-Record*, June 17, 1920, pp. 1181 and 1202, and are again brought to the front by the article on p. 463 of this issue.

Epidemics and the Engineer

CHOLERA has almost disappeared from countries that function ably in a health-protective way and typhoid is following rapidly after, although still far too much with us in America. Influenza now heads the list of epidemic diseases. This fact is strikingly brought out by statistics recently published by the British Registrar-General. He shows that in the 46 weeks from June 23, 1917, to May 10, 1918, influenza caused deaths at the rate of 47.74 per 100,000 population. To find a British epidemic approaching this in severity he had to go back to the cholera outbreaks of 1849, in which the death rate was 30.33 per 100,000. The engineer has played no mean part in vanquishing cholera and typhoid. As yet the medical fraternity has not shown him what, if anything, he can do to prevent influenza sweeping over the country or the world like wildfire. Unfortunately the doctors, notwithstanding earnest concerted effort, have to confess their own helplessness against epidemics of influenza. Once the doctors will point the way, engineers will do their part, if fortunately there is a part for them, to make the world as safe against influenza as it now is against cholera and typhoid and may be made, with the engineer's help, against malaria.

Canadian Rate Hearing

IN EVIDENCE presented before the Board of Railway Commissioners of Canada during the hearing on increasing railroad rates in the Dominion, which ended Aug. 21, the similarities and differences of the case from that in this country was clearly brought out. First the question of a universal wage increase was irrevocably linked up with the question of a blanket rate increase, as in this country. It is generally thought that Canada must meet the recent wage award made here by the Railroad Labor Board. The most striking similarity between the Canadian situation and that in this country, as clearly brought out by the evidence, is reluctance to increase rates to a level that will make "average" lines pay, for fear of too great profit accruing to lines which have greater earning power. This similarity has been noted previously in these columns, but we did not expect that it would be expressed so clearly in formal

evidence as that given by a representative of Western Canada Boards of Trade, on the last day of the hearing, in a statement that the condition of the Canadian Pacific Railway should be considered the basis for rate-making. But here again is the striking difference between the case in Canada and the United States. The whole railroad system of the country, except the prosperous Canadian Pacific, is now operated by the Government, and at a loss. The primary purpose of the rate increase is to reduce a Government deficit but the fear exists that in doing so the great private corporation now earning substantial dividends will profit unduly. At this writing no decision has been reached, but it appears that forthcoming wage adjustments alone would force a rate increase.

The Plight of the Street Railways

THAT the present plight of the street railways is due to their own sins of omission and commission, aggravated by war conditions, and that there are due drastic reforms from the street railways and an assumption of much burden by the public, and that employers and employees must agree to and abide by arbitration because strikes and lockouts are intolerable, is the substance of the report of the Federal Electric Railway Commission, appointed over a year ago by President Wilson. The conclusions of the report are notable not for their novelty but rather because a commission representing the street railways, their employees, investment bankers, the Federal government and the mayors of the country should be unqualifiedly unanimous in its statement of the case and in its conclusions—conclusions (see our News Section) which, on the whole, are constructive and progressive.

What the commission fails to recognize—and this is true of most of the discussions of the street railway situation—is that the existing contracts between the cities and street railway companies are the result of bargaining in which each side made concessions in order to secure provisions that were considered of moment. The inviolability of these contracts has been fought for by the companies in the courts for decades—and has been upheld by the courts in the absence of proof of fraud—regardless of the possible injustice of the contract terms to the cities and the public. But when the war came on and costs went up and the street railways found that the five-cent fares they had eagerly accepted yielded less profit than formerly, or no profit at all, and that they lacked reserve and depreciation funds, then the railways began asking the cities—not to make a new bargain with concessions on both sides, but to consent to rate increases without concessions to the city. The cities should insist on either a reopening of the entire contracts or else an iron-clad provision that any increase of rates granted shall be temporary only.

It is to the credit of the commission that although opposing municipal ownership as a present measure it advocates removing all legal bars to its adoption. This is a principle that has long been maintained by many conservative students of municipal government and of public utilities alike. The legal right to enter upon municipal ownership of any utility if the city authorties or the voters think best is an incentive to good service by the utlity and affords the city a possible means of relief from intolerable conditions.

In passing, we may remark that the commission might well have pointed out the remissness of the cities and the public in protecting their own interests when making contracts.

Finally, the commission's assent to a larger measure of local control over the street railways, while at the same time recognizing the need for a considerable measure of state control, is in line with the trend of sound public policy and the general progressiveness of a report which, if heeded, is bound to aid materially in relieving the street railways from the sad plight into which they have brought themselves and their patrons —a plight aggravated by war conditions but which, sooner or later, was bound to call for drastic remedies even had there been no war.

The Retirement of Charles Whiting Baker

CHARLES WHITING BAKER'S retirement from engineering journalism, announced in this issue, closes a third-of-century of exceptional service to the engineering profession. Those of this, his own generation, need not be told of the influence he has had on engineering progress. Week by week for thirty-three years, and particularly since 1895, when, after years of service as associate editor, he became editor of *Engineering News*, his views and those of his associates under his guidance and counsel have gone out to bid the profession to turn its thoughts now in this direction and now that, have cautioned against danger and false doctrine, have encouraged this reform or proposed that remedy. Always, the controlling thought has been to contribute to the sound progress of the engineer and of engineering. If the termination of his journalistic work be a proper time to judge of the discharge of the heavy responsibility which he has borne, we know that the profession, no less than his associates, will say, "well done."

Without experience as a journalist one can have no conception of the exactions of the work. The extent of the field to be covered alone makes the task an appalling one. Manifestly, no man personally can be an authority beyond a very limited field. He must rely on specialists, but his must be the determination of policy. Nor can policy be lightly determined for a great journal. Along paths of obvious error, no editor can lead, but error does not have to be flagrant to be pernicious. In fact, even when the scales are nearly balanced the potentialities for harm may be very great. The error, then, is difficult of detection, and, under the editor's persuasive pen, gets the greater vogue.

His responsibility is with him daily. He cannot, even if his conscience would allow, become unconscious of it. Daily he has evidence of the vigilance of his readers, in the form of letters of protest. Should he slip, disaster is likely to be the just reward.

It is right that it should be so, for the development of a whole art or of the entire profession is constantly at stake.

The mental and nervous tax is heightened by the element of strife. The editor's path is strewn with the wrecks of controversy. One cannot please everybody. The easy way is to take no strong positions, to be equivocal, to "carry water on both shoulders," but that is not the right way nor the courageous way. One can be honored by the enemies he makes, but the process of making them can hardly be reckoned in the day's pleasures. The offending of those who deserve offense wor-

ries none but the weak, but, unfortunately, it is necessary to disagree with those whom one respects and who deserve respect. Satisfaction comes from the consciousness that one has done what to him appears right.

But there are compensations. The editor of a journal that has maintained its prestige can look back on a life of real accomplishment. His name may not be attached to a mighty bridge, he may not have built a railroad through a box canyon, or planned, financed and organized a great industry. But shall we say that he has had no part in these developments? What of the years of inspiration he has given the designer? What of the information he has spread broadcast on economical methods of construction? What of the fruits of the accumulation of data he has made for every branch of his field?

As truly as the designer puts himself into the individual design, so has the editor put himself into the whole art. His influence is there. He has had a part in shaping the progress that shows itself in the best practice of the day. The world at large does not see this, and, not seeing, does not concede. For work well done, personal satisfaction must often be the best reward. So is it generally with editorial work.

Looking back on his long editorial career, and appreciating the part he and his associates have played in the development of engineering and the engineering profession, Mr. Baker has indeed cause for satisfaction. His was the chief responsibility for a journal that was held in exceptional esteem, not only here but abroad. Its accounts and editorial positions were eagerly awaited on all important engineering developments.

To Mr. Baker has come more than to most technical editors, recognition and honor. Blessed with a pleasing personality and with ability as a speaker, he has been much in demand to address engineering assemblies. His careful study of the needs of the profession has caused his views to be sought in the council room. He has been the confidant of the leaders of the profession, arbitrator of controversy.

While his direct connection with technical journalism is now to end, we cannot conceive that his gifted pen will be idle. We know that it will be employed whenever the interests of engineers and engineering are at stake.

Proposed Amendments to the Civil Engineers' Constitution

THE action of the Portland convention of the American Society of Civil Engineers brings to the final step proposals that have been under discussion for many years. It also refers again to the membership the question of affiliation in a specific federation of engineering societies.

Certain of the amendments referred to letter ballot were approved in the questionnaire canvassed in April—those providing for the broadening of the society's objects, for the increase of non-resident dues by $5, for the nomination and election of directors by geographical districts, for the assignment of every member to a local section, for the establishment of an annual conference of the representatives of sections, and the nomination of candidates for office by the annual conference. Previous approval having been given, it is to be expected that these amendments will prevail.

Three proposals are new—those relating to the election of honorary members by two votes less than the full membership of the board of direction, to the elimination of members of the nominating committee as candidates for office, and the reduction of the number of members of the board. The first two of these require no comment. The third needs clarification.

Under the present constitution the board consists of thirty members, of whom at least nine shall be from the New York (resident) membership. Under the proposed amendment, by the reduction of the number of New York directors from six to three, and the elimination of the secretary and of two past-presidents from the board, the membership is reduced to twenty-four. At the same time the requirement that "at least one vice-president" shall be a "resident" member is dropped, so that New York, instead of having a certain membership of nine on the board, will now have only four—three directors and the treasurer. Since this reduction brings New York's representation down to proportionate representation of the remainder of the country the proposal is not unfair to District No. 1.

The reduction in the total membership in the board is desirable, though with the present breaking with the earlier order it is questionable whether it would not be better to retain the past-presidents, for the benefit of their experience, and to cut the number of two-year vice-presidents from four to two.

The justification of the resubmission of a referendum on joining the Federated American Engineering Societies is that the previous vote was taken before the federation was formed, that the basis of representation now puts the large societies on the same basis as the smaller ones, and that the previous proposal was lost by only a small majority. Over this situation it is not necessary to spend time. It has been thrashed out most thoroughly. The decision is now, and finally, in the hands of the membership.

Returning to the amendments, it is worth while to consider the effect of two of them. In the effort at democratization the nomination and election of directors is to be put in the hands of the districts, the theory being, and properly, that the directors will thereby be more responsive to the views of their constituents. At the same time, it is proposed to establish an annual conference of representatives of local sections which, contrary to its original purpose of furnishing a medium for the interchange of views on section management and activities, is to "consider the welfare of the society and its members and report thereon to the Board of Direction." In other words, there is to be set up a body to counsel the board. Under the present constitution, with a board nominated and elected by the society as a whole, there is a feeling that such a counseling body is needed. If the district election plan is adopted the counseling function should be unnecessary. If with directors nominated and elected by them without interference the districts are unable to get their views considered they are not likely to make more of an impression through the conference. As a forum to discuss section activity there may still be a function. As proposed in the amendment, though, it merely increases the machinery of the society without apparent good reason.

Taken as a whole, the amendments run in the direction of the reforms that have long been demanded—a democratization of the society, and a strengthening of the section activities. They will undoubtedly prevail.

The Surface Shrinkage of Rapid Filter Sand Beds

Opinions on the Article by Abel Wolman and Shepperd T. Powell in Engineering News-Record July 29, 1920—Two Engineers Think Shrinkage Away from Filter Walls Due to Horizontal Pressure —One Believes It a Matter of Physics Rather Than Physical Chemistry—A Fourth Gives More Credence to Colloidal Theory

Physics Rather Than Physical Chemistry

By Robert Spurr Weston
Consulting Engineer, Boston, Mass.

PARTICULARLY interesting is the authors' discussion of the absorptive power of sand grains. The absorption of various collodial matters by sand grains has been frequently noted in the writer's practice. For example, at Middleboro the first water passed through the sand filter was free from iron. A day or two later, when equilibrium was established, that is when the sand became coated with a film of colloidal iron, silica and organic matter, the iron in the effluent increased and has remained practically constant since. It would seem, therefore, that the characteristic absorptive action of a new sand disappears in a short time. To cite an extreme analogy, if one passes an acid mine waste containing iron and calcium sulphates and free acids through a filter filled with lumps of limestone the neutralizing action of the latter is at first prompt and complete. Soon, however, the iron hydrate coats the limestone lumps and the action nearly ceases. So with the filter sand; we must consider aged sand with its accumulated coating—not fresh sand from beach or bank.

While I have had no experience with drifting-sand filters I agree with the authors that the absorptive power of the sand brought into contact with the water is a most important factor in purification by this process.

The authors are to be commended for resorting to physical chemistry to explain sand-layer phenomena, for it is in this field that the progress of the future is to be made. The part played by highly absorptive films on sand grains in the formation of mud balls belongs in this field, and the authors' beliefs regarding the same are borne out in my experience. With them I hope that studies of this nuisance may be continued.

The North Carolina sand reported on by H. W. Clark was not pure silica, and he believed that its cementitious properties were due to the presence of carbonates and hydrated silicates, that is of compounds distinct from the slightly absorptive quartz and quartzite of which most filter sands are chiefly composed. The North Carolina sand was indeed absorptive when new, but Mr. Clark does not state how it differed from other sand of the same size when aged in a filter.

The absorptive character of filter sand, coating and all, probably does affect, perhaps by coherence, the angle of repose of sand under water, and therefore probably interferes with the sloughing off of the sand to fill peripheral voids after they are once formed at the filter edges. In our practice we have noticed cracks and voids in small mechanical filters many times, in slow filters never, and believing that the sand particles simply acted as supports for colloidal films, and that the important characteristics of the particles were their size and shape. I have explained sand-bed shrinkage by physics, and not by physical chemistry.

In the mechanical filter it is quite a frequent occurrence for the higher wash-water velocities to occur at the sides of the filter. The combination of these higher velocities and un-uniform sand will segregate the coarser material at the sides of the filter, with the result that when the filter is next washed, to paraphrase the authors, the water will gush around the open spaces on the sides. In one filter plant under our observation the sand from the side was considerably coarser than that in the center. If the filter sand be segregated according to size in different parts of the filter all parts of the sand layer will not compact to the same degree after washing. The finer sand will shrink the most.

In a recent paper (Proc. Am. Soc. C. E., Vol. 46, April, 1920) Allen Hazen proved conclusively that in large hydraulic-fill dams the pressure of the hydraulically filled cores against the toes of the dams may be reduced —that is, their horizontal pressures may be largely overcome—by using material of large enough size to properly compact. He showed that freshly deposited silts do shrink in volume under water, slowly or more rapidly according to the sizes of their constituent particles. His cases are extreme, of course, but his conclusions apply at least to the finer filter sands.

Shrinkage of Fine Material

If, at the conclusion of washing, the sand in the mechanical filter is so segregated that areas of fine quicksand exist these latter will contract when filtration begins, and if the contracted area be large cracks or voids will appear. It is therefore my present opinion that when a segregated bed is put into service, after washing, the fine sand compacts and the whole bed shrinks. If the sand layer has a high coefficient of cohesion it will shrink away from the walls; if not it will crack. I have seen isolated fine areas contract away from the coarser remainder of the sand layer, leaving circular or polygonal cracks. As the highest filtering velocities are apt to be near the main effluent channel the shrinkage is often radial, and if the sand layer coheres the shrinkage will be most evident at the edge of the filter surface. Once shrunk, I have no doubt but that the absorptive power of the sand grains maintains the bed in its altered position.

To apply the authors' analogy of the syneresis of gelatine: My understanding of what the physical chemists teach is that the large molecules of gelatine, Irish moss and the like, consist of masses of interlaced, filamentous particles, analogous to the spicules of a sponge. When water is added these molecules do not actually dissolve, but the water enters the spaces between the constituent filaments of the molecule and expands it. Heat favors this process of expansion, and we say that gelatine dissolves in hot water. It does not. It becomes what I may call a colloidal quicksand. Now just as the elements of gelatine contract and squeeze out the water, so may sand. There is this difference, however. In the case of gelatine there is a marked

change between the conditions under which the hot water entered the gelatine molecule and those under which the cold water squeezes out. In the case of a mechanical filter bed all except the hydraulic conditions are practically constant. Therefore, notwithstanding the authors' apparently indisputable conclusions, I still look to this variable for an explanation of the phenomenon.

In our practice we have overcome this trouble, which is a serious one from a bacteriological standpoint, by better distribution of the wash water, and by removing the finer particles of sand by washing and scraping. I still believe that the shrinkage will not occur in filters having good wash-water distribution, sufficiently thick gravel layers, and well aged; uniform sand, even though the sand grains be quite fine.

Shrinkage Cracks Due to Colloids

By J. W. Ellms
The Frazier-Ellms-Sheal Co., Cleveland, Ohio

The authors of this paper have offered possible explanations for the surface contraction of sand filter beds which appear quite plausible. The principles upon which these explanations are based have not received the consideration by engineers to which they are entitled. In 1905 the writer in a paper published in the *Engineering Record*, May 13, 1905, p. 552, called attention to the significance of certain phenomena frequently observed in water and sewage treatment processes which might be explained by principles which were being developed as a result of the study of matter in the colloidal state. During the past twenty years many investigators have contributed a vast amount of data, which, together with the earlier observations of Ruhland, Berzelius, Selmi, Graham and those that followed, have been arranged and classified. A more orderly conception of these highly complex phenomena has resulted. The writer believes that more study should be given to water purification and sewage disposal processes along the lines of colloidal chemistry, and that the physical, chemical and biological problems involved may often be better explained if one is familiar with the principles underlying the colloidal state of matter. Certainly engineering structures can not be properly or successfully designed unless one is familiar with the principles which govern the processes taking place within them. The wide application of the basic principles governing the colloidal state of matter warrants a thorough understanding of the subject if engineering structures are to be intelligently designed.

Bacterial Efficiency and Shrinkage

The authors attribute the poor bacterial efficiency of centain filters which they had under observation to the cracking of the sand beds. The writer has frequently observed these shrinkage cracks in sand beds of rapid filters, but never considered them as contributing appreciably to the poor bacterial quality of the effluents sometimes obtained. In fact, so far as his own experience goes, and that of those operators whom he has questioned, the formation of cracks in the bed always takes place after it has been in service a certain length of time. The writer has never observed shrinkage cracks in new sand beds when first placed in service.

The writer, therefore, concluded that the shrinkage cracks were the result of the accumulation of a certain amount of colloidal organic and inorganic matter upon the sand, which, as is well known, is so necessary for the efficient action of the filter beds. It does not seem as though the adsorptive capacities of the sand grains are of significance except as they play a part in storing colloidal matter. This adsorptive capacity of the sand grains thus becomes an index of the colloidal matter which may be stored in and around the sand grains. The adhesive quality of the sand may be readily explained on this basis.

This conception naturally leads, as the authors have properly concluded, to internal forces within and around the sand particles. We know that the surface energy of a liquid, i. e., the energy upon the interface between itself and its vapor, is equal to the product of the surface and surface tension. Hence by increasing the interfacial surface through an increase of colloidal jellylike substances within and around the sand grains, an increase in the surface energy of the liquid results. That this surface energy may become evident the specific surface (surface divided by the volume) must be at least 10,000. This means that the particles and capillary passages within and around the sand grain must be extremely small. No particle of sand that would be found in any sand filter could possibly provide the surface required if it did not, in addition to its natural superficial area, have an immense internal surface. The additional internal area may be the result of its natural structure and composition plus an acquired area arising from adsorbed and deposited colloidal matter. These areas may be approximately measured by the adsorptive and absorption capacities of the filter sand.

Synerisis of Silicic Acid Gels

It must be admitted that this conception involves, in the case of filter sands submerged in water, the existence of capillary passages, and possibly of the presence of submicrons and amicrons so minute that the interfacial forces obey laws the same or similar to those which would exist if the sand were exposed to the air. The authors have suggested this possibility, and their reference to the "syneresis" of silicic acid gels is apparently put forward as a possible proof of this explanation.

Bütschli has demonstrated the honeycomb structure of silicic acid gels, and has shown, when the gels are partially dehydrated, the existence of minute air spaces within them. Is it not conceivable, therefore, that similar cellular spaces exist within the sand bed of a filter which are never entirely filled with water even though submerged? If this were true would not the interface between the liquid and vapor phases throughout the enormous areas thus made possible provide the necessary energy to produce the phenomenon of surface shrinkage in a submerged sand bed?

The writer believes, as do the authors of the article, that the phenomenon may be extremely complex and that too few data are as yet available to formulate a precise explanation.

The authors have suggested some very practical methods for studying filter sands, and it is to be hoped that their excellent paper will induce a more intensive study of colloidal phenomena, which play so important a part in water-purification and sewage-disposal problems.

Compression of Filter Sands

By Allen Hazen,
Consulting Engineer, New York City

IT seems to the writer that the facts as reported could have been explained more easily. Filter sand is nearly but not quite incompressible. It is slightly compressible mainly because the impurities and small grains in it hold the larger grains from seating as solidly when they first come down in a loose condition after washing as they will do under pressure.

After the sand in a mechanical filter is first washed it is under no pressure beyond that due to its own weight. As the run proceeds the loss of head increases and the pressure, due to the increase in loss of head, is brought to bear upon the surface of the sand bed and tends to compress the sand. At the end of the run a pressure of 300 or 400 lb. per square foot has been developed. The shrinkage due to this pressure is mainly vertical and harmless, but some of it may be horizontal and troublesome. The shrinkage is not enough to have any effect on the filtering ability of the sand, but if the shrinkage is horizontal the cracks resulting from it may have an important influence on the efficiency of filtration. When such cracks are once formed the tendency to compression is exerted horizontally in them on the adjoining sand, thus tending to enlarge and deepen the cracks. The shrinkages described by the authors are probably of this kind.

The amount of shrinkage under pressure depends upon the kind of sand. A pure clean silica sand shows but little shrinkage. Any impurities will tend to hold the grains slightly apart, and will result in a looser position when they first come to the bearing, and more shrinkage will follow when pressure is applied. This is in accordance with the findings of the authors.

The idea of gradual compression of filter sand during the use of a filter is an old one. Kirkwood stated in 1866 that if the loss of head were permitted to go too high it would result in too much compression of the sand and was therefore to be avoided.

The writer's first experience with sand compression was in the St. Lawrence days about thirty years ago. In one of the first water filters there was a marked example of compression of this kind. The filter was in a galvanized-iron tank, 20 in. in diameter and 6 ft. deep. It was one of a number of such experimental filters receiving Merrimack River water. This particular filter ran much longer than its neighbors, and there was much speculation as to the cause. After the run was finished a close examination disclosed it. The sand had been pushed back from the walls of the tank almost down to the gravel, and the raw water had gone down the crack so formed. The sand was in the form of a Pasteur filter bogie surrounded with a thin layer of raw water.

The filtering area was not only the top of the sand but practically the whole area of its sides; and this whole area had finally become clogged and showed the effects of the water that had passed through it. The sand had been compressed horizontally by the increasing loss of head to allow this to happen and to support the whole of the sand as a column. In this case the loss of head was mainly suction, or negative head as it was afterward called. It must have amounted at the end of the run to more than 300 lb. per square foot acting on the top and the whole of the sides of the sand. Why this particular filter sand separated from its walls while that in the other filters did not we never knew; but it was easy to see how, after it once started, the horizontal pressure, acting on the crack as formed, would enlarge and deepen it, until the rather extraordinary result was reached as above described.

The published Lawrence reports have contained no mention of this incident. So many interesting things happened at Lawrence that it was impossible to include them all in the reports. It was necessary to select for publication those believed to be of the greatest interest and to limit the reports to them.

Some years afterward, in the litigation under the negative-head patent, one of the claims of the patent was that the increasing head acting on the sand compacted it and made it more efficient as a filtering material. The writer made tests of the amount of compression of sand in actual filters during the course of the run, and with the increasing loss of head. These were made by putting a small plate on the top of the sand and connecting to a delicate measuring apparatus supported rigidly overhead which indicated the drop in the sand level.

Cracks Opened by Compression

The actual compression in the course of runs of mechanical filters tested in this way were found to average about ½ in. Of this about one-third took place at once when the filter was put in service; that is, when the first substantial increment of pressure was brought to bear upon the sand. The remainder developed gradually, and approximately in proportion to the increase in loss of head during the progress of the run.

Looking back after many years it now seems probable that the falling off in efficiency in many of the old English and German filters may be accounted for by passages through cracks opened by compression. It will be remembered that this falling off in efficiency in these old filters was definitely connected in some cases, at least, with increasing loss of head. There was a theory that the filters "broke" when the loss of head exceeded some limit. This theory was widely held. A statement of it is found in Kirkwood's "Filtration of River Waters" (1869; p. 14). The writer encountered it very generally among filter operators in Europe in 1894. ("Filtration of Public Water Supplies," first edition, p. 57 In some cases it was found that the decrease in efficiency was due to the passage of water in the corners of the columns of the vaulted roof and around the ventilators for the underdrains through which unfiltered water found its way ("Filtration of Water Supplies," first edition, p. 17).

To guard against this condition, in the writer's designs horizontal ledges were built on the columns, and the filter gravel was kept away from the bottoms of the walls, permitting the filter sand to come to a bearing on a horizontal surface with which it would make a sure connection that would stop the passage of raw water. This principle in the design of slow sand filters has been generally followed ever since. With slow sand filters so protected there was no "breaking," and the full efficiency has been maintained to the end, even with very high heads. This matter was studied carefully in detail at a number of early filter plants. It was more important before chlorine came into use.

In mechanical filters there is still an idea that filters "break" when the loss of head reaches some limit, and

no doubt in some cases there are results that justify this view. As far as mechanical filters do "break" it is the writer's belief (and has been for years) that the breaking results from the shrinking of the sand away from the walls of the filter, permitting unfiltered water to run down the narrow passages so formed without actually passing through the sand.

Because of the method of washing the simple and efficient measures used in slow sand filters cannot be so easily applied to mechanical filters; and generally speaking the results with mechanical filters have not been such as to cause anxiety in regard to this detail. This is especially true where chlorine treatment follows filtration.

Perhaps it would be well to introduce protective ledges in mechanical filters above the gravel with a view to securing a mechanical seal at that point. At any rate the subject is worthy of consideration.

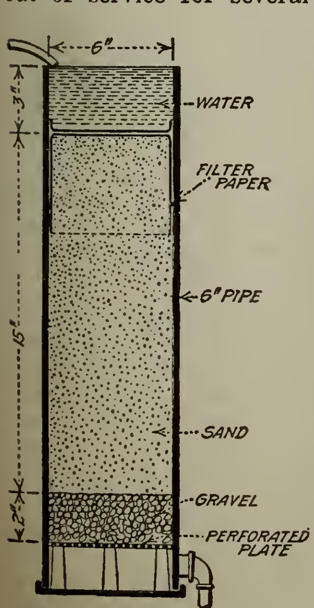
The authors' idea on the absorption power of sand is interesting. This was one of the first subjects studied at Lawrence. The study there was mainly as to the capacity of various sands to absorb coloring matter from the peaty waters that were applied to the experimental filters. Pure quartz has hardly any capacity to absorb and store such matters. The mixed silicates of iron, alumina and lime have considerably varying capacities; so that different sands have very marked individual qualities. Although the subject is an interesting one the writer has always regarded it as a secondary importance in filtration. It accounts for many facts that would otherwise be puzzling.

Shrinkage Due to Horizontal Pressure

By Cornelius M. Daily
Engineer-in-Charge, Supply and Purifying Section, Water Division, St. Louis, Mo.

I HAVE read the very interesting article on "Surface Shrinkage of Rapid Filter Sand Beds" by Messrs. Wolman and Powell and find a few stumbling blocks in the road to accepting their hypothesis.

At various times in the operation of the St. Louis plant a filter bed was washed, filled with water and left out of service for several days without showing any under-water shrinkage cracks, but the same filter bed invariably showed shrinkage cracks when in operation for that length of time. Is it possible that a powerful internal force would lie dormant whenever the filter was idle and be active when it was in use?



MINIATURE TEST FILTER AT ST. LOUIS

The cause of the sand shrinking away from the side walls can be explained without burdening colloids with the task. The filter precipitate which forms a blanket on top of the sand gradually increases the resistance for water to flow through it until a difference of pressure of as much as 6 ft. has been found to exist between the top and bottom of the blanket. This difference of pressure, when great enough, breaks the blanket at its weakest point, which is along the smooth side walls, and allows the water to filter into the area of lower pressure. The water flowing through the break in the blanket carries filter precipitate with it, forming a new blanket on the sand that works deeper and deeper along the walls. This, like the top blanket, resists the flow of water through it, causing a side pressure on the bed which produces the contraction indicated by cracks along the walls.

To prove this theory I constructed a miniature filter (see sketch) and substituted paper for the side as well as the top blanket and produced a crack as wide as 1/16-in. around the wall of the circular bed. Only a few minutes of operation of the miniature filter was required to produce the shrinkage crack.

The phenomena of under-water shrinkage of filter sands do not seem to be fully explained by the hypothesis advanced by Messrs. Wolman and Powell but the colloidal film on the sand grains undoubtedly is a contributory cause.

Chicago Adopts Asphaltic Cushions

THE Board of Local Improvements of the City of Chicago has decided to lay sections of creosoted wood block, granite block and brick pavements on a cushion composed of 92 parts of graded lake sands and 8 parts of asphaltic cement.

This cushion, according to John B. ittell, who was formerly chief engineer of streets for the Board and is now district engineer for the Asphalt Association, will not be as expensive as the 1 to 4 cement mortar cushion and although slightly more expensive than the 2-in. sand cushion previously used under granite blocks, it is believed the resulting benefits will more than compensate for the difference in cost.

Mr. Hittell's estimate of the situation follows:

Chicago has many miles of brick, granite and wood-block pavements laid on sand cushions. A large percentage of these pavements are in streets occupied by street car tracks, and as they are not impervious to water, the shifting of the sand bed, due to combined action of traffic, seepage of water and vibration of car tracks has caused the surface of the pavements to be distorted generally by a settlement of that portion adjacent to the rails and a raising of the part along the quarter or gutter. The displacement has not been uniform and has reduced the life of pavements.

To overcome this objection, especially in brick and wood block pavements, the specifications were changed to provide a cushion 1 in. in thickness composed of 1 part of Portland Cement to 4 parts of torpedo sand or limestone slag screenings. The cement and sand were thoroughly mixed dry and immediately spread upon the concrete foundation, shaping to contour being secured by use of a templet. Immediately before laying the block the cushion was wet by means of a rosehead sprinkler with water merely sufficient to dampen the cushion and set the cement. The result expected from the use of this mortar cushion has not been attained, especially in the case of brick pavements which are deprived of all resiliency and which create considerable noise under traffic. To remedy these difficulties the adoption of the asphaltic cushion was decided upon.

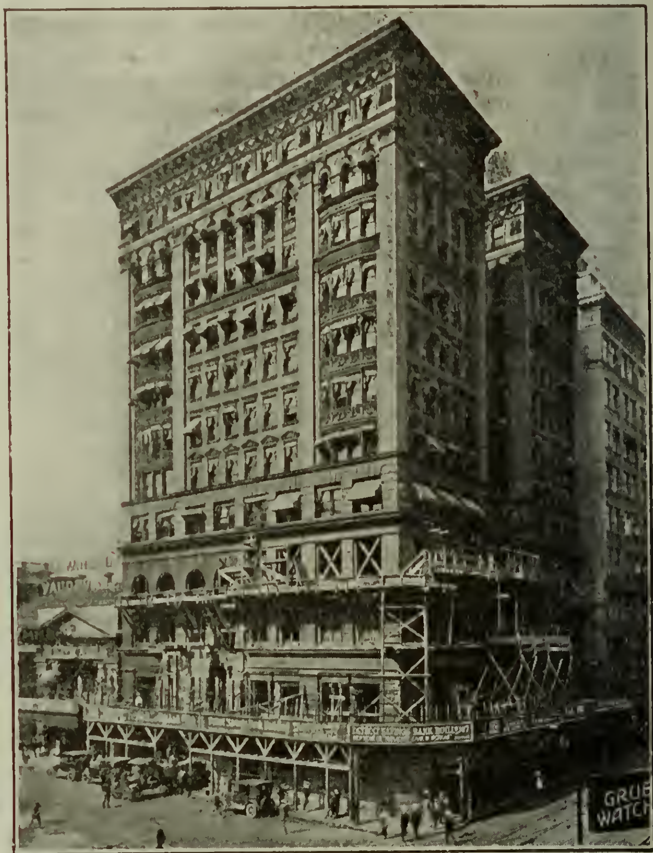
Fuel Oil Pipe Line From Havre to Paris

Construction of a pipe line to convey fuel oil from Havre to Paris has been authorized by the Minister of Public Works of France. The Compagnie Francaise de Transport des Mazouts et Petroles agrees to deliver in Paris a minimum of 2,400 long tons of crude petroleum a day within a year.

Corrosion of Column of High Building Due to Inadequate Protection

By E. H. Eardley
Detroit, Mich.

In the course of extensive alterations to the Detroit Savings Bank Building, formerly known as the Chamber of Commerce, which are being carried out under the supervision of Albert Kahn, architect, a condition of corrosion was discovered in one column which invites the attention of engineers and architects as a warning to use more care in the protection of steelwork, especially where pipes are imbedded in or attached to columns. The photographs herewith show the base of the column in question, where the rusting is clearly apparent, and the building itself, a 12-story structure erected in 1894.



RUSTING NEAR BASE OF COLUMN IN BOILER PIT OF DETROIT SAVINGS BANK BUILDING

All columns of the building are of the Gray type, made of eight steel angles connected by batten plates. In the original construction, they were fireproof with a 2-in. tile protection around the outside of each column. This in most cases made the interior of the column an inclosed space which would hold water. Moisture or acid that had access to the column exterior could therefore easily work their way to the metal and set up corrosion unnoticed. The particular column shown by the photograph was in the boiler pit, about 2 ft. below the basement floor proper, and 3 ft. away from the nearest oiler. Connected to the column near its base was a water pipe, fitted with a tap used for wetting the cinders. Continual leakage from this tap, together with seepage from the water used to wet the cinders, apparently allowed water to pass through the tile fireproofing and remain in contact with the steel indefinitely, corroding three of the four faces of the column in the manner shown by the photograph.

The interior legs of the angles forming the column were unaffected. Further, this was the only column in the building that was not found in good condition. That the corrosion occurred at the level shown is due to the fact that the top of the boiler-pit floor was at the level of the top of the wing plate; in other words, the corrosion developed just above the pit floor level.

Rubber Roads

Although there are places in London and elsewhere where rubber has been used as a road surfacing material over small areas it has hitherto only been adopted for the purpose of deadening the sound of traffic in situations where quiet is essential. The idea of employing rubber on a large scale, however, has long been mooted, but it has been left for the Southwark Borough Council to give this question a definite trial on a road subject to heavy traffic—namely, the Borough High St. Half only of the road is being faced with rubber, so as to afford a comparison in efficiency. The new material is being laid in flat slabs three-quarters of an inch in thickness, attached to steel plates, from which project broadly flanged studs, which are gripped by the concrete foundation. There can be no doubt as to the interest attaching to this new departure in city road construction, and it is significant that local authorities are willing to embark on such novel methods in the search for materials of construction which will meet the new main road traffic conditions. The autumn is the regular season for the roads in London to be "up," and in most of the boroughs important works are now in progress. We may mention, too, the widening of Berkeley St., where that thoroughfare leads into Piccadilly—a much-needed improvement that is about to be undertaken.—*The Surveyor*, London.

Progress Versus Stagnation Is Issue in Am. Soc. C. E. Affairs, Says A. P. Davis

Presidential Address at Annual Convention an Indictment of Standpat Minority Rule—Membership in Federated American Engineering Societies Urged

CHARGING a small but influential minority of conservatives with the domination of the policies of the American Society of Civil Engineers and with opposition to progressive measures designed to expand the activities of the organization and to effect co-operation with the other Founder Societies, Arthur P. Davis, director of the U. S. Reclamation Service, in his presidential address delivered at the fiftieth annual convention of the society, held in Portland, Ore., Aug. 10 to 12, characterized as "progress versus stagnation" the real issue which exists in the administration of the Society's affairs and gave strong endorsement to the movement for a nation-wide federation of engineering organizations as provided for by the recently created Federated American Engineering Societies. President Davis also indicted the ultra-conservative element on the grounds of neglect of opportunities in technical, as well as civic, work. He advocated the termination of the centralized control of the organization which, he claimed, has "hung like a mill-stone about the neck of the society, retarding its growth, restricting its usefulness and threatening it with dry rot." The greater portion of President Davis' address is given herewith:

THE demand for active participation of all engineers in Civil Engineers had they been given proper encourage- and the advancement of the engineering profession has been growing for many years, and is greater today than ever before. Various plans for accomplishing this purpose are suggested, and the pressure has been such that the American Society of Civil Engineers and the other Founder Societies have each taken a more or less active part in such work.

Recognizing the necessity of combining efforts in this line, and also the desirability of somewhat separating such activities from the technical functions of these societies, Engineering Council was formed with the idea that it would represent the four Founder Societies and gradually add to this number through powers conferred upon it for that purpose. It has, in the three years of its existence, added the American Society for Testing Materials and the American Railway Engineering Association, but is still far from embracing all of the engineering societies of the country. It has some fundamental weaknesses. It lacks in representative character and democracy, and is without power to raise funds, but must depend upon voluntary contributions from its constituent societies and others. Experience has shown that these deficiencies can be best remedied by substituting a league or federation designed to include all of the engineering societies, national, state, regional, and local. A constitution to this effect was adopted at the convention held in Washington in June. The federation does not provide for any individual members, but is merely an instrument for combining the efforts of existing societies by forming them into a federation with definite powers and provided with sufficient funds to accomplish its purpose.

The unanimity of the conference was practically complete, with the exception of the American Association of Engineers, a recent organization which has been rapidly growing as the result of active and persistent drives for membership. It fills a niche among engineering societies by admitting large numbers of men working in engineering lines, but without the necessary qualifications to be admitted to full membership in the Founder Societies. It has been quite active and has accomplished good work. It can accomplish still more by continuing its efforts along right lines. But its ambition to be an all-inclusive society, representing all grades of the profession, can scarcely be realized, and seems unreasonable to be expected, and even though it should achieve a greater success than is expected along this line, its prestige is not such as to give it standing comparable to the federation of the four Founder Societies and other large organizations with long standing, prestige and high standards.

Active Minority in Control

In spite of the unanimity of the Washington Convention, there is still a small but very active minority in the American Society of Civil Engineers that opposes this federation and professes to oppose any participation of the American Society of Civil Engineers in civic or other welfare work. Due to the peculiarities of an antiquated constitution, and to a particularly effective organization, this minority has an influence within the society far beyond its numerical strength. Up to date it has, in the main, governed the policies of the society, yielding to pressure only when this became irresistible. It opposed the junction of our society with the other Founder societies in the Engineering Societies Building, and opposed the formation of the United Engineering Society, and successively each and every step tending to co-ordination and co-operation, of the Founder Societies.

In spite of the overwhelming majorities in the recent vote upon Questions 1 and 2 touching the principles involved in the federation, and the recent progressive majority shown by the Committee on Nominations, the conservative element is said to be contemplating an independent or insurgent ticket, supported of course by the usual arguments of caution and conservatism, and utterly ignoring the blunders of the past which such alleged caution has involved.

The real issue in the contest now going on, and especially in the election of directors, which will take place next fall, is whether or not the society is to take its proper place among human activities, or gradually decay and become an obstruction to progress, pretending to fill a niche which it does not fill, and wasting the prestige and history of this glorious Society which ought to be devoted to some end more useful than individual benefits to a small circle of its membership.

Technical Field Neglected

In opposing progressive tendencies the advice is offered that the society restrict its field to technical matters, and leave civic activities to others. This advice would come with more convincing force were it not for the fact that those who offer it have controlled the policies of the society for the past twenty years, and have so neglected the technical field that the demand for technical standards and specifications, which it should have furnished, could be met only by the organization of new societies, such as the American Railway Engineering Association, and the American Society for Testing Materials, whose activities have been largely directed by enterprising and public spirited members of this Society, who could and would have performed the same services through committeees of the American Society of Civil Engineers had they been given proper encouragement and facilities. After having frittered away the opportunities for usefulness and growth in the technical field, it now ill becomes these false leaders to advise us to confine ourselves to the restricted remainder of that field.

The argument usually given is that civic or welfare work might violate the dignity of the society. We might advocate mistaken policies and afterward be obliged to modify these. This is the same excuse given for shrinking its technical duties in the past. It was feared that if our society adopted and uttered standard specifications, these might be found

imperfect or become obsolete, and the necessary changes would reflect upon its dignity. Such argument, if relied upon, would effectually block all attempts at usefulness in any field. It has caused untold damage to this society and to the profession, and should be discarded forever. We should use due diligence and care to avoid errors, but the possibilities of error should not be made an excuse for inactivity.

Whatever the real issues back of the conservative advice, its tendencies are unmistakable. The demand for broader activities is from the country at large, and the opposition is confined mainly to three or four of the large cities. These, with their compact and well organized membership, have been able in the past, with the help of our antiquated constitution, to control the main points of policy of the society, and to perpetuate themselves in power. This domination is threatened by the growth of membership in the rural districts which would be stimulated by the measures proposed by the Committee on Development, especially those measures designed to increase the growth and influence of local sections, and the expansion of activities in accordance with their demands. Every measure that is popular with the membership outside the great cities will add to its growth, and proportionately tend to terminate the centralized control that has hung like a millstone about the neck of the society for so long, retarding its growth, restricting its usefulness, and threatening it with dry rot.

There are thus two distinct issues involved in the pending measures and the coming election of officers. These issues are "progress *versus* stagnation" and "democracy *versus* centralized domination." These issues are largely interdependent, and upon their determination depends the future usefulness and growth of the society. Their importance can hardly be overestimated.

Important Measures Pending

Measures of great importance to the world, to our country and to our profession demand immediate and vigorous attention, and it is imperative that they have behind them the unified efforts of all the organized engineers of the country, and all the prestige that the greatest, the oldest, and the most eminent societies can offer.

Among these measures are the unification of the engineering work of the Government under one department with a technical head. This will promote efficiency and eliminate waste, and, what is more important, will serve as a precedent for the reorganization of other departments along similar lines of homogeneity, efficiency, and economy.

Other important measures pressing for attention are the laws proposed in many states for the licensing of engineers. This policy is steadily progressing. In some states this movement is doubtless inspired by a desire to shut out the competition of engineers from other states, a most destructive policy, and unless some recognized authority, like the federation, backed by both the leaders and the rank and file of engineers, takes a strong hand, we may find ourselves burdened by a mass of pernicious laws that will work untold harm before they can be swept away or otherwise remedied. Properly directed, however, this movement has beneficial possibilities.

We find great disparity between the rewards received by men, and this disparity is by no means in proportion to ability or to any other circumstance which contributed to production. In other words, it is not the man who works the hardest who becomes the richest. It is not he who produces most that receives most. There are problems involved in distribution which have not been solved. Social and economic progress has not kept pace with material progress, and the time has come when the discrepancy must be bridged over, for further increase of production unless accompanied by a more reasonable distribution is likely to become a menace rather than a blessing. It is to the solution of these problems that the leaders of men must give their attention if civilization is to be saved instead of destroyed, as all past civilizations have been.

I have neither the time, the ability nor the assurance to attempt a solution at this time of any of the great problems presented, but will call attention to typical illustrations of what these problems are:

Expansion of Government Activities—The great changes caused by the war and the accompanying upheavals have led irresistibly to larger functions of Government. It has become necessary to increase those function to prevent great injustice and suffering. The control of our transportation lines and other public utilities, once criticised and condemned, is no longer questioned. It is admitted by all to be inevitable and unavoidable. It has even become necessary to control the price of food and of other commodities, and the pressure is strong and the argument almost irresistible for extending this control in many other lines. Rent commissions have been established, arbitrarily fixing the price which the owner may charge for his property, his title to which has never been questioned except in this indirect manner.

The need for these vast expansions of Governmental activities admonishes us that they must be restricted to those cases where such expansion is absolutely necessary. Many who years ago advocated the public ownership of all public utilities such as railroads, gas works, water works, and power plants have in the last five years changed their minds. For one thing, public control through judicial commissions has proved more successful than anticipated, due mainly to an awakened public consciousness, or at least a more enlightened public selfishness. But fully as potent a reason for this changed attitude has been the alarming demands upon the Government for the expansion of its functions in other lines, and it becomes important therefore to confine its functions to those which are inevitable or absolutely necessary. I am therefore in hearty sympathy with many who are now opposing the public ownership of railroads and power plants and commercial shipping. But while agreeing with the conclusions, I must strongly condemn the principal reason which they advance for this. It is common to hear intelligent men whose motives cannot be questioned basing their opposition to Government ownership of railroads on an argument which is condensed into a statement or opinion that "Government operations cannot possibly be as efficient or as economical as those under corporate control." One objection to such a statement is that it is untrue. It has been proved over and over that this is not necessarily the case.

While admitting that there are, and always have been, abuses and defects in our postal system, who would be so bold as to assert, or, if asserted, who would believe the assertion, that our mails would be carried more cheaply, promptly or economically by private enterprise than they are at present.

The public activity with which I am most familiar is the United States Reclamation Service. No claim is made for infallibility or super-human wisdom in the conduct of that service, but its principal officers have always striven for the highest efficiency and economy. It has not been without its mistakes, but results as a whole have proved the fallacy of the theory that the Government cannot do things economically and well.

United Effort Necessary

The preservation of human rights and of the results of scientific progress in the present crisis will require the united efforts of all intelligent, patriotic citizens. In this category I place all engineers; and as they owe a debt of gratitude for the blessings of civilization which they enjoy, they must repay this debt by vigilance and activity in the preservation and improvement of these blessings. Such a program will have its difficulties and its pitfalls; but these will not deter nor discourage worthy men in the pursuit of excellence. Rather, the dangers will serve as a stimulus to activity.

We cannot act effectively unless united, and by calmly reasoning together on pressing questions, guided by the pole star of righteousness, we can unite upon fundamental principles and make our influence for good a power in the land. Only thus can we performe the duty we owe to ourselves, to our fellowmen, and to posterity.

Excessive Rainfall Frequencies at Springfield, Mass.

By Charles W. Sherman
Of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

In the course of a study of the needs of the city of Springfield for new and relief storm sewers the firm of engineers of which the writer is a member made a detailed study of the available rainfall records. It was found that 26 years' records were available from a recording gage maintained by the city of Springfield.

This gage is a Draper pluviometer of the old or tipping bucket type, and was originally installed by the Water Commissioners on Dec. 27, 1891, on the roof of their office building on Bridge St. It was maintained in this position until Dec. 1, 1913, and was then out of service for nearly a year, but was re-established Nov. 15, 1914, on the roof of the new city hall and is now maintained by the city engineer. The period of observations therefore includes a little less than 22 years in the original location, and a little more than four years (to the end of 1918) in the present location—a total of almost exactly 26 years, the year 1914 being omitted from the records.

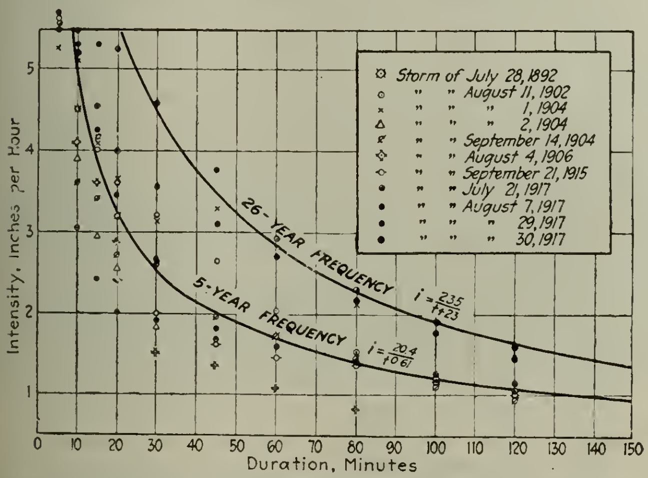


FIG. 1. CURVES OF INTENSITY OF PRECIPITATION AT SPRINGFIELD, MASS., FOR FREQUENCIES OF 26 AND 5 YEARS COMPARED WITH OBSERVED FREQUENCIES IN 11 MOST CRITICAL STORMS

The two locations are in the same portion of the city—that is, on the low plain adjoining the river—and about 1,000 ft. apart. Both of them may reasonably be considered as satisfactory locations as it is usually possible to obtain within a city. The results are subject to the possibilities of error that always obtain in the case of a rain gage mounted upon a roof, particularly when no screens or parapets are provided to minimize the effect of wind currents.

Such elevated gages are frequently checked by comparison with the records of ordinary non-registering gages at ground level in the near vicinity. In this case there was no gage with which satisfactory comparison could be made. The nearest ordinary rain gage is that at the United States Armory, which is about five-eighths of a mile distant and 100 ft. higher in elevation. This locality is on the edge of the plateau overlooking the river plain, and conditions of precipitation may conceivably differ to a considerable extent owing to the difference in locality. Moreover, the exposure of the Armory gage is not satisfactory, owing to the proximity of buildings and trees, particularly the latter. In fact, two large trees almost overhang the gage and there is reason to believe that the records here kept are growing progressively more untrustworthy as the trees increase in size.

A study of the chart records of the recording rain gage showed that during the 26 years there were 67 storms of significant intensity. The data relating to these storms were taken off in figures and tabulated in the usual form to show the maximum average intensity for periods of 5, 10, 15, etc., consecutive minutes. From this table the data relating to most severe storms were rearranged in the order of their magnitude for each period of time. The results are here presented as Table I.

TABLE I—MAXIMUM INTENSITY OF PRECIPITATION AT SPRINGFIELD, MASS., ARRANGED IN ORDER OF MAGNITUDE FOR VARIOUS PERIODS DURING EXCESSIVE RATE, JAN. 1, 1892 TO DEC. 1, 1913, AND NOV. 15, 1914 TO DEC. 31, 1918.

Order No.	Time in Minutes									
	5	10	15	20	30	45	60	80	100	120
1	8.51	5.48	5.32	5.26	4.59	3.76	2.93	2.30	1.90	1.61
2	6.00	5.32	4.54	3.99	3.55	3.29	2.80	2.19	1 76	1.47
3	5.85	5.21	4.25	3.63	3.20	3.10	2.68	2.16	1.72	1.44
4	5.50	5.10	4.16	3.60	3.14	2.64	2.03	1.53	1.26	1.13
5	5.24	4.50	4.08	3.46	2.66	1.96	1.72	1.44	1.23	1.05
6	....	4.08	4.00	3.21	2.60	1.81	1.60	1.42	1.18	1.02
7	....	4.02	3.88	3.00	2.26	1.66	1.50	1.38	1.17	1.02
8	....	3.90	3.60	3.00	2.20	1.65	1.46	1.29	1.12	.95
9	....	3.60	3.40	2.85	2.16	1.64	1.32	1.14	.99	.90
10	....	3.60	3.20	2.85	2.09	1.60	1.32	1.10	.95	.85
11	....	3.60	3.20	2.85	2.06	1.60	1.30	1.10	.87	.80
12	....	3.60	3.12	2.70	2.00	1.60	1.30	1.09	.84	.75
13	....	3.54	3.00	2.61	1.98	1.58	1.30	1.03	.84	.75
14	....	3.50	3.00	2.55	1.91	1.54	1.29	1.02	.80	.72
15	....	3.36	2.92	2.55	1.86	1.48	1.28	1.00	.80	.71
16	....	3.30	2.80	2.40	1.82	1.47	1.27	1.00	.80	.70
17	....	3.30	2.80	2.40	1.80	1.47	1.21	.98	.79	.67
18	....	3.24	2.64	2.39	1.80	1.46	1.20	.97	.78	.67
19	....	3.20	2.60	2.28	1.76	1.44	1.20	.89	.72	.65
20	....	3.18	2.60	2.25	1.76	1.43	1.10	.82	.72	.62
21	....	3.18	2.44	2.19	1.64	1.36	1.07	.82	.70	.60
22	....	3.18	2.41	2.10	1.60	1.36	1.02	.81	.67	.59
23	....	3.03	2.40	2.10	1.60	1.23	.99	.80	65	.57
24	....	3.00	2.40	2.07	1.60	1.21	....	.78	.64	.53
25	....	3.00	2.40	2.00	1.56	1.14	....	.76	.63	.53
26	....	2.76	2.40	1.96	1.50	....	....	.75	.55	.51
27	....	2.76	2.32	1.95	....	....	....	.73	....	.50
28	....	2.64	2.28	1.95	....	....	....	.68	....	.50
29	....	2.45	2.28	1.89	....	....	....	.64	....	.50
30	....	2.29	2.20	1.83	....	....	....	....	....	.48
31	....	....	2.20	1.80	....	....	....	....	....	.48
32	....	....	2.20	1.68	....	....	....	....	....	.48
33	....	....	2.20	....	....	....	....	....	....	.47
34	....	....	2.12	....	....	....	....	....	....	.47
35	....	....	2.12	....	....	....	....	....	....	.45
36	....	....	2.02	....	....	....	....	....	....	.42

Note: Record obtained by Draper Pluviometer (old style).

The figures in this table furnish the data for plotting directly intensity curves of 26-, 13-, $8\frac{2}{3}$-, $6\frac{1}{2}$-year frequencies, etc. By interpolation between curves so drawn curves for 20-, 15-, 10- and 5-year frequencies can be constructed.

It is found that the following formulas satisfactorily represent the intensity curves for the frequencies shown: Once in 26 years $i = \dfrac{235}{t + 23}$; 13 years, $i = \dfrac{250}{t + 38}$; 5 years, $i = \dfrac{20.4}{t^{0.61}}$. In these formulas i represents the intensity, or average rate of precipitation, in inches per hour, and t represents the corresponding duration of time in minutes.

It is of significance to know the number of storms exceeding the intensity shown by various curves, as well as to know the number of times when the intensity indicated for definite periods of time has been exceeded. Fig. 1 shows the observed intensities for various periods of time in the eleven most significant storms covered by the observations, together with the curves of 26-year and 5-year frequency. It will be noted that the

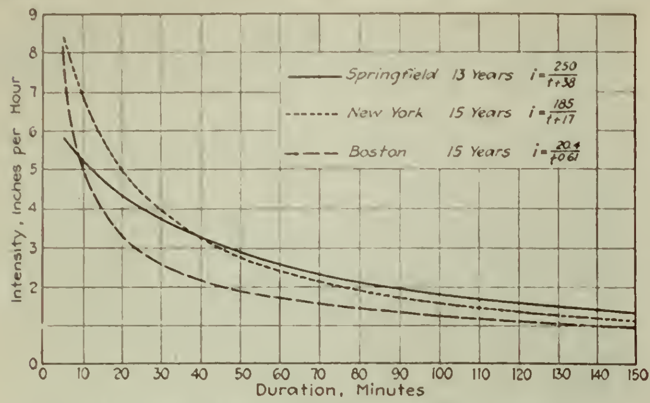


FIG. 2. COMPARISON OF RAINFALL INTENSITY-FREQUENCY CURVES AT SPRINGFIELD, NEW YORK AND BOSTON

26-year curve is governed by a single storm—that of Sept. 21, 1915. The 13-year curve is governed at some points by the storm of Aug. 30, 1917, and at other points by that of Aug. 1, 1904. It will also be observed that during the 26 years there are but four storms which materially exceeded the curve of 5-year frequency, and two of these occurred during the year 1917.

As an indication of the changes in intensity of rainfall from place to place it is significant to compare the intensity curves for Springfield with those obtained for Boston and New York City. Data relating to the precipitation at Boston, as shown by the 38-year record of the automatic rain gage at Chestnut Hill reservoir and the 26-year record of the Weather Bureau gage on the post office building at Boston, are given in a paper entitled "Maximum Rates of Precipitation at Boston for Various Frequencies of Occurrence," by Harrison P. Eddy, (Jour. Boston Soc. C. E., Feb., 1920). Corresponding data for New York City, compiled from the records of 45 years, are contained in the report of a committee of the Society of Municipal Engineers of the City of New York, published in the *Proceedings* of that society for 1913. Table II contains a comparison of the intensity curves for approximately corresponding periods and Fig. 2 shows graphically the comparison of curves for 15-year frequency (13 years at Springfield). These comparisons show that the Springfield intensity and frequency curves correspond closely with those for New York City, and are materially higher than those for Boston. In fact, the Springfield curve for 5-year frequency is identical with the Boston curve for 15-year frequency.

TABLE II—COMPARISON OF RAINFALL INTENSITY CURVES FOR SPRINGFIELD, NEW YORK AND BOSTON

Place and Frequency	Expression for Intensity, i, Inches per Hour	Intensity, i, in Inches per Hour, for Duration, in Minutes									
		5	10	15	20	30	45	60	80	100	120
New York 45 years	$\frac{260}{t+18}$	11.30	9.30	7.89	6.85	5.40	4 12	3.33	2.65	2.20	1.8[illegible]
Springfield 26 years	$\frac{235}{t+23}$	8.40	7.13	6.19	5.47	4.44	3.46	2.83	2.28	1.91	1.64
New York, 22½ years	$\frac{220}{t+18}$	9.56	7.87	6.67	5.80	4.58	3.48	2.82	2.24	1.86	1.59
Boston, 38 years	....	9.10	6.70	5.40	4.65	3.60	2.58	2.06	1.70	1.45	1.29
Springfield, 13 years	$\frac{250}{t+38}$	5.81	5.21	4.71	4.31	3.68	3 01	2.55	2.12	1.81	1.58
New York 15 years	$\frac{185}{t+17}$	8.41	6.85	5.78	5.00	3.94	2.98	2.40	1 91	1.58	1.35
Boston, 15 years	$\frac{20.4}{t^{0.61}}$	7.64	4.95	3.91	3.28	2.56	2.00	1.68	1.41	1.23	1.10
Springfield, 5 years	$\frac{20.4}{t^{0.61}}$	7.64	4.95	3.91	3.28	2.56	2.00	1.68	1.41	1.23	1.10
New York 5 years,	$\frac{130}{t+17}$	5.91	4.82	4.06	3.51	2.77	2 10	1.69	1.34	1.11	0.95
Boston, 10 years	$\frac{125}{t+20}$	5.00	4.17	3.57	3.12	2.50	1.92	1.56	1.25	1.04	0.89

Water-Supply Problems and Projects in California

By C. G. GILLESPIE
Resident Engineer, Filtration Division, City of Sacramento: Lately Engineer, California State Board of Health

CALIFORNIA is experiencing the scantiest rainfall in ten years, while at Sacramento this is the ninth of a succession of dry years. These facts are driving home to Californians the fact that the full development of the great resources of the State—and the growth of its cities, therefore—will from this time on be measured primarily by the enterprise with which great projects for both irrigation and domestic water supply are undertaken.

To those unacquainted with California its topography must be understood to appreciate the remarks to follow. From the aviator's viewpoint the State is flanked by the Coast Range Mountains along the Pacific, and the Sierra Nevada Mountains along its eastern boundary. Both mountains link together to enclose the great valleys of the Sacramento and San Joaquin, whose rivers, bearing the same names, join and break through the Coast Range via San Francisco Bay and the Golden Gate. South of the southern end of the link lie numerous disconnected ranges and valleys, chief of which is the Imperial Valley and the valleys of Southern California lying about Los Angeles. Within the Coast Range the streams, in general, flow parallel to the range and finally break through it, by a curious geological process, to the Pacific Ocean. The early development of the State occurred in these minor valleys and they are still the seat of some of the best agricultural prosperity. In more recent years, however, attention has been directed to the great valleys of the South and the interior.

The development of the Imperial Valley through diversion of a portion of the Colorado River on the Mexican side across into California is well known. But problems of tremendous magnitude have appeared through the gross waste of water from the canal on the Mexican side and the silting up of canals and laterals due to the 20 tons or more of dry silt per million gallons carried by the Colorado River water. Relief from the first condition is proposed by constructing an all-American canal costing millions. To the knowledge of the writer, no improvement is in sight to desilt canals other than that of dredging as is now the custom.

All the towns in the Imperial Valley depend on the silt-laden canals for municipal supply. Advantage is taken of a most peculiar natural coagulating property of the Colorado River water whereby the finest of silts settle out quite completely in standing for a day or so. But the results are erratic, especially during seasons when one of the tributaries, the Gila River, is in flood. At that time coagulation is lacking and sed

imentation slow. To supplement sedimentation, three of the cities of the valley have already put in slow sand filters equipped with Blaisdell sand washers, to supplement sedimentation, and quite good results are obtained.

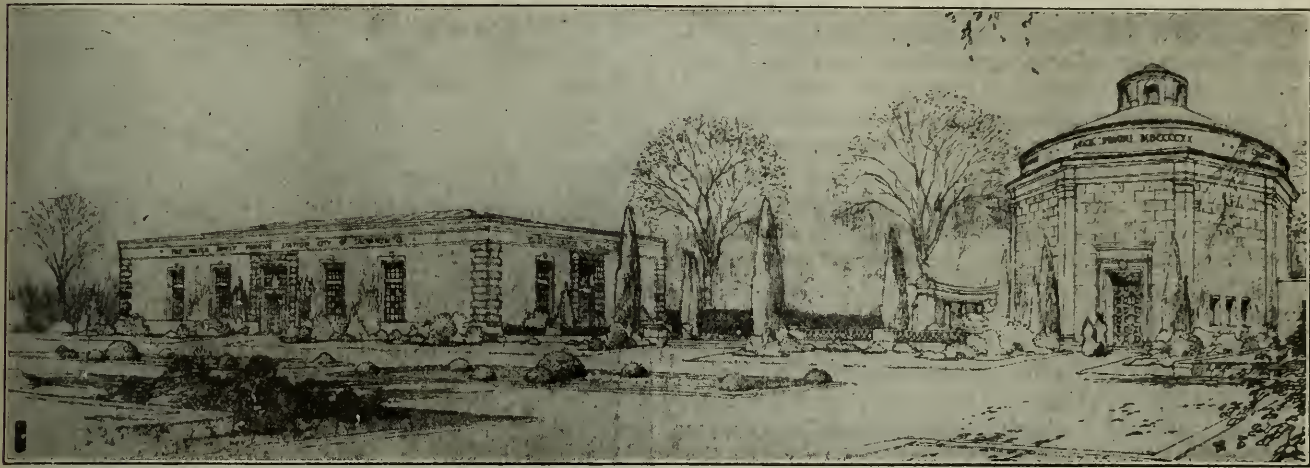
In the vicinity of Los Angeles there has taken place the maximum development of wells in the granitic formation underlying the region. Los Angeles itself, that dauntless city of the West, has spent millions to obtain its Owens River supply *257* miles distant at the south base of the Sierras. An attendant problem, perhaps not fully anticipated, however, is the considerable development of algae to which these mountain waters become at once subject when mixed with the runoff of pollution-carrying lower watersheds. On a large scale the primary cause of this algae growth cannot be controlled and so it is likely that the customary algae problems must be met and solved with perhaps a better understanding that will permit of a more accurate prediction of the rise and disappearance of groups, and of the need and time and amount of treatment.

San Francisco has voted $45,000,000 to go across the San Joaquin Valley to the headwaters of the Tuolumne River in the Sierras for its future water supply. In the face of dramatic obstacles the work still proceeds, as has been frequently noted in *Engineering News-Record.* This same river also furnishes all the irrigation water for one of the larger irrigation districts of the State, the Modesto-Turlock District, and not only this district but many outside people as well view with alarm a program which does not recognize that irrigation has first claim on streams in the vicinity, over cities in the State which can harness and redeem other more useless waters.

In the East Bay Cities (Oakland, Berkeley, etc.) the water situation is most acute. Near-by streams and undegrround supplies have been practically all developed by the local water company and the inhabitants are on a strict economy consumption of something like 60 gal. per capita per day. These cities are casting about for a more copious supply but decision is yet to be reached. A recent engineering report considered two main projects—one to bring water from the McCloud River, a tributary of the Sacramento, in the Sierras *225* miles distant at a cost of $75,000,000 to $105,000,000, and the other to divert the Eel River, a Coast stream, from a useless course northward to the sea, to a useful one southward through one of the Coast Range valleys, a distance of 127 miles, across San Francisco Bay to the East Bay Cities. The initial installation of the project is estimated at $45,000,000. Still another project suggested, probably far more economical, contemplates the pumping of the Sacramento River from a point near its mouth, during flood months when tidal salinity is lacking, into the artificial lakes and reservoirs surrounding the East Bay Cities, from which it could be filtered and distributed as needed.

In the Sacramento Valley irrigation water has always been plentiful for the land hitherto supplied. In the past few years, however, undreamed-of agricultural development of the upper valley, particularly in rice farming, has taken place and this river, once considered inexhaustible, has this year been nearly blotted out. It has been so dried up that the towns along its lower stretches and the long-established and fertile delta region, claiming ruin by the backing up of saline tide water past their doors, have instituted a "$60,000,000 suit" against the rice growers and other users, and the upper users themselves have been obliged to pool their interests in the stream and allow for its distribution by a water master to save the crops planted this spring.

The situation in the interior valleys has given rise to at least two proposals for permanent relief. One is the so-called Iron Canyon project whereby some of the flood waters of the Sacramento River could be stored in an artificial reservoir near its headwaters, which could add some 150,000 or 200,000 acres to the irrigable area. The other is a most colossal scheme, with good engineering backing, which contemplates diverting the Klamath River, which now runs a useless course through the wild hills of the north, through the range into the Sacramento watershed. The combined rivers would then be diverted into two tremendous meandering high-level canal systems flanking the interior valleys their entire length, picking up and storing all waters caught along the way and delivering them where needed for power, irrigation and domestic supply. Press reports place the estimated cost at something like $800,000,000 and the area to be benefited at 12,000,000 acres. As a project for conservation of the State's water, and for insuring almost the maximum development of its



ARCHITECTS' CONCEPTION OF PUMPING STATION AND FILTER HEAD HOUSE FOR SACRAMENTO WATER-WORKS
The pumping station, at the left, will house electric-motor-driven centrifugal pumps.

unclaimed millions of acres, it has no equal. Little discussion has been given the matter, perhaps because its magnitude is overwhelming. Editorials in some of the local papers, however, point to the administrative difficulty of getting the consent of existing irrigation developments to a sacrifice of their rights and holdings. It is likely that the State must pass through more than this trying drought before it will take seriously this master project of all.

In water filtration California has been most backward. Last year, however, the City of Sacramento took the lead in voting $1,800,000 bonds for a strictly up-to-date filtration plant of 32,000,000 gal. capacity and opportunity to quadruple the plant. The supply is obtained from the Sacramento River and has been becoming steadily more foul due to settlement of its watersheds and the valley above, and especially to the rice industry, which has set up conditions rich for the development of algae. Anabena, for instance, has been prevalent as high as 4,000 standard units per c.c. all summer long. Tidal action now carries the city's sewage backward, and a new intake farther up the river is badly needed. In winter the stream is a turbid torrent due to soil erosion.

The new water-works will include an attractive mass concrete intake pier in the river, gravity conduits to a pumping station about 1,100 ft. inland, low-lift pumps delivering to the treatment works, high-lift pumps pumping direct from the filtered water storage to the city at 75 lb. pressure, grit basins, coagulating basins, coagulant manufacturing house, head house, filters and filtered water basin. Design of the water-supply end is completed and bids for the work are soon to be received. Plans for the treatment works are being made by a special staff appointed for the purpose. Experiments on special phases of filtration—pipe underdrains, coagulating, benefits of aëration, air-binding of filters, and local deposits of bauxite—have been of invaluable aid in prescribing the most suitable design.

COMPARATIVE COST ESTIMATES OF VARIOUS TYPES OF WATER-WORKS PUMPING EQUIPMENT FOR SACRAMENTO CALIF.

Type of Station	Cost to Construct	Yearly Charges for 20 M.G.D.
Main unit reciprocating, high duty, other units steam-turbine centrifugal	$803,000	$154,650
Steam-turbine-driven high-lift centrifugal pumps, balance motor driven from turbo-generator	521,000	146,700
All units steam-turbine centrifugal	450,000	148,140
Diesel generator, motor-driven centrifugal units	610,000	124,000
Electric station, motor-driven centrifugal pumps, power purchased at approximately 1c. per kw.-hr.	190,000	104,000

Motor-driven centrifugal pumps will be used for the entire pumping station. Comparative estimates of the first and yearly costs of the various types of pumping equipment are given in the accompanying table. A network of hydroelectric power lines intersect in Sacramento and the engineers did not hesitate to recommend the selection of a motor-driven station.

Where Gas Is Cheap and Getting Cheaper

A reduction of the price of gas to 1s. 6d. per 1,000 cu.ft. for lighting and heating and to 1s. 4d. for power (36 and 32c.) has recently been announced by the Sunderland Gas Co. of England. The London *Engineer* states that the reduction, in spite of the "higher price of coal for domestic purposes is due entirely to the better prices obtained for residual products."

Water Supply for Irrigation in China

By Donald F. McLeod

The writer has traveled by rail and ferry between China and Japan twice, once in winter and once in summer. The most noticeable feature of the landscape, to him, is the way the rice fields are laid out and the irrigation systems installed in connection therewith.

The fields, or paddys, average small, usually half an acre, or less. They are arranged in a series of steps, with usually one or two feet difference of elevation. In some instances the steps are much greater and a series of fields extends for a hundred feet difference of elevation up a mountain side. In this case the irrigation is from a spring and the water flows down from field to field. The usual scheme of irrigation is to run a ditch a mile or so in length from a low dam across a stream. The ditch is carried across low places in a wooden flume, although in many instances it is carried on the top of an embankment along the sides of which trees are planted to keep the slopes in place.

MAN POWER RAISES WATER FOR IRRIGATION

Where the ditch is a few feet below the level of a rice field three ingenious devices are used for raising the water by man power. The writer believes the first to be of Chinese origin; the second, Korean; the third, Japanese.

The first device consists of a shallow basin to which is attached two pairs of ropes. A Chinaman on each side grasps one pair. When he and his *vis-à-vis* lower their arms the basin drops into the pool below. When both men pull horizontally opposite to one another a toggling action is produced, the basin rises to the required height, and the contents are thrown out into a sluice, due to the upward motion being halted.

The second device has a pendulum-like action. It is hung from a sort of tripod and is operated by one man. An elongated trough-like device of wood scoops up water at the lowermost part of the pendulum stroke and discharges it when the stroke has reached its greatest amplitude. Apparently, the muscular exertion required to operate the device is small, as the rope from the top of the tripod sustains the weight of the "scoop" and its contents.

The third device, shown in the accompanying photograph, is the most elaborate and ingenious of all. It is built on the general lines of an undershot water wheel, or, perhaps, a breast wheel. The operator treads on the vanes on the downstream side, and the wheel, revolving backward, lifts the water and discharges it at the breast of the wheel. This device, like the two others, is portable, and is set up anywhere, ready for action. The vertical "carrying" poles have three functions: To help anchor the machine in place; to help the operator balance himself as he stands treading; to carry the machine when it is moved. In transport the operator carries the whole outfit easily, balanced on his shoulder.

Water Use Variation in Completely Metered Systems

By Allen Hazen

Consulting Engineer, New York City

One of the functions of a distributing reservoir is to balance hourly fluctuations in flow. This is not the sole object of a distributing reservoir but it is important to know how much storage is required when this standpoint alone is considered. Data bearing upon this subject were presented by John R. Freeman in his report upon the Water Supply of the City of New York, in 1900, and these have been commonly used as a basis of estimate in the writer's office for the last twenty years. The following study was made to get new data from completely metered systems.

Data from Springfield, Mass., Hartford, Conn., and Superior, Wis., were used. The record in each case was the graphic record of a self-registering venturi meter, arranged so that the whole flow and all fluctuations in consumption were shown by it. These records were kindly furnished to the writer by the engineers of the several systems and were for the year ended May 1, 1920. Census populations for Jan. 1, 1920, were used, adjusted to include outside populations supplied.

The Springfield record was first examined for the whole period of 366 days. Afterward a shorter calculation, using only twelve days (the 15th of each calendar month being selected), gave practically identical results, and only the shorter calculation was used for Superior and Hartford.

The results are shown in three diagrams. Fig. 1 shows the rates of output in terms of mean flow. In a general way the minimum rate of flow is found to be nearly 0.5 of the mean; and the flow is below the mean for about 50 per cent of the time. The lines representing the rates of flow curve sharply upward near the right-hand side of the diagram. In other words, there are high rates of draft that occupied only a small percentage of the total time. To show this more adequately a small inset diagram was made on 10 times the scale. Fig. 2 shows the same data but calculated on a basis of gallons per capita daily above and below the mean. This is the basis that Freeman used and it is convenient and useful. This diagram shows that the minimum rate of flow is about 42 gal. per capita less than the mean. The flow is above the mean by more than 20 gal. per capita for about 28 per cent of the time, and exceeds the mean by 50 gal. per capita for very short periods. Fig. 3 shows the average hourly variation in rates of draft throughout the day for Springfield. Three lines are shown, representing Sundays, Saturdays and all the other days of the week taken together. Each is the average for 12 days, one from each month of the year.

These data include whatever fire drafts actually occurred, and there were, no doubt, the usual number of fires in each of the three cities. Practically the amount of water drawn for fire service has no influence that can be detected in the diagrams. At Springfield much more water was drawn for flushing snow from the streets than for fires.

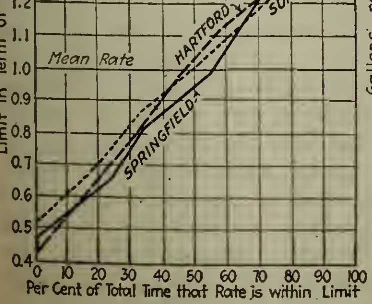


FIG. 1. IN TERMS OF MEAN

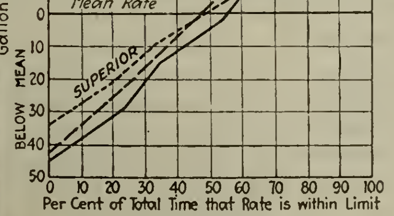


FIG. 2. ABOVE AND BELOW MEAN

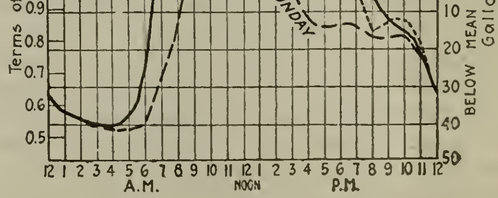


FIG. 3. IN HOURLY RATE

FIGS. 1 TO 3. VARIATION OF WATER CONSUMPTION IN COMPLETELY METERED WATER-WORKS

The average amounts of storage required to balance hourly fluctuations are obtained by planimetering these diagrams. The average for the three systems is found to be 14 per cent of the mean flow, and this is equal to 11 gal. per capita.

A number of data for the three systems are as follows:

	Population	Average Consumption, M.G.D.	Gallons per Capita, Daily	Required Storage to Balance Hourly Fluctuation in Rate of Draft: Million Gallons	Per Cent	Gal. per Capita
Hartford	170,000	12.85	75.6	1.76	13.7	10.3
Springfield	141,700	12.21	86.2	1.83	15.0	13.0
Superior	39,654	2.87	72.4	0.33	11.5	8.3
Totals and averages	351,354	27.93	79.5	3.92	14.0	11.2

At Springfield it was possible to check the results by an independent procedure. The water is delivered to the city from a masonry service reservoir of known dimensions. The records from a self-recording gage furnish data for computing the daily and weekly storage requirements. Data for three selected weeks showed an average daily variation in water level of 3.02 ft., representing a capacity of 2,000,000 gal. or 14.2 gal. per capita. This result compares with the 13 gal. per capita computed from the venturi meter readings and the check is as close as could be expected.

In addition to the hourly fluctuations this reservoir balances in considerable measure the daily fluctuations during the week. It fills higher on Sunday night than at other times, and reaches a weekly minimum on Saturday morning. The average weekly variation is found to have been about 3,720,000 gal., or 26 gal. per capita. While changes were being made at the filters the capacity of the reservoir was availed of to a greater extent, and in one week of maximum requirements the utilized storage was 8,350,000 gal., which is equal to 59 gal. per capita. This was slightly more than half of the available capacity of 16,000,000 gal., or 113 gal. per capita.

These data give a good idea of the storage required to meet daily and weekly fluctuations in completely metered systems. They do not give any indication of the amounts prudently held in reserve for conflagrations and other emergencies; and amounts allowed for such purposes must of course be added to the daily requirements. They also furnish, subject to the same limitations, a basis for estimating peak loads on leading mains and pumps.

Flood Protection Levees for Dallas, Texas

Improvement of the Trinity River by straightening and deepening and the construction of levees is the plan adopted for flood protection at Dallas, Tex. In addition about 4,000 acres of land will be reclaimed by means of the levees, which will have a total length of ten miles and will form a channel 2,000 ft. wide. Bridges, storm-water outlets and railway relocation will be necessary auxiliary parts of the work. The levees will be about 35 ft. high and 10 ft. wide on top, with slopes of 1 on 3. Through the work of the Dallas Property Owners' Association a levee district has been organized and plans and land appraisals are now being made. It is expected that these preliminaries will be completed in time to petition for a bond issue in 1921. E. N. Noyes is engineer for the Dallas and Dallas County Levee Improvement District.

City Zoning Plan for Milwaukee

A CITY zoning ordinance for Milwaukee, Wis., drafted recently by the Board of Public Land Commissioners, provides for districting by use, height and area of buildings. The ordinance is to be submitted to the city council at an early date.

For area of buildings, there are four classes of districts, with restrictions controlling the percentage of the lot which may be built upon and the minimum sizes of yards and courts from which light and air are received, in accordance with the height of the structure. For residential buildings, these open spaces must extend from the ground; for other buildings they are to extend from the top of the first story. In *A* districts, residence buildings may occupy 70 per cent of the area of an interior lot or 85 per cent of a corner lot, but other buildings may occupy 90 per cent of interior lots or 100 per cent of corner lots. In districts *B*, *C* and *D*, a building may occupy 70, 50 or 30 per cent of an interior lot, or 85, 60 or 40 per cent respectively of a corner lot. The number of families per acre is restricted to 50 in *C* districts and 20 in *D* districts.

Height Restrictions

For restriction in height of buildings, there are four classes of districts with limits of 125, 85, 60 and 40 ft., and with a corresponding limit on the number of stories in residences. In the districts for 125 ft. height, tower buildings are permitted for a total height of 225 ft. over 25 per cent of the lot area. Chimneys, elevators, tanks and similar structures are not limited.

For restriction of use of buildings, four classes of districts are employed. No existing uses are stopped, but any change must be toward conforming with the restrictions. In "residence districts" the ordinance permits dwellings, hotels, clubs, churches, educational and philanthropic institutions, railway passenger stations, greenhouses and farming. In "local business districts" there are permitted retail stores, the making of products chiefly for sale on the premises, public garages and other uses supplying local needs. In "commercial and light manufacturing districts" all uses are permitted except such industries as emit odor, dust, smoke, gas or noise. In "industrial districts" all except residential uses are permitted.

The enforcement of this ordinance is assigned to the inspector of buildings. Permits for construction and alteration will depend upon conformity with the ordinance. Certificates of occupancy will be required for the use of all new or altered buildings and for any change in use. Amendment of the ordinance is permitted after public hearing and report by the board, but if protest is made by 20 per cent of the owners of the property affected, such change will require a 75 per cent vote of the city council for its approval.

The Board of Public Land Commissioners is in effect a city zoning and city planning commission, as the law creating these boards provides that in a city of the first class which has no such commission the provisions of the city planning law shall be invested in the board of public land commissioners. At Milwaukee, the board is composed of C. B. Whitnall, George F. Stall (city engineer), Percy Braman (commissioner of public works), William H. Schuchardt and Edward Grieb; Arthur C. Comey is consultant and R. E. Stoelting is city planning engineer.

How Los Angeles Meters Aqueduct Water for Irrigation

Meter Case for Each Irrigator, but Moving Parts Transported From Consumer to Consumer in Ford Car by Zanjeros

SINCE surplus water from the Los Angeles aqueduct became available for irrigation in the San Fernando valley the irrigated area in that district has steadily increased until 60,165 acres have been brought under the ditch. This is largely held in small tracts, the water requirements of which vary materially. Water is distributed in pipes under pressure, the services to individual consumers varying in size from 2 to 6 in. A total of more than 2,000 services have been installed of which about 1,200 are of the 4-in. size. The rate established for irrigation water is 1.4c. per hundred cubic feet, with a minimum charge of $2 per irrigation.

The ordinary weir method of measuring the water supplied to each consumer was not considered because the pressure in the distributing system fluctuates considerably. Means of recording the total quantity passed under varying pressure was required. After some study Trident crest velocity meters were made standard for the entire system, 2, 3, 4 and 6-in. sizes being used. At first only about half as many meters were bought as there were services to be metered. The meters were taken out and moved from one service to another as water was to be delivered.

This proved too costly in time and labor so tests were made to see whether the meter main casings could be left in place and the moving parts interchanged without introducing material error. The error was found to be so small that it was considered negligible for use such as this. Accordingly main casings were purchased and set on all services and about half that number of moving parts are in use. The zanjero moves these from casing to casing as each tract receives its water. The bronze covers containing gear train and register are numbered and a record is kept of the date and location each time one is used, but the propellers are not numbered and are used promiscuously with any casing or cover of corresponding size.

The zanjero is provided with a Ford equipped with a rack for carrying the meter parts. He goes about alone from service to service, taking out or putting in meters according to a prearranged schedule. It takes him on an average of 8 to 10 min. to open or close the valve, put in or take out the moving parts, read a meter and make a record in his field book. A special brace-wrench is used for tightening nuts on stud bolts in the meter head so that a minimum of time is required for this operation. The parts removed are inspected to see if anything has gone wrong during service and record is made of anything that might affect the accuracy of the reading.

The meters are not used under heads of less than 8 ft. Sometimes when the demand is heavy there is a considerable velocity head in the mains near the upper end of the district. This reduces the effective head on the services in this section which approaches the lower limit even under normal conditions. Thus there are times when the desired flow would not be delivered by the standard meter. To meet this condition in the 4-in. meter, for example, a complete set of moving parts for a 6-in. meter is used in the 4-in. main case. This increases the flow about 19 per cent because of the decreased resistance. The propellers of 3-in., 4-in. and 6-in. meters are interchangeable, the only difference being in size of openings between vanes.

In order to save the wear on the small meters which work at relatively higher speeds, and to avoid choking the flow unnecessarily, the custom is to use a propeller and cover of larger size than the main casing where there is departure from the standard, choking the service gate down as may be necessary to keep the discharge within the desirable limit. This limit is set as not more than 495 gal. per min. for 3-in. meter, 900 gal. for a 4 in. and 2,025 gal. for a 6 in. meter.

Although standard combinations are used whenever possible, to meet emergent conditions, a table of corrections has been prepared by means of which the actual amount of water delivered can be determined from the record made with any combination of gear train and propeller. For example if a 4-in. cover containing gear train and register was placed on a main case containing a 3-in. cage and propeller, the registration would be 154 per cent of true reading. The various combinations give corrections ranging from 30 to 331 per cent.

The plan of using comparatively expensive meters on an irrigation system has worked out to the entire satisfaction of city officials. It prevents the diversion of any water except when it is being charged to the consumer, because the valves are left locked. The aqueduct water carried practically no sediment after passing through the several reservoirs and there has been but little damage or abnormal wear on the meters from any cause.

Important Changes in Mechanism

Some minor but nevertheless important changes in the mechanism of the meter have been made to make it more suitable for interchangeable use and to prolong its life under rather severe conditions of service. Some of these are as follows: The bronze propellor cage was machined to taper, leaving only a narrow ring at the base to serve as a cut off in the main case bearing. This eliminated the sticking experienced at first and greatly facilitated the removal of propeller cages. The agate bearing at the base of the propeller shaft was made as an adjustable agate sphere so that when it had worn on one surface it could be moved to another. At the same time a thumb screw was put in so the height of this bearing could be adjusted to compensate for wear that reduced the length of the propeller shaft. The pitch of the vanes in the 2-in. propellers was reduced and the change gears adjusted to suit. The decreased speed resulting from this change accomplished the double purpose of reducing the choking effect in the meter and lessening the wear. The lower side of the gasket, which goes between casing and cover, is always given a coat of graphite before the joint is made. This prevents the gasket from sticking to the casing and has materially prolonged the average life of gaskets.

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Volume of Salt in Ocean

The volume of the salt in the ocean, according to the U. S. Geological Survey, is enough to cover the entire surface of the United States to a depth of 8,500 ft.

A Study of the Venturi Flume as a Measuring Device in Open Channels

Experimental Work at the Cornell Hydraulic Laboratory To Obtain Data for More Rational Design of Venturi Flumes—Loss of Head in Venturi Flume Much Less Than in Weir of Same Capacity Range

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EXPERIMENTAL work on the Venturi flume performed by the writers at the hydraulic laboratory of the College of Civil Engineering, Cornell University, indicates that, if properly designed, this device should prove to be of as great value in open channels as is its forerunner, the Venturi meter, in a pipe. It will combine, under field conditions, accuracy at least equal to that of any other open-channel measuring apparatus, together with reliability and small loss of head in the channel. The discharge coefficient in the case of the flume is, however, subject to variations due to the exposed surface, which must be taken careful account of in the design and operation of the instrument.

A Venturi flume consists, fundamentally, of a contraction in the channel having a form roughly similar to a longitudinal section of a Venturi meter. Its transverse section may be rectangular, trapezoidal, triangular, or any other shape. To find the quantity of water flowing in such a device the surface elevation is determined at two points, one up stream from the apparatus and the other in the throat or narrow portion. These elevations are usually determined by means of float gages in separate stilling wells connected to the channel by suitable piping. The difference between the two surface elevations so indicated gives the fall in potential head, most of which has been transformed into velocity head as the stream passes into the narrow throat. From the two elevations the depth, and consequently the cross-sectional areas, at both points are obtainable. With these data and the use of an experimental coefficient, whose value as in the Venturi meter is near unity, the discharge is computed. The Venturi flume has been demonstrated to be a means for measuring water with an accuracy about equal to that of the ordinary weir in practice.

So far as the writers are aware, this device was first mentioned in an article in *Engineering-News*, Aug. 10, 1916, p. 271. It was presented in more detail by V. M. Cone in the *Journal of Agricultural Research*, April 23, 1917. A paper in the *Proceedings* of the American Society of Civil Engineers, Oct.-Nov.-Dec., 1919, by E. W. Lane, treats some phases of the flow of water through Venturi flumes. The Division of Irrigation Investigations, Bureau of Public Roads, U. S. Department of Agriculture, has also been directing considerable experimental work on this device at Fort Colline, Colo., and at Cornell University.

The Venturi flume would probably have a greater first cost than some other devices—a weir, for instance—and an indicating or recording device for it, if direct discharge readings rather than only gage heights were desired, might involve some complications, but in certain respects the Venturi flume has considerable in its favor. It requires very little loss of head to pass water through it, and it is very unlikely to become inaccurate or inoperative by the deposition of silt or floating matter, since, due to the comparatively high throat velocity, any suspended material carried into it will also be carried out. For the latter reason it may very possibly be used successfully for the measurement of the flow of sewage or similar liquids.

The experimental work of the writers was done with the object of obtaining information upon which to base a more rational design of Venturi flumes so that more definite coefficients might apply and so that geometrically similar flumes might be built with greater confidence in their performance.

Two different designs of rectangular Venturi flumes were experimented upon by the authors. Each flume

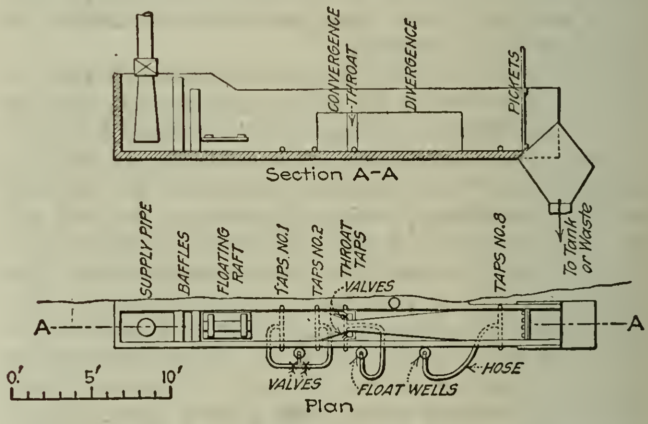


FIG. 1. PLAN AND SECTION OF CANAL AND VENTURI FLUME

had a throat width of 8 in., equal to one-third the width of the channel, and each converged in a distance of three throat widths and diverged in a distance of ten throat widths. The first of these Venturi flumes had a length of throat equal to three throat widths, or 24 in., and the second, a throat length of one throat width, or 8 in. No curved surfaces were employed. The flumes (Figs. 1 and 2) were built up of tongued and grooved dressed cypress with the grain horizontal, the walls of the flume being 30 in. high. At the junction of the wooden flume walls and the concrete channel, at both ends and along the floor, the joint was carefully caulked so that practically no water circulated in the dead space behind the flume walls. All joints, screw heads, and other irregularities were filled with putty to form smooth plane surfaces.

The canal in which the flumes were installed is located in the Hydraulic Laboratory of the College of Civil Engineering of Cornell University. It is a reinforced-concrete channel, rectangular in section, 2 ft. wide by 4 ft. deep, and about 30 ft. long. It is supplied with

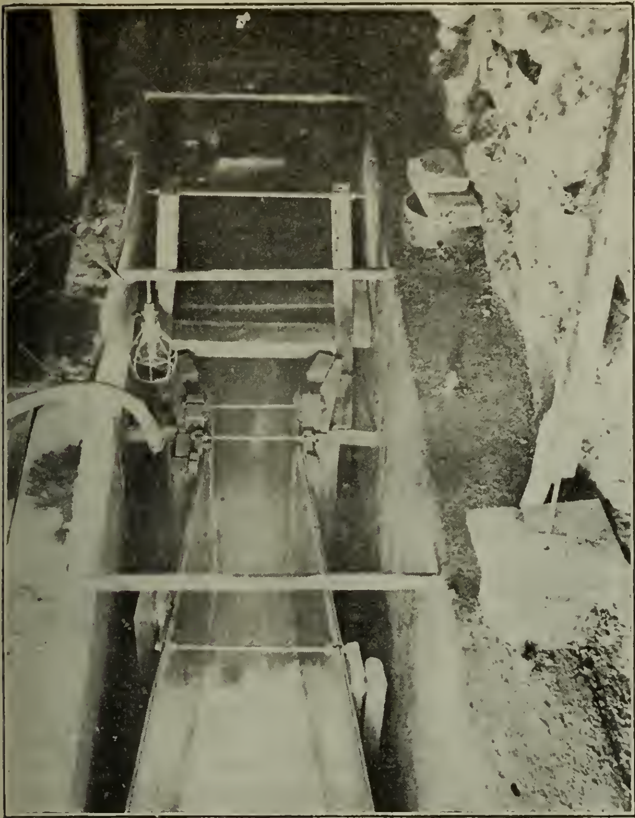


FIG. 2. VIEW OF FLUME LOOKING UP STREAM
About 6 sec.-ft. flowing at depth of 2 ft.

fresh water from Fall Creek through a 10-in. pipe line under about 40-ft. head. A gate valve at the entrance to the canal controls the flow. In order to introduce the water to devices installed further down stream in the canal with as little entrance turbulence as possible, the 10-in. line terminates in a diverging sheet-iron draft tube which helps reduce the entrance velocity. There are also two sets of horizontal baffles and a floating raft.

Discharge measurements were made volumetrically by means of a 400-cu.ft. measuring tank equipped with a diverter by means of which the discharge from the flume could be instantaneously switched from the tank to waste, and vice versa. The volume of water in the tank was determined by means of a carefully calibrated float gage which could be read to tenths of cubic feet. For timing the runs both observed clock time and a two-pen ribbon chronograph, connected to a seconds pendulum, were used.

Every 2 ft. along the canal a pair of opposite, 1-in. pipe openings had been built into the concrete. These entered the sides of the canal normally and horizontally, with inverts level with the floor. The flumes were so placed in the canal that one pair of these openings (taps No. 2 on Fig. 1) came just at the beginning of the convergence. This pair of taps, and the pair 2 ft. further up stream were connected to the gage used for measuring the up-stream head. This arrangement caused taps No. 8, which were used for the down-stream connections, to be approximately 1 ft. 4 in. below the end of the divergence in the case of the 8 x 24-in. throat, and approximately 2 ft. 8 in. for the 8 x 8-in. throat. With the 8 x 24-in. throat, two pairs of gage connections were made to the throat, one pair at a distance of 10¾ in. down stream from the beginning of the throat, the other pair 16 in., or two-thirds of the throat length, down stream in the throat. The latter pair of connections was used exclusively because a greater Venturi difference (drop in potential head) was thereby shown, and at that time this was thought to be the chief consideration. The 8 x 8-in. throat had but one pair of gage connections, placed 5⅓ in. (two-thirds of the throat length) down stream in the throat. These connections consisted, in both throats, of ½-in. iron pipe leading to the nearest pair of taps in the concrete. The pipes entered the throat in a direction normal to the throat walls, ended flush, and with edges slightly rounded. Outside of the canal the two taps of each pair used were symmetrically connected, by means of ½-in. iron pipe fittings, to a tee at a point beneath the center of the canal, from which point ¾-in. rubber hose led to the gages. In the case of the throat connections valves were placed (Fig. 1) so that either side alone, or both together, could be connected to the gage. The gages consisted of 6-in. iron pipes with cylindrical copper floats provided with radial fins to prevent capillary effects. One-fourth-inch brass rods extended up from the floats and carried pointers which were guided on brass scales. The scales were graduated to hundredths of feet and readings were estimated to thousandths of feet.

SUMMARY OF ORIGINAL DATA, ARRANGED BY SETS

Each set is the average of from two to four independent runs. Sets 68 to 126, for the 8x8-in. throat, show effect of surface disturbance. Column headings are explained in text.

8 x 24-In. Throat

Set	Q	d1	h	h_t	C_f
1	0.335	0.375	0.034	0.007	0.992
2	0.332	0.437	0.023	0.005	0.974
3	0.331	0.529	0.012	0.001	1.067
4	0.331	0.673	0.007	0.001	1.081
5	0.625	0.462	0.110	0.027	1.013
6	0.623	0.517	0.067	0.014	0.994
7	0.623	0.634	0.038	0.005	0.985
8	0.621	0.750	0.024	0.002	1.006
9	0.653	0.997	0.016	0.002	0.948
10	0.655	1.227	0.010	0.002	0.968
11	0.652	1.524	0.006	0.001	1.008
12	0.939	0.589	0.217	0.086	0.987
13	0.938	0.647	0.101	0.015	1.000
14	0.941	0.817	0.051	0.007	0.990
15	0.993	0.982	0.040	0.006	0.954
16	1.012	1.176	0.027	0.004	0.965
17	1.015	1.364	0.020	0.003	0.954
18	1.011	1.543	0.014	0.001	1.000
19	1.007	1.743	0.011	0.002	0.992
20	1.017	1.942	0.008	0.001	1.066
21	1.005	1.981	0.008	0.001	1.022
22	1.651	0.868	0.338	0.248	1.008
23	1.669	0.896	0.242	0.036	0.969
24	1.839	1.059	0.135	0.023	0.994
25	1.831	1.068	0.131	0.024	0.986
26	1.853	1.232	0.090	0.013	0.984
27	1.850	1.453	0.060	0.009	0.973
28	1.851	1.668	0.043	0.006	0.996
29	1.845	1.996	0.0255	0.003	1.052
30	1.838	2.322	0.017	0.002	1.097
31	2.15	1.037	0.402	0.349	1.003
32	2.15	1.044	0.370	0.084	0.981
33	2.15	1.166	0.151	0.023	0.993
34	2.15	1.409	0.086	0.009	1.001
35	2.24	1.638	0.064	0.005	1.018
36	2.24	1.949	0.041	0.002	1.042
37	2.23	2.319	0.026	0.000	1.061
38	3.38	1.413	0.527	0.619	0.981
39	3.38	1.413	0.518	0.308	0.978
40	3.38	1.442	0.427	0.121	0.942
41	3.38	1.501	0.303	0.048	0.940
42	3.38	1.531	0.197	0.029	0.962
43	3.37	1.778	0.149	0.023	0.970
44	3.37	2.007	0.106	0.015	0.979
45	3.36	2.191	0.085	0.011	0.982
46	3.42	2.368	0.072	0.009	0.997
47	4.66	1.744	0.635	0.998	0.983
48	4.66	1.751	0.621	0.433	0.976
49	4.65	1.785	0.522	0.227	0.945
50	4.62	1.882	0.347	0.073	0.935
51	4.64	2.040	0.238	0.041	0.953
52	4.63	2.225	0.178	0.030	0.971
53	4.63	2.385	0.148	0.022	0.970
54	5.99	2.045	0.737	1.315	0.991
55	5.97	2.163	0.505	0.220	0.933
56	5.97	2.406	0.294	0.051	0.946
57	7.41	2.340	0.846	1.602	1.003
58	7.45	2.385	0.750	0.549	0.973

SUMMARY OF ORIGINAL DATA, ARRANGED BY SETS

Each set is the average of from two to four independent runs. Sets 68 to 126, for the 8x8-in. throat, show effect of surface disturbance. Column headings are explained in text.

8 x 8-In. Throat

Set	Q	d_1	h	h_t	C_f
1	0.333	0.370	0.029	0.004	0.969
2	0.333	0.413	0.022	0.003	0.972
3	0.334	0.465	0.017	0.003	0.970
4	0.332	0.540	0.012	0.002	0.979
5	0.333	0.609	0.009	0.001	1.004
6	0.332	0.788	0.005	—0.001	1.029
7	0.500	0.416	0.055	0.012	0.952
8	0.498	0.458	0.047	0.008	0.954
9	0.499	0.496	0.038	0.005	0.954
10	0.500	0.559	0.027	0.003	0.982
11	0.499	0.640	0.019	0.001	1.001
12	0.499	0.727	0.013	0.001	1.054
13	0.498	0.782	0.012	0.001	1.019
14	0.500	0.930	0.008	0.000	1.047
15	0.508	1.306	0.005	0.001	0.962
16	0.501	1.294	0.004	0.000	1.004
17	0.795	0.517	0.169	0.047	0.964
18	0.790	0.532	0.134	0.019	0.940
19	0.790	0.569	0.090	0.011	0.950
20	0.792	0.629	0.052	0.008	0.971
21	0.793	0.715	0.042	0.005	0.994
22	0.794	0.845	0.030	0.004	0.979
23	0.790	1.024	0.019	0.003	0.989
24	0.795	1.168	0.014	0.001	1.015
25	0.801	1.379	0.010	0.000	1.026
26	0.803	1.560	0.007	0.001	1.084
27	0.793	1.700	0.005	0.000	1.152
28	1.305	0.720	0.220	0.154	0.978
29	1.305	0.776	0.144	0.019	0.958
30	1.313	0.818	0.113	0.013	0.970
31	1.301	0.949	0.039	0.009	0.983
32	1.312	1.089	0.048	0.005	1.005
33	1.311	1.331	0.030	0.002	1.019
34	1.307	1.655	0.018	0.001	1.039
35	1.312	2.038	0.012	0.002	1.039
36	1.308	2.397	0.009	0.001	1.018
37	2.19	1.008	0.293	0.310	1.004
38	2.21	1.044	0.259	0.085	0.982
39	2.18	1.108	0.178	0.025	0.983
40	2.18	1.200	0.112	0.010	1.000
41	2.18	1.540	0.053	0.002	1.036
42	2.18	1.809	0.038	—0.002	1.112
43	2.18	2.016	0.025	—0.003	1.211
44	2.18	2.237	0.017	—0.004	1.320
45	2.19	2.364	0.014	—0.004	1.384
46	3.33	1.334	0.404	0.513	1.007
47	3.33	1.368	0.355	0.166	0.987
48	3.31	1.500	0.233	0.058	0.963
49	3.30	1.778	0.129	0.014	0.986
50	3.30	2.079	0.080	0.006	1.029
51	3.31	2.427	0.050	0.002	1.098
52	4.52	1.617	0.495	0.723	1.030
53	4.52	1.635	0.467	0.302	1.016
54	4.52	1.734	0.362	0.168	0.979
55	4.52	1.948	0.237	0.069	0.967
56	4.52	2.207	0.159	0.025	0.981
57	4.52	2.417	0.121	0.015	1.005
58	5.83	1.882	0.581	0.980	1.062
59	5.83	1.906	0.554	0.411	1.046
60	5.87	2.038	0.424	0.233	1.002
61	5.86	2.215	0.314	0.143	0.983
62	5.87	2.427	0.235	0.082	0.985
63	7.00	2.094	0.635	1.284	1.084
64	7.01	2.102	0.623	0.542	1.082
65	6.99	2.418	0.378	0.207	0.998
66	8.63	2.393	0.810	1.68	1.098
67	8.67	2.419	0.772	0.636	1.085
68	1.044	2.436	0.0045	.....	1.125
69	1.215	2.426	0.006	.....	1.138
70	1.413	2.428	0.007	.....	1.082
71	1.696	2.431	0.012	.....	1.124
72	1.940	2.427	0.010	.....	1.411
73	2.17	2.429	0.007	.....	1.800
74	2.37	2.426	0.0105	.....	1.678
75	2.63	2.426	0.019	.....	1.398
76	2.87	2.474	0.029	.....	1.237
77	3.13	2.423	0.038	.....	1.183
78	3.39	2.419	0.047	.....	1.161
79	3.62	2.423	0.064	.....	1.071
80	1.023	2.202	0.005	.....	1.157
81	1.218	2.199	0.008	.....	1.091
82	1.428	2.199	0.011	.....	1.092
83	1.667	2.201	0.015	.....	1.093
84	1.916	2.200	0.013	.....	1.350
85	2.15	2.203	0.014	.....	1.459
86	2.39	2.199	0.020	.....	1.361
87	2.62	2.204	0.029	.....	1.244
88	2.84	2.203	0.041	.....	1.141
89	0.922	2.003	0.005	.....	1.146
90	1.122	2.004	0.007	.....	1.178
91	1.329	2.001	0.010	.....	1.171
92	1.558	1.998	0.015	.....	1.124
93	1.821	1.997	0.017	.....	1.234
94	2.06	2.003	0.021	.....	1.262
95	2.29	1.999	0.026	.....	1.258
96	2.51	2.000	0.038	.....	1.149
97	2.75	1.998	0.052	.....	1.091
98	0.814	1.805	0.004	.....	1.252
99	0.988	1.805	0.007	.....	1.149
100	1.177	1.806	0.010	.....	1.148
101	1.406	1.803	0.016	.....	1.084
102	1.666	1.500	0.021	.....	1.135
103	1.907	1.802	0.028	.....	1.129
104	2.15	1.799	0.039	.....	1.083
105	2.37	1.798	0.049	.....	1.074
106	0.570	1.501	0.004	.....	1.053
107	0.733	1.497	0.008	.....	0.963

SUMMARY OF ORIGINAL DATA, ARRANGED BY SETS

Each set is the average of from two to four independent runs. Sets 68 to 126, for the 8x8-in. throat, show effect of surface disturbance. Column headings are explained in text.

8 x 8-In. Throat

Set	Q	d_1	h	h_t	C_f
108	0.848	1.500	0.011	.....	0.950
109	1.092	1.503	0.016	.....	1.013
110	1.280	1.501	0.022	.....	1.025
111	1.491	1.508	0.029	.....	1.037
112	1.724	1.499	0.035	.....	1.105
113	2.01	1.499	0.053	.....	1.059
114	2.27	1.499	0.075	.....	1.022
115	2.52	1.499	0.099	.....	1.006
116	0.409	1.000	0.004	.....	1.123
117	0.558	1.005	0.009	.....	1.028
118	0.723	1.000	0.017	.....	0.977
119	0.878	1.002	0.025	.....	0.987
120	1.056	1.000	0.037	.....	0.996
121	1.222	1.001	0.050	.....	1.002
122	1.396	1.001	0.071	.....	0.985
123	1.633	1.004	0.102	.....	0.995
124	1.829	1.000	0.155	.....	0.968
125	2.04	1.005	0.233	.....	0.972
126*	2.13	1.001	0.296	.....	0.987

In order to vary the depth of water in the flume under conditions of fixed discharge, and to avoid the unequal velocity distribution which would have been caused by an ordinary gate or weir, an adjustable system of vertical pickets was arranged downstream in the canal by means of which the water could be backed up to the desired extent.

In the operation of the flume a "run" consisted of a single tank measurement of the discharge, preceded and followed by a reading of each gage. Depending upon the steadiness of the gages, usually three, and sometimes more, runs were made for each condition of flow and the results averaged to make what were termed "sets." These values were used in plotting the curves. The runs varied in length from ½ to 3 min., being never under 1 min. unless limited by the capacity of the tank. In runs of over 1 min. the chronograph was not generally used, as the clock time was found to be sufficiently accurate.

The coefficient referred to previously, and which was used in all computations, is the corrective multiplier which it is necessary to use, as in the Venturi meter in a pipe, in order to obtain the actual discharge from that computed from the gage readings. It is found from the equation derived below. The notation used is as follows:

d_1 = Up-stream depth, the depth at the up-stream gage openings.

d_2 = Throat depth, the depth at the throat gage openings.

d_3 = Down-stream depth, the depth at the down-stream gage openings.

h = Venturi difference, the loss of potential head or drop in surface elevation of the water between the up-stream and throat gage openings.

h_T = Total potential head lost through the flume, the drop in surface elevation of the water between the up-stream and down-stream gage openings.

w_1 = Width of channel at the up-stream gage openings.

w_2 = Throat width at the throat gage openings.

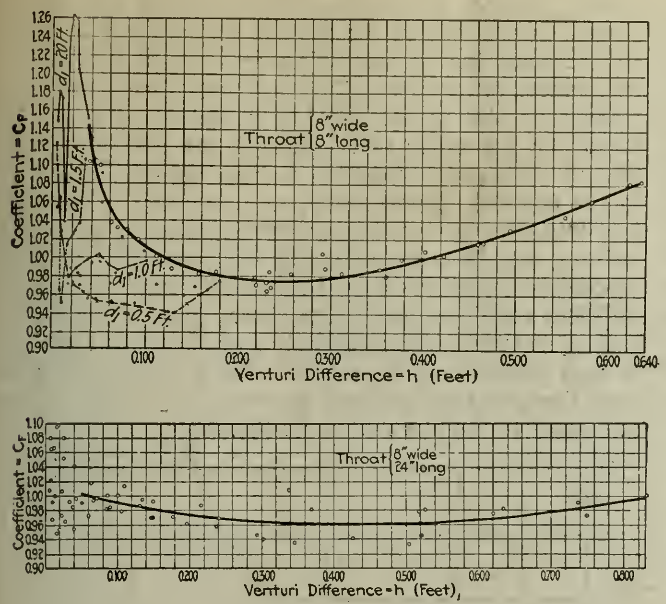
$F_1 = d_1\, w_1$

$F_2 = d_2\, w_2$

v_1 = Average velocity at the up-stream gage openings in ft. per sec.

v_2 = Average velocity at the throat gage openings in ft. per sec.

Q_A = Actual discharge through the flume in sec.-ft.



FIGS. 3 AND 4. VARIATIONS IN COEFFICIENTS FOR 8x8-IN. AND 8x24-IN. VENTURI FLUMES

Q_I = Ideal computed discharge through the flume in sec.-ft.

C_F = Friction or discharge coefficient $= \dfrac{Q_A}{Q_I}$

The formula for C_F is derived from the following two fundamental equations applying to the steady flow of water:

$$\begin{cases} h = \dfrac{v_2^2}{2g} - \dfrac{v_1^2}{2g} & (1) \\ Q = v_1 d_1 w_1 = v_2 d_2 w_2 & (2) \end{cases}$$

From (2): $v_1 = \dfrac{v_2 d_2 w_2}{d_1 w_1} = v_2 \left(\dfrac{F_2}{F_1}\right)$

Substituting in (1):

$$h = \frac{v_2^2}{2g} - \frac{v_2^2}{2g}\left(\frac{F_2}{F_1}\right)^2 = \frac{v_2^2}{2g}\left[1 - \left(\frac{F_2}{F_1}\right)^2\right]$$

$$v_2^2 = \frac{2gh}{1 - \left(\dfrac{F_2}{F_1}\right)^2}; \quad v_2 = \sqrt{\frac{2gh}{1 - \left(\dfrac{F_2}{F_1}\right)^2}}$$

Substituting in (2):

$$Q = F_2\sqrt{2gh}\sqrt{\frac{1}{1 - \left(\dfrac{F_2}{F_1}\right)^2}} = Q_I$$

$C_F = \dfrac{Q_A}{Q_I}$, therefore, is equal to

$$\frac{Q_A}{F_2\sqrt{2gh}\sqrt{\dfrac{1}{1 - \left(\dfrac{F_2}{F_1}\right)^2}}}$$

Since the quantity $\sqrt{\dfrac{1}{1 - \left(\dfrac{F_2}{F_1}\right)^2}}$ is determinable by direct measurements it has been termed C_M, the meter or flume coefficient.

In order to show the variation of the coefficient, C_F, of the flumes for changes in the conditions of flow the curves shown in Figs. 3 and 4 were plotted, having C_F as ordinates and h as abscissas. As will be noted from the plottings, no differentiation is made in the case of the 8 x 24-in. throat for different up-stream depths, as there seemed to be no difference with different depths even for low values of h, and in the case of both throats, especially the 8 x 8-in., all points appear to define a definite curve above certain values of h.

While making runs on the 8 x 8-in. throat with low Venturi differences and comparatively great depths, the peculiar phenomenon shown most clearly by Fig. 5 was observed: that is, a decrease in h for increased Q_A under certain conditions. Upon careful observation of the surface appearance under these conditions it was concluded that this variation was entirely due to the presence of waves of various types superimposed on the otherwise natural surface of the water flowing through the throat, these existing on account of the tendency under some conditions for the tail water to run back into the low throat. This affected the throat gage and varied the observed values of h and d_2 from their otherwise proper values. Of course this variation causes a corresponding irregularity in the coefficient C_F. It is seen from the curves that as the depth decreases or the Venturi difference increases, the effects due to the waves are reduced.

This is principally due to the fact that the increased throat velocity prevents the tail water from encroaching on the throat to as great an extent as with small Venturi differences. It will also be noted that the variation of the coefficient, Figs. 3 and 4, at low Venturi differences is not nearly so great in the case of the 8 x 24-in. throat, where the throat gage openings were three times as far from the down-stream end of the throat as in the 8 x 8-in. throat, where the waves could more readily run back from the divergence to a point opposite the gage openings. It is quite probable that variation in the coefficient, possibly accounting for a considerable part of that shown for the 8 x 24-in. throat, is due to the increased percentage of error in the determination of h, as that quantity decreases.

For these reasons the exact location of the gage openings in the throat is of great importance. A change in length of throat, or position of openings, or both, may greatly affect the variation in the coefficient by removing the openings from the influences of the surface disturbances under certain conditions, and possibly subjecting them to these influences under different conditions. It seems probable that by removing the throat gage openings to a greater distance than one-third the throat length (with throat length equal to the throat width) from the down-stream end of the throat, either by placing them at the midpoint of a throat of length equal to its width or by increasing the length of the throat to, say, one and one-half or two times its width, and leaving the openings at the two-thirds point, the variations in the coefficient might be greatly reduced. This is confirmed by the comparative absence of these variations in the 8 x 24-in. throat.

It is seen that for rough measurements of discharge, provided extreme values of h are not employed (with flumes the size and design of those experimented with by the writers h should be kept between 0.1 ft. and 0.4 ft. approximately), the use of a constant coefficient of about 0.98-1.00, as with the Venturi meter in a pipe, will give results satisfactory for most purposes within 5 per cent error.

The actual loss of head involved in the use of the Venturi flume occurs chiefly during the reconversion of velocity to potential head in the diverging portion of the flume, and is, of course, greater than in the pipe Venturi meter, due to the disturbances incident to an exposed surface. With a constant up-stream depth the loss of head increases as the discharge increases, and with a constant discharge it decreases as the up-stream depth increases. With a given discharge the Venturi difference increases as the backwater and depth are decreased until a more or less definite point of free discharge is reached, beyond which point the conditions in the throat and up-stream from the flume are no longer changed by a removal of backwater, the loss of head alone being increased. The value of h, under these conditions, is at its maximum for the given discharge,

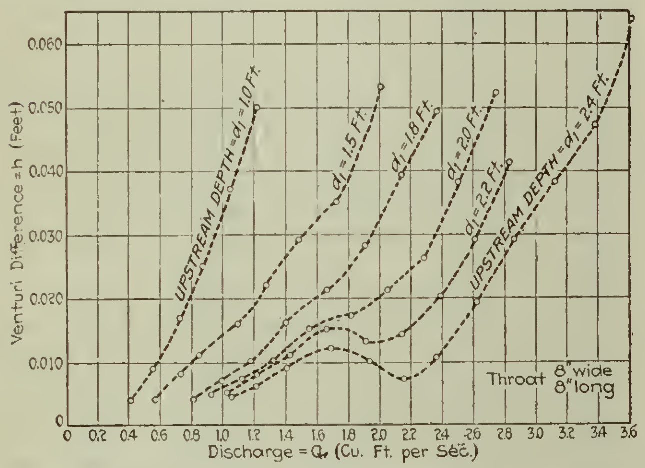


FIG. 5. IRREGULAR VARIATION IN INDICATED VENTURI DIFFERENCE DUE TO SUPERIMPOSED WAVE EFFECTS IN VENTURI FLUME

and thus no useful purpose is served by exceeding the loss of head occurring when that point is reached, unless it is desired to use the flume as a kind of orifice. In Fig. 6 is shown a curve for each of the two flumes experimented upon which gives the loss of head occurring at the point of maximum Venturi difference for each discharge. The value of the loss of head thus shown for any particular discharge represents the loss of head necessary to discharge that quantity of water through the flume with the maximum possible value of h and the minimum possible up-stream depth, d_1. This value of h_T (loss of head) may be decreased, and still discharge the same quantity of water, by increasing the depth, incidentally decreasing the Venturi difference. In order to determine the minimum possible value of d_1 for a given discharge, the rating curves, discussed later, should be used. If it is desired to exceed the discharge thus determined for any particular up-stream depth the throat width must be increased. It is seen that with an 8-in. throat width the maximum necessary loss of head in tenths of feet is numerically about equal to the discharge in cubic feet per second.

In the already mentioned Cornell University work under the Irrigation Investigations Division, Bureau of Public Roads, U. S. Department of Agriculture, all of the Venturi flumes used were built with an angle of divergence equal to the writers' angle of convergence, 1:3, and in these flumes a phenomenon was observed very similar to that described by Mr. Lane for channel contractions (p. 773 in the *Proceedings* referred to above), namely, a swinging of the main thread of the stream to one side of the channel or the other in passing through the throat. This was found to cause a pronounced difference in the reading of the throat gage when connected to the opening on but one side of the throat or the other and indicated the advisability of having each gage connected to two opposite openings in the channel. Accordingly, as previously mentioned, this was done in the flumes experimented upon by the writers, and in order to verify the necessity for such procedure a number of gage readings were taken under different conditions, with the throat gage connected to each of the two sides separately and also both together. It was found that, especially with high velocities of flow, there was a difference between the readings when connected to the one side or to the other. In the small

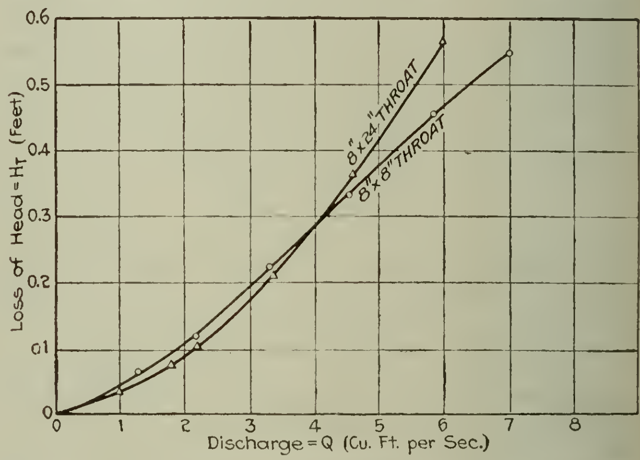


FIG. 6. LOSS OF HEAD AT MAXIMUM VENTURI DIFFERENCE FOR EACH DISCHARGE

flumes used this difference amounted at times to several hundredths of a foot. It was also found that when connected to both sides of the channel at once the reading was very nearly, if not quite, equal to the mean of the readings connected to each side separately. The difference in the two sides did not, however, appear to be due to a more or less optional shifting of the main thread of the stream, as in the two cases mentioned above, but seemed to be due to some minor, imperceptible lack of symmetry in the flumes, as the high and low sides could not be interchanged. The reason for the thread of the stream not shifting in the writers' flumes probably was due to the more gradual divergence and indicates an advantage in such design.

As has been previously mentioned, provision was made for connecting the up-stream gage to either one of two pairs of gage openings, one of these pairs being located just at the beginning of the convergence and the other 2 ft. further up stream. For practically all runs the down-stream one of these two pairs of openings was used but the up-stream pair was frequently connected to the gage (meanwhile disconnecting the other pair) and the difference in reading, if any, noted. By means of a number of readings taken while connected to one or the other of these two pairs of openings under various conditions of flow, with no Venturi flume installed in the canal, it was ascertained that the presence of the Venturi flume made no difference in the relation between readings obtained with these two pairs of openings. It may therefore be concluded that the openings into the channel connecting with the up-stream gage may be

located at any point convenient, down to the actual point of beginning of the convergence. Practice in this regard, however, should conform to that followed in the flume, the calibration for which is used. Of course, in no case should the distance up-stream be great enough to involve appreciable loss of head by friction in the channel.

The conclusions arrived at by the writers may be stated briefly as follows:

1. The coefficient of the Venturi flume for any particular condition of flow within rather wide limits is a fixed determinable quantity about unity. With the flumes experimented upon, however, the value of the coefficient varied over a range of possibly 10 per cent with varied conditions of flow, most of this variation being apparently due to surface phenomena, waves, etc., the effect of which could be controlled by the design of the flume so as to obtain a more definite coefficient.

2. The maximum loss of head necessary in the use of the Venturi flume is very small compared to that lost with other measuring devices under similar conditions. A weir with the same range of capacity would probably involve at least five or six times as much loss of head.

3. The necessity for connecting each of the gage wells to a pair of opposite gage openings in the channel was verified.

4. The exact location of the up-stream gage openings was found to be immaterial as long as they were placed up stream from, and fairly close to, the beginning of the convergence.

The determination of the discharge of the Venturi flume, from the readings of the up-stream and the throat gages, is slightly more involved than in the case of the Venturi meter in a pipe, since, besides the Venturi difference, the depth must also be taken into account. For this reason an automatic recording device, such as commonly used with the Venturi meter, while undoubtedly practical, would probably be more complicated.

For obtaining the discharge from the gage readings without recourse to the formula, rating curves were constructed from the flumes experimented upon. These were plotted on logarithmically ruled paper with up-stream depths as ordinates and Venturi differences abscissas. Interpolation may be made between the curves of constant discharge on this plotting. The form of these rating curves was suggested to the writers by Prof. E. W. Schoder, of Cornell University. A table, such as the one presented by Mr. Cone in the article already mentioned, may also be constructed giving discharges for various values of depth and Venturi difference.

The writers wish to acknowledge their indebtedness to Prof. E. W. Schoder, in charge of the Hydraulic Laboratory at Cornell, for his suggestions and advice.

Vitrified Brick Production

With the removal of Government restrictions on road building the output of vitrified brick or block in 1919 increased to 485,139,000, 20 per cent higher than the 1918 output, though below the normal, having been little more than half the average reached during the preceding ten years. The estimated average price per thousand in 1919, -23.11, was the highest ever recorded, says a recent press bulletin published by the U. S. Geological Survey.

Sewerage and Water Improvements at Decatur, Illinois

Contracts for Intercepting Sewers and Storage Dam To Clean and Regulate Sangamon River—Sewage Treatment Proposed

AFTER six years of investigation and a series of sewage-treatment experiments the first two of several large contracts for intercepting sewers and sewage treatment have been let by the Sanitary District of Decatur, Ill., and work has actually started. At the same time the City of Decatur has entered into a cost-plus contract for the construction of a storage dam for additional water supply which is also related to the sewage disposal problem. These improvements for cleaning and regulating the flow of the Sangamon River are estimated to cost over $2,000,000.

Decatur has population of about 50,000. Its sewage flow is about 5,500,000 gal. per 24 hours. Included in this is about 1,250,000 gal. of strong industrial sewage from a starch factory, exclusive of condenser water. There is also included the sewage and wastes from a creamery, packing house and gas-works. The city sewage, without the industrial sewage, has a biological oxygen consumed value of 171 p.p.m., which is increased by the industrial sewage to about 400 p.p.m. The minimum required volume of diluting water for the latter figure is about 40. Sewage treatment is required because during three or four months in the summer the entire flow of the Sangamon River is used for the water supply of the city and is subsequently turned back into the stream as sewage. This creates an open sewer passing by the city and continuing in a lessening degree for twenty miles below.

Even with the use of the whole dry-weather flow the river is insufficient for the water supply needs of the city and consequently a large storage dam is under construction. This will afford water for sewage dilution also.

Sewage-Treatment Experiments

A number of special tests of sewage-treatment processes have been made. A testing station comprising an Imhoff tank and sprinkling filter with appurtenances was built in 1914 and operated during 1914, 1915 and 1917. During 1917 small-scale tests were made of the activated-sludge process on the mixed sewage, and in 1919 a testing station was built and operated to try the activated-sludge process on the crude starch works sewage. It was found that the activated-sludge process is applicable to the mixture of city and starch-works sewage, but not to the starch-works sewage alone. The tests also showed that Imhoff tanks removed 50 to 60 per cent of the suspended solids from the mixed sewage, and that sprinkling filters operating with settled sewage at a maximum rate of 1,000,000 gal. per acre per 24 hours would produce a 90 per cent stable effluent. A decision has not yet been made as to the type of treatment that will be adopted.

In the meantime two of the three contracts for intercepting sewers are under way. The first contract (let in October, 1919) is for 35,000 cu.yd. of earth embankment at 65c. per cu.yd. The second is for about 7,000 ft. of 5- and 6-ft. sewer in open cut and tunnel (let in April, 1920) for $285,000 the principal bid unit prices being as follows:

6 ft. sewer, open cut, per lin ft	$33 00
Tunnel, per lin.ft	45.25
5-ft. sewer open cut, per lin.ft	22.10
Tunnel, per lin.ft	40 25
Standard manholes, each	200 00
Reinforcing steel, per lb.	.06
Earth embankment, per cu yd	1.00

The intercepting sewer starts at the main city sewer farthest upstream, parallels the river, intercepts four existing main sewers and extends about 14,000 ft. to the sewage-works site, where the elevation of the sewer invert is about 19 ft., about the normal water level in the river, so that interference by floods and pumping to the treatment plant are avoided. The first half of the sewer is 6 ft. in diameter, designed to carry some storm sewage to an overflow located below the built-up portion of the city. The remaining portion is to be 5 ft. in diameter, designed to carry three times the estimated 1960 dry weather sewage flow. Special interceptors have been designed at the various main sewers. The sewers will be partly of segmental block and partly of concrete. The sewerage work is being carried out by the Decatur Sanitary District under the general direction of Pearse, Greeley and Hansen, consulting engineers, with P. T. Hicks, district engineer, in direct charge.

Water-Supply and River Regulating Dam

To provide an ample water supply for the rapidly increasing domestic and industrial needs of the city a storage dam is under construction. The dam consists of a 500-ft. concrete spillway section 28½ ft. high above the river bed, flanked by 1,100 ft. of earth embankment, the top of the latter rising 13 ft. above the spillway crest. A moveable crest of special design is included, by which an additional 2 ft. of storage can be secured, giving a total storage capacity of about 9,000,000,000 gal. and an estimated dry-weather yield of about 40,000,000 gal. per 24 hours. This will provide some additional water during the next few years for flushing out the river during dry-weather periods, thus assisting the sewerage program. The 13 ft. of free board between the crest and embankment levels will pass, with an ample margin of safety, the maximum flood of record in 1913, which was 21,500 sec.-ft. equivalent to 25 sec.-ft. per square mile on a tributary area of 862 sq.mi.

Borings at the site of the dam show a reddish brown clay for the first 10 ft., and then alternately layers of fine and coarse sand with pockets of gravel and clay. At a depth of 30 to 45 ft. is a layer of sand and clay 8 ft. thick, dipping slightly from south to north, and below this depth more sand.

To prevent disintegrating percolation the design provides a sheet piling cut off under the entire length of the dam, varying in depth below the dam up to a maximum of 30 ft. The spillway section has a heavy concrete apron extending 32 ft. downstream and a clay apron extending 40 ft. upstream. The earth section will be tied into the sheet piling with clay puddle. Bearing piles will be driven under the spillway section on 3½ ft. centers, with pressures limited to 1¼ tons per sq.ft. Two 9 x 14-ft. flood gates are provided with all the necessary footings for two hydro-electric units.

The dam, exclusive of land and the cost of relocating bridges and highways, is estimated to cost $800,000. A cost-plus contract has been let which fixes a maximum price of $975,000 and a base price of $700,000, both computed on the engineers' estimate of quantities. If the actual cost of the work is $700,000 the contractor will receive a fee of 10 per cent plus $20,000 for his plant, or the total of $90,000. If the cost exceeds $700,000 the fee of 10 per cent is reduced by 20 per cent of the over-run, down to a minimum of $35,000. If the cost is less than $700,000 the contractor's fee of ten per cent will be increased by 20 per cent of the under-run. The payment of $20,000 for plant is made in either case and the contractor agrees that the total cost to the city, under the engineers' estimate of quantities, will not exceed $975,000. If these quantities change the engineer will base prices accordingly.

The contractors for the dam are L. N. Cope & Son of Decatur, and the work is under the direction of Pearse, Greeley and Hansen, consulting engineers, with F. Albert Holmes as resident engineer. W. J. Collins is city engineer.

Design Elements of Various Imhoff Tanks

COMPARISONS of elements used in the design of Imhoff tanks at different places in the country indicate a wide diversity of opinion as to several factors. The following table is taken from a report by Pearse & Greeley, consulting engineers, Chicago, on the sewage problem of Decatur, Ill. (See preceding article.)

The populations for which the tanks were designed range from 10,000 at one of the Rochester plants to 300,000 at Philadelphia. The range in settling periods allowed is from 1.33 hours at the larger Rochester plant to 3 gal. at several places. The greatest liquid depth is 35 ft. at the smaller Rochester works and the smallest is 13.5 ft. in tank finally built at Schenectady. Sludge storage capacity provision ranges from 0.43 ft. at Dallas to the larger Rochester plant.

SEWAGE TREATMENT ELEMENTS OF IMHOFF TANKS IN CITIES OF OVER 25,000 POPULATION

City	Population in Thousands		Settling Period Hours		Total Liquid Depth Ft. In.	Sludge Storage Cu.Ft. per Capita		Gas Vent Area, per Cent Total Tank Surface	Sewerage
	Connected to Sewers	Basis of Design	Present Flow	Basis of Design		Connected to Sewer	Basis of Design		
Fitchburg	(1) 37	55	6.8	3.0	25—2	1.94	1.3	15.0	Comb.
Albany	101	150		3.0	27—2½	....	1.41	4.2	Comb
Schenectady (a)	...	120	...	....	21—4½	....	0.71	....	Sep.
(b)	65	120	3.18	....	13—5	....	0.75	....	Sep.
(c)	105	..	2.3	....	.....	0.66	....	...	Sep.
Rochester (d)	240	200	1.07	1.33	34—4	2.65	3.18	26.8	Comb.
(e)	5	10	3.67	2 to 1.2	35—0	3.6	1.8	10.1	Sep.
Dallas	120	135	....	3.0	.....	....	0.43	12.5	Sep.
Columbus	220	250	3.1	2.46 max.	25—8	1.62	1.25	9.0	Comb.
Akron	...	150	....	2.0	23—9	....	0.75	4.6	Sep.
Atlanta (f)	...	52	....	3.0	24—9	....	1.73	4.8	Sep.
Philadelphia	..	300	....	3.0	27—0	....	1.78	6.2	.....
Decatur (g)	43	60	....	2.0	22—3½	....	1.24	20.0	Comb

(1) In 1918—(a) Original design. (b) Final design as built. (c) On basis of population 105,000 served and flow of 8,000,000 gal. per 24 hours. (d) Irondequoit. e) Brighton. (f) Peachtree Creek. (g) Basis used for estimates.

Economies in Pumping Station Operation at St. Louis

A Review of Coal Saving Efforts and Results in the Past Five Years—Boiler Efficiencies Increased by Changes in Grate Settings and Baffles—Pump Duties Raised by Using Superheated Steam

Abstract of a paper by L. A. Day, Engineer-in-charge, Operating Section, Water Division, St. Louis, Mo. Read before the American Water Works Association, June, 1920.

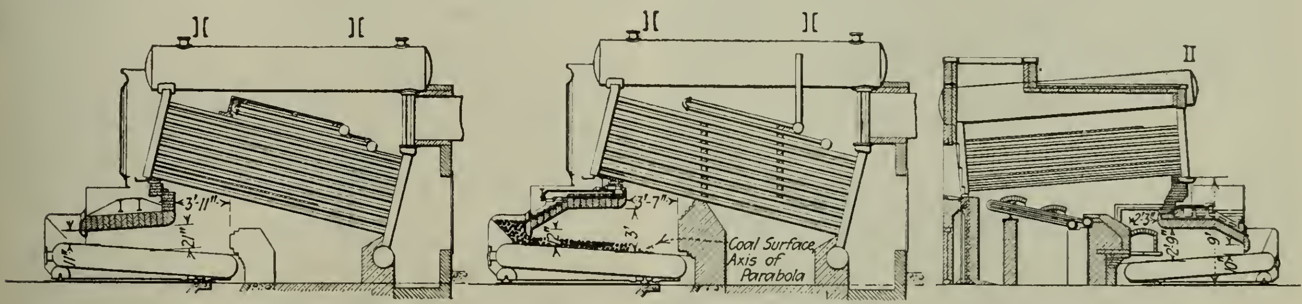
OWING to the rapid increase in the cost of coal it became imperative on the part of the mechanical engineers of the St. Louis Water Department to make a thorough investigation of the heat losses existing in our respective pumping plants with a view to reducing the losses to the lowest possible minimum. When it is considered that the coal makes up probably 40 per cent of the total pumping cost and that in the average pumping plants throughout the country not more than 10 per cent of the heat value in coal is utilized, it is easy to see that the more economical use of coal is highly profitable. The object of this paper is to present an account of the pumping station economies effected at St. Louis during the past five years.

According to our experience, the chain-grate type of stoker is best suited for burning the low grade clinkering coals, such as are found in the Illinois coal fields within a radius of 25 miles from St. Louis. This type of stoker is capable of meeting any peak load up to 100 per cent above normal boiler rating. It is simple in construction, easy to repair, it can be operated under all load conditions with natural draft, thereby greatly simplifying the boiler room equipment, and can be operated efficiently on light loads and overloads. It's first cost is about half of that of the forced draft underfeed type. A ratio of 1 sq.ft. of grate surface to 48 sq.ft. of boiler heating surface has given the best results, considering our loads and coals. The coal is 2-in. Southern Illinois screenings having an average heat value of 10,300 B.t.u., with from 20 to 25 per cent ash.

In addition to the proper size grate our experience shows that a properly designed furnace arch, and a combustion chamber with sufficient volume to allow complete combustion, will add greatly to the efficiency and capacity of the boilers.

The first chain-grate stokers we installed were at the Chain of Rocks plant in 1914. The stokers were placed under six National water tube boilers, each of 360 hp., and two O'Brien water tube boilers, each of 250 hp. capacity. The boilers were set 7 ft. from the floor, and the arches were set 11 in. from the grate at the front and 22 in. from the grate at the rear, the arch being 6-ft. 5-in. long. The original arch was set according to the design of the stoker contractor. The boilers were arranged with horizontal baffles, the lower baffle being placed on the second row of tubes. The average boiler efficiency under operating conditions with this setting was approximately 58 per cent and it was difficult to obtain an overload of 25 per cent.

Investigations were started with a view of increasing the boiler efficiency and capacity. We have found that a stoker arch to function properly should be set high enough over the grate to allow the volatile gases to be distilled off without being crowded under the arch; also the shape of the arch should be such as to allow the heat from the bridge wall to be focused on the coal as it enters the furnace; this is necessary to start combustion in as short a time after the coal leaves the feed gate as possible so that every available foot of grate surface is utilized for burning coal. By referring to Fig. 1, which shows the original arch, it will be apparent that from the standpoint of obtaining a large liberating volume under the arch and an efficient shape of the roof so as to obtain the maximum benefits of heat reflection coming from the bridge wall, this arch did not function properly. It did not permit a concentration of heat at a point where a maximum concentration is desired, namely: at the point of ignition. These objectionable features have been overcome by the new design of arch shown by Fig. 2.



Old Setting at Chain of Rocks — New Setting at Chain of Rocks — New Boilers at Baden Station

FIGS. 1. TO 3. BOILER SETTINGS AT PUMPING STATIONS OF WATER-WORKS OF ST. LOUIS, MISSOURI

In this setting, the distance from the floor to the front water leg remains 7-ft., being determined by the original setting of the boiler. The arches are set 12-in. from the grate at the front end, rise rapidly to a hip, and are 36 in. high at the rear. The length of the arch is 6½ ft. This arch has a better concentration of heat rays near the feed gate, the rays being reflected from the bridge wall, than the one shown by Fig 1, due to our obtaining a contour which approximates the curve of a parabola, in which curve all reflected heat rays would concentrate at the focus.

Comparative tests made before and after the change in the arch shape showed: With the old type of arch, on a capacity test run by the stoker contractor, an evaporation of 15,770 lb. of steam per hour was main-

tained for 10 hours. With the new style arch an evaporation of 17,140 lb. of steam per hour was generated for five hours. The former represents an overload of 38 per cent while the latter represents an overload of 60 per cent. At the same time the average boiler efficiency was increased from 58 to 63 per cent, or a gain in efficiency of approximately 9 per cent. After all the boilers have been equipped with the new arch, it is estimated that the saving in annual coal cost will amount to about $5000 at this station.

A similar improvement in capacity and efficiency was made at the Bissell's Point Station. The boilers here

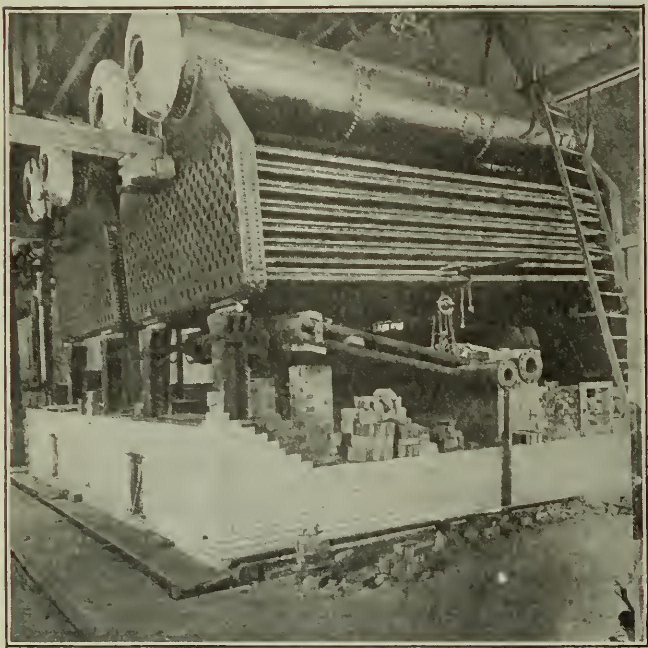


FIG. 4. VIEW OF SETTING OF BOILERS AT BADEN STATION, SHOWING SUPERHEATERS IN COMBUSTION CHAMBER

are set with the front water leg 6½ ft. above the floor line. The original arches were sprung transversely across the grate, 9 in. above the grate at the hip, rising to 18 in. above the grate at the center. Longitudinally, the arch was parallel to the grate. This type of arch (that is, in respect to the low height above the grate) was the common practice among chain-grate stoker builders up to within but a few years past. The arch was removed and replaced with a new type of flat arch, which is 12 to 13 in. above the grate at the feed gate and rises straight, without a hip, to 30 in. above the grate at the rear end. The length is 7 ft. It was not possible to construct a hipped arch at this station because of the limitation of the low setting. However, a good saving was effected for the reason that prior to the change in arch design, it was only possible to burn crushed egg or lump coal at this station, due to the low arches, which did not effect a proper ignition with the lower grades of screenings. The new designed arch has resulted in our being able to burn the lower grades of screenings successfully, and obtain the same evaporation per pound of coal with screenings as with the crushed egg or lump coals, thereby resulting in a saving in the price of coal of about 18 per cent. This 18 per cent saving in the price of coal, when applied to our last year's coal cost at this station, amounts to an annual saving in coal cost of about $10,000. After all the boilers at this station were equipped with the new type arch, the average overall rating of the boiler room rose from 90 per cent to 115 per cent, even with the use of a lower grade of coal.

Although we realized, after the new arch was designed, that the setting was not perfect, the boilers being too low, yet even with the low setting the arch has given the improvement in capacity and efficiency mentioned above, permitting one boiler to be taken off the line.

The experiences outlined led us to adopt, in the installation of new boilers at the Baden plant, a setting in which we have embodied a construction which we believe eliminates all objectionable features found by previous experience (Fig. 3). In this setting the arch is similar to that of the new arch for the Chain of Rocks Station, the distance at the feed gate above the grate is 10 in., rising rapidly to a hip, and is 34 in. above the grate at the rear. The length of the arch is 7 ft. The height of the front water leg above the floor is 9 ft., this height providing a larger combustion chamber than in the previous settings, thereby obtaining a more thorough mixing of the gases and oxygen and providing a relatively longer gas travel, all of which is necessary for the efficient burning of coal at high rates of combustion. The evaporation at this station averages 6½ lb. of water per pound of coal at a boiler efficiency of 66 per cent, and comparing this performance with that of the other stations, when the old type of settings prevailed, shows a saving of about 13.8 per cent in coal.

As has been previously stated, the over-all boiler efficiency of the other two stations is 63 per cent with the improved arches while that at the Baden station, with practically the same style arch as was adopted at the other stations, shows an over-all boiler efficiency of 66 per cent. This increase of 3 per cent in efficiency, or a gain of 4.8 per cent, may be attributed to the higher boiler setting, namely 9 ft. instead of 7 ft. which prevails at the other two stations. In other words, by setting the boilers 2 ft. higher at the Baden station, we show a gain of 4.8 per cent in over-all boiler efficiency, and this gain when computed on the annual cost of coal at this station, amounts to $3,000 annually.

An operating over-all boiler efficiency of 66 per cent, using Southern Illinois screenings of 10,000 b.t.u. per pound, and meeting a variable daily load, may be considered as good as can be expected from this type of boiler room installation.

The cost of rebuilding the arches at the Chain of Rocks and Bissell's Point stations amounted to about $300 per arch or a total of $4,200, while the saving in coal effected by these changes amounts to approximately $15,000 a year. The entire work of rebuilding the arches was paid for in 3½ months.

The above mentioned gains are principally due to the improvement in furnace design, but part of the saving in coal must be credited to improvements made in our boiler baffling.

Boiler baffling should be so placed as to force the gases into contact with all parts of the tube bank. In the older Heine type of settings at our plants, the lower baffle was made up of box tile on the lower row

of tubes and the upper baffle was 13 tubes above on the top row of tubes. The opening in the lower baffle was in some cases as much as 60 in. from the rear water leg. The path of the gases in this type of boiler was diagonally upward through the tubes, leaving the rear water leg and the tube ends near it untouched by the hottest gases, and leaving a dead triangular pocket at the bottom of the front water leg.

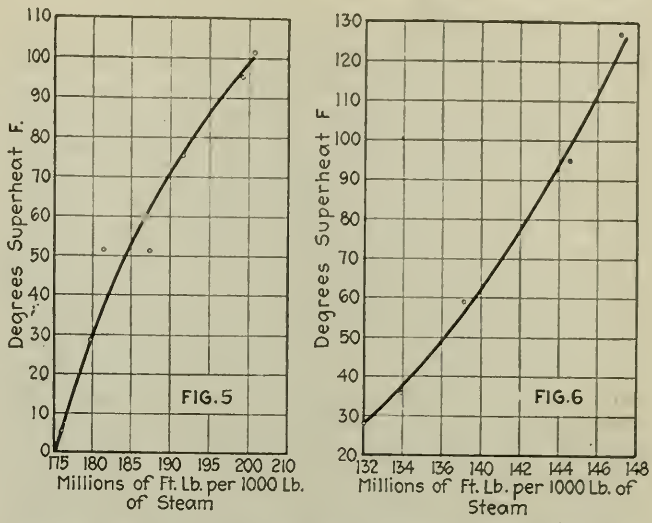
By eliminating the box tile on the lower row of tubes and placing a specially designed tile on the third row of tubes, and also reducing the opening in the lower baffle from 60 to 42 in., we reduced the flue temperature from an average of 650° F. to 550° F.

It will be apparent from Fig. 3 that the velocity of the gases is higher through the tubes, thereby reducing the insulating effect of the film of idle gas around the tubes and resulting in a better heat absorption. It will also be apparent that the bottom rows of tubes are now exposed to the radiant heat of the flames; thus by raising the baffle tile onto the third row of tubes, the gases are crowded into more intimate contact with the tubes, dead pockets in the passes are destroyed, and the lower row of tubes, by absorbing the radiant heat of the flames, tends to lower the temperature of the surrounding walls of the combustion chamber, which in turn tends to increase the life of the setting.

When it is remembered that roughly there is a gain of 1 per cent in boiler efficiency for every 25°F. reduction in flue temperature, it will be seen that there was an approximate gain of 4 per cent in efficiency for the 100°F. drop just mentioned, a gain effected by merely placing the boiler baffling in a better location and at a negligibly small cost.

Simultaneously with the installation of chain-grate stokers, superheaters were installed in our boiler settings (Fig. 4). For determining the size of superheaters, accurate gas temperatures were taken at the place where the superheaters were to be located, and steam, load, and firing conditions noted simultaneously as an aid to the manufacturer of the superheater arriving at its proper size. In the case of horizontally baffled boilers, our superheaters are located in the combustion chambers back of the bridge wall. In the vertically baffled boilers, the superheaters are located under the shell between the first and second pass. Although the location behind the bridge wall is apparently a severe location, yet it has been our experience that if the superheaters are not within the direct path of the flame they show no effects of the heat and promise a long life. The advantages of the location in the combustion chambers are a smaller superheater and greater accessibility.

The use of superheated steam at all of our plants has proven to be one of the greatest factors in increasing the efficiency of the engine rooms. Superheated steam in the cylinder of a steam engine transfers heat to the cylinder walls, but instead of condensation occurring on contact as with saturated steam, the superheat must first be withdrawn. Superheated steam maintains a higher cylinder wall temperature and if superheating is carried far enough, condensation can be delayed until after cutoff and even until expansion is partly completed. Also the specific volume of superheated steam is greater than that of saturated steam and this increase in specific volume, the pressure being constant, diminishes the weight of steam to the engine, and has



FIGS. 5 AND 6. PUMP DUTIES OBTAINED FOR VARIOUS DEGREES OF SUPERHEAT AT ST. LOUIS

an influence on the economy gain, as has also the lower thermal conductivity of superheated in comparison with saturated steam.

The Water Division has made tests on the effects of superheated steam on triple expansion and on compound pumping engines. The triple-expansion engines, which pump against 85 to 125 lb. pressure, and whose capacities vary from 15 to 20 m.g.d., showed a saving for various degrees of superheat as represented by the curve, Fig. 5. The steam saving for 100 degrees superheat amounted to 12.1 per cent, while the saving in coal amounted to 7.5 per cent. The low service compound pumping engines, which pump against a maximum head of 65 ft. or about 28 lb. pressure, and whose nominal capacity is 30 m.g.d. showed a saving for various degrees of superheat as represented by Fig 6. The steam saving for 100 degrees superheat amounted to 17.3 per cent, while the saving in coal amounted to 13.2 per cent.

The saving in coal due to the introduction of superheated steam at the Chain of Rocks station has been sufficient to pay for the superheaters in about 3½ years. The life of a superheater, when the elements are not exposed to the direct flame, should be equal to the life of the boilers.

It is commonly accepted that the degree of superheat for the usual equipment of engines and pumps is limited by a total temperature of 500°F., especially when cast-iron fittings are used. The Water Department has resorted to the use of cast-steel fittings and valves on all new pipe work. The new pipe was put in only to meet the total temperatures of the superheated steam which we intended to use, but also to insure more reliable service in all of our pipe lines than cast-iron fittings and valves would give. In one of our plants the original extra heavy cast-iron fittings have given excellent service with a total temperature of as high as 500°F. These fittings have been in service some five years under superheated steam conditions without showing any apparent signs of weakness.

When the compound pumping engine was originally installed 25 years ago, it developed a duty of 118,000,000 ft.-lb. per 1,000 lb. of saturated steam, no superheat being used. The pumping engines at this station were all bought on the bonus and forfeiture basis which naturally led the contractor to make every effort toward

obtaining the highest duty possible. The Water Department, however, in running the duty tests with variable degrees of superheat, made no attempt whatever to increase the economy of the pumping unit before the test was run—by increasing the vacuum, repacking the plungers, renewing pump valves, inspecting valves and pistons, etc. In other words, the test was made on a pump running under every day plant conditions and even with a superheat of only 28°, which is the lowest we could obtain, the pump developed a duty of 132,000,000 ft.-lb. per pounds of steam, which is a saving of 11.9 per cent in steam consumption over that of the original duty test with saturated steam, where the duty obtained was 118,000,000 ft.-lb. per 1,000 lb. of steam. This is a very creditable showing for a pump that has been in service for 25 years.

As previously mentioned we expected a better saving by the use of superheated steam on our compound low-service pumping engines than on the high-service triple-expansion engines, for the reason that a compound pumping engine of the usual cylinder proportions is not as economical as a triple-expansion pumping engine, due to a greater heat drop in each cylinder causing a greater cylinder condensation, and as superheated steam specifically functions to prevent cylinder condensation, it follows that its greatest virtue will be manifested in the less economical engine.

There seems to be, to the writer's knowledge, a prevailing impression in a great many water-works plants, that the use of superheated steam, with its consequent economies, is offset by difficulties with lubrication. This contention is not borne out by our experience. In lubricating engines using superheated steam, the only parts which actually come into continuous contact with superheated steam are the inlet valves on the high-pressure cylinder, for all other parts of the engine beyond this point, cylinder and piston, are at a mean temperature lower than the steam temperature entering, due to the fact that steam with even 100° superheat becomes saturated by the time the piston travels to the point of cutoff in the high-pressure cylinder. We found that our lubricating problems were, therefore, no more difficult with superheated steam, than with saturated steam.

We will now consider the comparisons of the performances of steam-turbine-driven centrifugal pumps, with and without the use of superheated steam. Our turbine-driven pumps are installed in the same station with the low-service compound pumping engines previously referred to. Two of these are of the single-stage centrifugal type, each of a nominal daily capacity of 35,000,000 gal They were installed in 1913 and have been in active service ever since. The test duties of these pumps at a head of 65 ft. was 100,000,000 ft.-lb. per 1,000 lb. of saturated steam A recent test run under the same pumping conditions, but with 124 degrees of superheat instead of saturated steam, showed a duty of 115,000,000 ft.-lb. per 1,000 lb. of steam, an increase in duty of 15 per cent. The physical condition of the pump may be said to have been the same during the two tests, for the reason that the unit had just been overhauled.

On the same turbine-driven centrifugal pump, comparative tests were made to determine the difference in duty, with the same superheat and vacuum, before and after the pump was overhauled, as just described. The duty before overhauling was 93,500,000 ft.-lb. per 1,000 lb. of steam and after overhauling was 106,000,000, showing a saving of 13.3 per cent, due entirely to overhauling.

It might be well to mention that the pumps at our low-service station are subject to abnormal wear due to their pumping raw river water containing much sand in suspension.

Commercial Motor Car Production Shows Large Increase

Seven Eastern States Register 40 Per Cent of Estimated Vehicles in Use During 1920—1½ to 3½-Ton Units Popular

APPROXIMATELY 370,000 commercial motor vehicles will be manufactured in the United States during 1920, exceeding the 1919 production by approximately 65,000, according to information recently acquired by the *Commercial Vehicle*. This figure also exceeds by approximately 20,000—save those vehicles operated by the War Department—the total number of commercial motor cars in operation in the United States during 1918.

While exact figures are not available on commercial motor vehicle production in the United States during the past few years, the *Commerce Vehicle* has made an estimate of this production as follows:

1910	9,500	1916	98,000
1911	1[illegible],000	1917	190,000
1912	25,000	1918	250,000
1913	28,000	1919	305,000
1914	35,000	1920	370,000
1915	74,000		

Eliminating trucks exported and those sold to and operated by the War Department from these production figures, the estimate is made that during 1918 there were in domestic use 351,000 commercial motor vehicles. During 1919 this number was increased to 480,000 and to an estimate of 674,300 during the current year.

Many states reported, on Jan. 1, 1920, enormous increases in registration of commercial motor vehicles over the preceding year. Not all the states register commercial cars independent of passenger cars, so that comparative registration figures between the years 1918 and 1919 are not available. However, the seven eastern states of Connecticut, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, and Rhode Island, in registration figures reported as of Jan. 1, 1920, registered a total of 267,319 commercial motor vehicles or approximately 40 per cent of all trucks estimated as in use during this year. No doubt the registration figures are much higher this year as those seven states reported an average increase in commercial vehicle registration during 1919 of 35 per cent over 1918. Massachusetts reported the highest per cent increase—61 per cent—and New Jersey, the lowest—24 per cent.

While no figures are available on the classification of vehicles registered or produced according to capacity, Table I indicates the number of truck models announced by various manufacturers from 1913 to 1920, inclusive, and for all capacities from those under ½ ton to 7 tons and over, as well as tractors. The chart would at first indicate that manufacturers were running to the production of units ranging in capacity from 1½ to 3½ tons, but there may be other explanations than this in the fact that the number of models of 1½-ton trucks, for

TABLE I—NUMBER OF TRUCK MODELS OF VARYING CAPACITIES MANUFACTURED DURING YEARS LISTED

Capacity—Tons	1913	1914	1915	1916	1917	1918	1919	1920
Less than ½	13	15	19	8	3	4	1	1
[illegible]	19	28	31	28	19	13	14	6
¾	47	48	44	40	23	26	18	12
1	59	72	68	65	54	64	68	47
1½	46	50	66	54	45	51	75	90
2	62	62	76	93	70	87	89	73
2½	5	10	19	17	29	34	41	62
3	55	48	43	33	20	21	17	12
3½	14	14	28	38	48	64	62	67
4	19	17	15	14	12	11	11	10
5 and 5½	49	44	45	43	42	52	59	60
6 and 6½	9	16	18	14	9	10	8	6
7 and over	6	8	12	10	7	9	6	4
Tractors	0	0	0	12	8	16	18	9
Total	403	422	485	469	389	462	487	459

instance, has increased so rapidly within the past few years. Notwithstanding arguments to the contrary, it is apparent from the table that models within these capacity ranges, are popular with manufacturers. However, there is no decrease in the number of 5- and 5½-ton trucks manufactured, judging by the number of models reported by manufacturers, and it is a patent fact that highway engineers will have to take into fuller account such heavy units, the frequency of whose appearance on the public highways can only be determined by numerous traffic counts.

TABLE II—TRUCK WEIGHTS—CHASSIS AND BODY

Capacity	Chassis, Pounds	Body, Pounds	Total, Pounds
¾-ton	2,400	750	3,150
1-ton	3,000	900	3,900
1½-ton	3,500	1,050	4,550
2-ton	4,500	1,200	5,700
3-ton	6,000	1,500	7,500
5-ton	8,000	1,800	9,800
6-ton	8,700	1,900	10,600
7-ton	9,400	2,000	11,400

There are other considerations with which the highway engineer is interested besides the increase in truck production. Among these are truck weights, both chassis and body, a compilation of which is made in Table II above.

Highway Construction in Canada

The Canadian Minister for Railways has approved plans submitted by the Manitoba government for extensive highway construction under terms of the Dominion Highways Act. The expenditure contemplated will amount to about $3,500,000, and about 4,000 mi. of roadway will be improved. The highways approved are those from Winnipeg to Lake Winnipeg; Winnipeg to Rainy River; Winnipeg to Emerson, at the United States boundary; Winnipeg to Reston, connecting with western roads there; Winnipeg to Portage la Prairie and Brandon to Elkhorn, and connecting with the Saskatchewan system at Russell. There is also a system starting at the United States boundary and extending through the Province of Manitoba. Plans have also been approved for the expenditure of about $40,000,000 improving the highways of Ontario and Quebec. The outlay contemplated in Ontario is $22,000,000, of which the Dominion Government will contribute $6,800,000 and the Province $12,000,000 and the municipalities $4,400,000. Quebec's projected outlay is $17,390,000, of which the Dominion will pay $5,000,000 and the Province and municipalities the balance. An additional roadway will be built through the central part of the Province of Manitoba, extending north and south, with a series of intermediate trunk and market roads. All of the provinces are participating in the Federal scheme of highway improvement, which is calculated to revolutionize public highway transportation in Canada.—*Commerce Reports.*

Railway Water Supply at Atkins, Iowa

Electric Pumps at River Supply 300,000 Gal. Daily by 5-Mile Main to Terminal—Test of Surge in Long Pipe Line

By Fred D. Yeaton
Assistant Engineer, Chicago

WATER supply of good quality and ample quantity was an important factor in the selection of Atkins, Iowa, as the location for a new engine terminal on the Chicago, Milwaukee & St. Paul Ry. This railway water supply system has the unusual features of a 5.3-mile force main and duplicate pumping units. Atkins is on the main line between Chicago and Omaha, being 104 and 119 miles, respectively, from the adjacent division points of Savanna, Ill., and Perry, Iowa. Water is obtained from the Cedar River, at a distance of five miles, as the terminal could not be located closer to the river on account of the topography and the alignment and grade of the railroad.

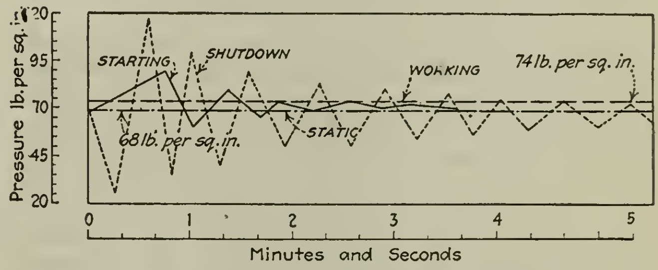


FIG. 1. PROFILE AND LOCATION OF VALVES ON LONG FORCE MAIN TO ENGINE TERMINAL

Shallow well water at Atkins is scarce and the deep well water contains 45 grains of incrusting solids per gallon, 40 grains being calcium sulphate and magnesium sulphate which form a hard scale. The river water contains less than ten grains of incrusting solids per gallon, eight grains of which are calcium and magnesium carbonates that form a soft scale and two grains are non-incrusting solids. The maximum rise and fall of the river is 15.2 ft. As the water is somewhat muddy during high stages, land for settling basins was obtained, but so far it has not been necessary to build these basins. The maximum demand has been 350,000 gal. per day, but the average is 300,000 gal., divided approximately as follows: Filling locomotive tenders, 150,000 gal.; washing out and filling locomotive and stationary boilers, 120,000; cinder pit, 15,000; hotel, toilets and wash bowls, 12,000; coaling station, 3,000 gal. To provide for future requirements the plant is designed to handle 750,000 gal. per 24 hours.

From the river, the water flows 824 ft. through an 18-in. pipe to the pumphouse. For cleaning this pipe there is a manhole 140 ft. from the river, and a 12-in. branch from the manhole to a small creek provides an emergency supply if the main intake should become clogged during high water.

As duplicate pumping units are advisable for locomotive terminals where a continuous supply of water is essential, two triplex pumps are installed, each having a rated capacity of 622 gal. per min. at 42 r.p.m. and a maximum safe working pressure of 160 lb They are operated at about 30 per cent less than the rated speed, because our experience is that in this way more reliable

service is obtained. One pump has a 25-hp. and the other a 30-hp. motor, current being supplied from the terminal. Each 10-in. suction pipe has a foot valve, and on the discharge pipe are air chambers and a 4-in. relief valve set to release at 125 lb. A telephone line enables the pumper to keep in touch with the water requirements and to call for assistance in case of breakdown. Revolution counters keep a record of the pumpage.

The 12-in. cast-iron delivery main has hub-and-spigot joints calked with jute and lead. The maximum theoretical lift is 180.1 ft., the equivalent pressure being 78.3 lb. Previous to backfilling the pipe line was tested in 100-ft. lengths by compressed air at 100 lb., leakage being detected by brushing the joints with a soap solution. After recalking the joints in one section the pressure was raised to 109 lb. and left on for 24 hours with a loss of only 4 lb. Air was used because it was impossible to obtain water for the purpose. A test after completion indicated that the leakage was less than 175 gal. per mile of pipe line per 24 hours.

Blow-off branches with 4-in. hose connections and gate valves are placed in the sags, and air relief valves at the summits, as shown in Fig. 1. The valves are in frost-proof manholes, marked by signs on cedar posts 4 ft. high. A 150,000-gal. steel tank is located near the roundhouse. Three water columns supply the locomotives. Fire hydrants and gate valves are located at convenient points, the valves controlling the fire main being marked by tall posts. Charts showing the locations of the pipe lines, valves, blow-off branches, hydrants and water columns, together with instructions for operating the water-supply system, have been framed and posted at the pumphouse and in the foreman's office. The instructions read as follows:

Both pumping units must be maintained in first-class working order and generally operated alternately. The pumper must notify the roundhouse foreman immediately in case of trouble and call on him for assistance. Air valves have been placed at summits and blow-off and gate valves in the sags of the pipe line. Air valves must be carefully inspected by the pumper every week. All valves must be opened and shut slowly. All gate valves must normally be left open when pumps are in operation. Mud must not be allowed to accumulate in pipe line. Blow-off valves must be opened at intervals to determine whether mud has accumulated. In blowing off, start at blow-off No. 1. Blow off if possible when storage tank is full.

One pumper is employed. When it is necessary to operate at night, he can start a pump and depend on the night foreman at the terminal to cut off the current when the tank is filled, the pressure gage indicating the height of water in the tank. If the pumper fails to stop the pump when the tank is full, an automatic alarm at the terminal warns the foreman to cut off the current. Glass water gages show the pumper the amount of air or water in the air chambers; pet cocks on the suction pipes can be opened and air pumped into the chambers.

A test to determine the pressure in the 12-in. pipe line due to surge is shown in Fig. 2, in the form of time-pressure curves for the 25-hp. pump. The static pressure with the storage tank full is 68 lb. and the working pressure is 74 lb. Maximum and minimum pressures of 120 and 125 lb. occurred in starting and stopping the pump, but by stopping suddenly and then starting before the surge had died down the pressure reached 135 lb. By starting and stopping the pump slowly the pressure could be controlled and held within the limits of 60 and 80 lb. When the valve at a water column near the terminal was closed suddenly a surge of 120 lb. pressure occurred at the pumphouse. These results show that a margin of safety should be allowed for excess pressures in pipe lines and at pumps.

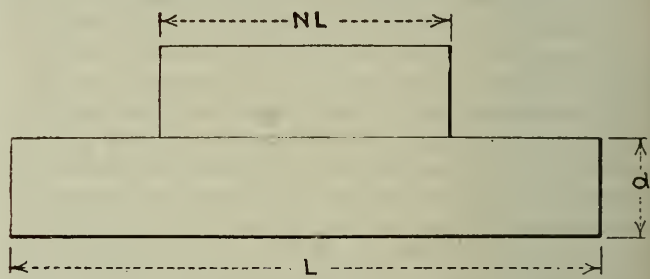
This water-supply system was built during 1919 at a cost of about $130,000: Pipe line from pumphouse to tank, $95,000; distribution pipe, water columns and storage tank, $12,000; pumphouse, pumps, machinery and connections, $16,000; pumper's dwelling, $1,000; intake, $6,000. Material for the pipe line was furnished by the railway company and placed by a contractor. The intake pipe, water columns and pumping machinery were placed by the company's forces, E. L. Sinclair being the engineer in charge. The design and construction of the plant were under the direction of C. F. Loweth, chief engineer, Chicago, Milwaukee & St. Paul Ry.

Practical Design of Concrete Cap Footings

By H. H. Frenzel

Corrugated Bar Co., Inc., Chicago, Ill.

Two types of concrete footings are commonly used; the plain slab footing in which the column rests directly upon the slab, and the footing in which the column rests upon a cap which in turn rests upon the footing slab. Specifications generally read that cap and footing slab be poured monolithically. The use of the first type is generally restricted to small footings; the latter is used on the larger and more important footings. A variation from these two types is used sometimes in which the footing slab is sloped from the column or cap to the outer edge of the footing, but while this type is economical with respect to materials it is open to objection on account of the added forming necessary for the slab.



Soil Value Lb. per Sq.Ft.	N	$E = \frac{d}{L}$
2,000	0 4	0.094
3,000	0 4	0.121
4,000	0.4	0.141
5,000	0.4	0.156
6,000	0.4	0 169
8,000	0.5	0.162
10,000	0 5	0.206

Punching shear = 120 lb. per sq.in.
Diagonal tension = 40 lb. per sq.in.

Nothing can be added on the design of plain slab footings; the following deals entirely with the cap footing. There seems to be no general method of proportioning cap footings in use. The total depth is generally determined by the punching shear at the edge of the column, but the size of the cap and the relative depths

of the caps and the footing slab varies with the ideas of different designers.

The concrete in the footings is the major part of the cost, the cost of the steel being small in comparison. The footing designed to meet the requirements of diagonal tension and shear which contains the smallest amount of concrete will, almost without exception, be the most economical. It was found from the design of a large number of footings that for soil bearing values of 2,000, 4,000 and 6,000 lb. per square foot the most economical size of cap was about 0.4 of the size of the footing slab; for soil bearing values of 8,000 and 10,000 lb. per square foot the caps should be about 0.5 of the footing slab.

The depth of the footing slab should be proportioned for either diagonal tension requireemnts, or for punching shear at the edge of the cap, depending upon which gives the larger value, the diagonal tension being taken at a distance from the edge of the cap equal to the effective depth of footing slab.

In the design of a footing the required total depth is generally determined by the punching shear at the edge of the column, the size of the footing slab is determined by the soil bearing value. In the accompanying table are given the proportions which with few exceptions will give the most economical footing.

Borrow Pit for Levee Forms Drainage Canal

Combined Protection System for Palo Verde Valley Will Lower Ground Water Level and Minimize Levee Saturation

A LEVEE to protect 100,000 acres of low land in the Palo Verde Valley, California, from submergence by the summer flood water of the Colorado River is being constructed from material taken from a continuous borrow pit on the land side. The function of the resulting drain is to carry away possible seepage through or under the levee during flood periods as well as to lower the general ground water level of the valley throughout the year. The river has a meander length of 45 miles along the western side of the valley which it has blanketed with rich alluvial silt deposits from recurring flood waters.

The complete levee system consists of 34 miles of earth levee, all of a standard section of 12 ft. top width, 3 to 1 slopes on the river side and 2 to 1 slopes on the land side. The levee is located at least a quarter of a mile from the channel of the river and from this minimum up to whatever was required to secure a satisfactory alignment from the intake of the irrigation system, at the extreme north end of the valley, to the extreme south end where the river turns to the west to meet the mesa. A standard-gage railroad track will be laid on top of the levee for its full length providing means for revetting with rock any portion of the levee that may be endangered by flood waters. This rock protection is to be given, however, only to those sections which may be threatened with scour during high water.

In deciding upon the design of the levee it was concluded to construct the borrow pit so that it would constitute a continuous drain canal paralleling the levee on the land side. The canal will furnish a means for carrying off the ground water, the table of which is high along the line of the levee, thus helping to lower the entire ground water level of the valley; and it will carry off the water which would tend to accumulate near the levee when flood waters stand against its river side. The levee was considered as a temporary earth dam which would not withstand high heads of water for any length of time but which would be fairly safe for floods which continue for more than two months. Records in the district show that when flood waters stand against a levee for more than two months the water content becomes so high that the levee is in great danger of a breach. The drain canal constructed along the Palo Verde levee is expected to prevent saturation to a certain extent since the water table at the levee can at no time be higher than the level of the water in the drain canal.

Construction and Costs

As water was encountered in all test pits within 5 ft. of the surface, the specifications for the construction of the levee require that its outer portions be built first, filling in the core with the wet material excavated under water in the borrow pit. This is to provide a tight levee with a core more compact than could ordinarily be built with teams and Fresno scrapers. The specifications also require that a berm 50 ft. wide be left between the edge of the borrow pit and the inside toe of the levee slope.

It was found that levee construction of this sort would have an almost prohibitive cost of 45 to 50c. per cubic yard at the present price of teams and labor in the valley. Records of the district show that the work as constructed by drag-line excavator, which was the method decided upon, has averaged 20c. per cubic yard.

The work is being done with four drag-line excavating machines with steel booms varying from 55 to 75 ft. in length, and buckets of $1\frac{1}{2}$ to 3-cu.yd. capacity. These machines operate on the berm and by means of the long boom the material is excavated from the canal and put in final position in the levee with one handling. They are operated by gas engines burning distillate and carry a crew of four, consisting of operator, engineer, roustabout and a man on the levee to direct the placing of material. The 3-cu.yd. machines average (including breakdowns and stop for repairs) 1,100 cu.yd. per shift of nine hours. A length of 27 miles will be completed this season

The work is being done for the Palo Verde Joint Levee District of which J. C. Allison is chief engineer and general manager. The foregoing information was supplied by Paul N. Entemann, Mr. Allison's associate.

Housing Progress in England

Plans for 242,549 houses had been submitted by various local authorities to the British Ministry of Health up to July 31, and of these 228,422 had been approved. Bids had been received for building 153,282 houses, of which 135,358 had been approved, while contracts for 81,015 houses had been signed and about 5,800 of the houses contracted for were under construction or completed. The total number of housing projects (as contrasted with separate houses) submitted to the Ministry of Health up to July 31 was 10,842, comprising about 72,500 acres of land. The schemes approved totalled 7,434 and involved 52,000 acres.

Approach Spans Compared with High Bridge Abutments

Reduction of Scour and Elimination of Retaining Walls Favors Approach Spans—Costs in a Wisconsin Case

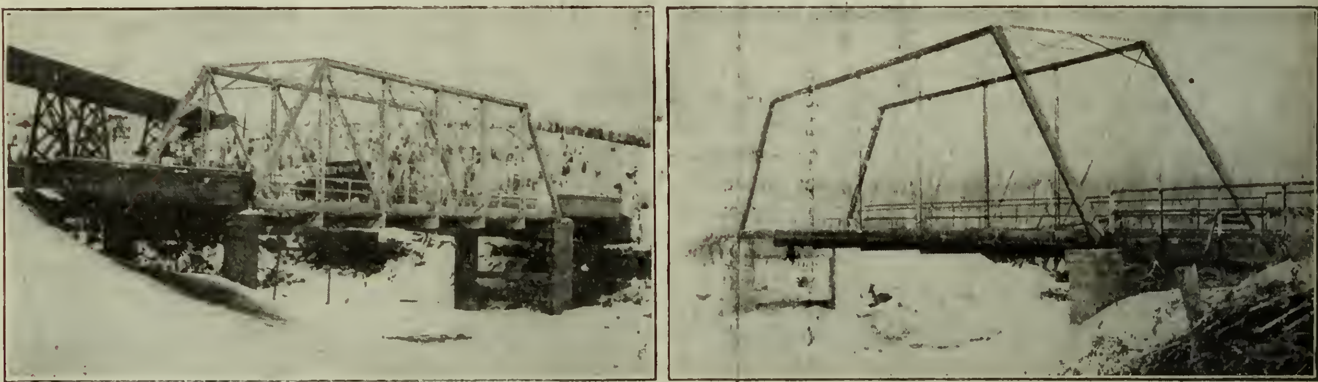
BY M. F. TORKELSON
Bridge Engineer, Wisconsin Highway Commission, Madison

ONE of the most common mistakes in the design of highway bridges is the tendency to use excessively high abutments. This mistake, in the writer's opinion, usually comes about through a desire on the part of an inexperienced designer to cut the waterway down to a minimum, believing that by so doing the expense of construction will be reduced proportionately. In numerous instances of this kind short-span bridges on excessively high abutments have come to grief through one or both of two causes: failure of the abutments due to their inability to resist earth pressure, and scouring out of foundations due to restricted waterway.

High retaining walls are practically always objectionable, and where possible should be avoided. It can never be possible to design rationally to resist earth pressure because it is practically impossible to foresee just what is going to be placed against the wall. The pressure exerted by the same material placed under different conditions may vary between wide limits, and when provision is made to resist the most severe conditions (as is the only safe plan) the expense is very great, becoming practically prohibitive when walls are high.

The Wisconsin Highway Commission's practice in cases where excessively high abutments would be required, if the minimum-length span were to be built, is to provide approach spans set on concrete columns. The earth embankment is allowed to take its natural slope and protected against washing by heavy riprap. In cases where the current of the stream is strong, the approaches are made of sufficient length to keep the fresh fill well out of the main current and especial precautions in the way of protection are taken. In cases where there is little or no current there is no hesitation about allowing the embankment to take its natural slope in the water and protecting the exposed portions of the embankment against such current and wave action as may exist. In this way large economies have been effected in a number of designs, which also have the advantage of considerable additional waterway, which is of assistance in cases of extreme floods.

The principles stated are well illustrated in a case of highway bridge construction in Douglas County, Wis., about ten miles from Superior. Where Pattison Avenue, the main road south from the city, which has since become a state trunk highway and which leads to the falls of the Black River, a scenic spot of unusual interest, crosses the Nemadji River, there was a light steel span of 102 ft. length, 16 ft. roadway, on a substructure consisting of steel tubes with steel backing and steel wings, the wings and backing being supported by means of 12-in. I-beams driven into the ground as piles. This span has just been replaced by a new and stronger bridge (shown at the left in the illustration herewith), and the old span has been re-erected at a site one mile up the river, replacing an old wooden structure known as the Drinkwine bridge. In both cases, pier and approach span construction was applied at large saving of cost.



PIER AND APPROACH-SPAN CONSTRUCTION APPLIED TO TWO BRIDGES OVER NEMADJI RIVER
Large savings over abutment construction were realized in both cases. The Pattison Ave. bridge, at the left, would have cost $7,000 more if the approach spans had been replaced by retained fill.

At Pattison Avenue the Nemadji River flows in a deep ravine and carries a large amount of drift. This made it necessary to construct a bridge much higher above the stream bed than ordinarily would be required, with the result that abutments, whether of gravity or of cantilever type, would have been exceedingly expensive. The design finally adopted consists of a central span of 100-ft. length, 20-ft. roadway, with reinforced-concrete approach spans of 30-ft. length. The central span and the stream ends of the approaches are supported by concrete columns 4 ft. square, set diagonally. These columns are carried well below stream bed and set on timber piles. The shore ends of the approaches are set on much smaller concrete columns which are carried down to a depth believed sufficient to insure them against ever being washed out and, likewise, set on wooden piling.

The quantities in the approaches as designed, and the quantities that would have been required for cantilever abutments of reinforced concrete, are as follows:

	Approaches As Designed	Reinforced-Concrete Abutments
Concrete	205.5 cu.yd.	644 cu.yd
Steel	21,980 lb.	8,500 lb.
Wooden piles (24 ft)	52	about 100
Riprap	220 cu.yd.	75 cu.yd.

The net saving in this particular case amounted to about $7,000, or 64 per cent of the total cost of the finished bridge. An additional advantage of the design adopted is the increased waterway of about 60 ft.

The same general type of substructure was also used at the Drinkwine site for the old Pattison Avenue span,

but the work was cheapened by pulling the 12-in. I-beams used in the original Pattison Avenue substructure and using them as stringers in the approach spans. The quantities of new material in this substructure are only 110 cu.yd. of concrete, 5,930 lb. steel reinforcement, 52 piles and 43 cu.yd. riprap.

The work was done in 1919 by contract. The cost of the Pattison Avenue bridge to the county was $10,998, and the cost of the Drinkwine bridge $5,500. Both structures are giving excellent satisfaction.

Cloudburst in Toledo Floats Pavement Away

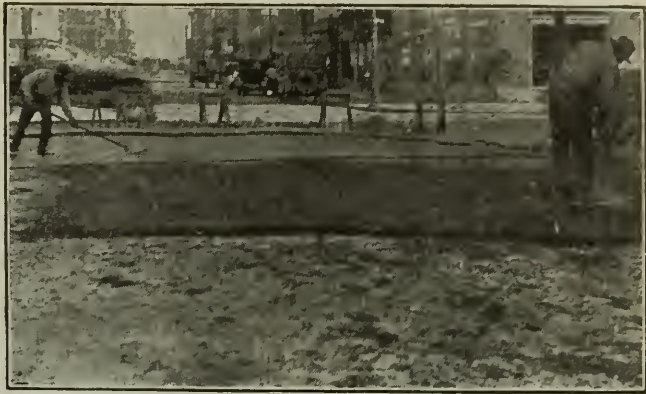
Greatest Intensity Recorded Since Weather Bureau Established—Wood Blocks Replaced on Asphalt Binder as Cushion

AN UNPRECEDENTED downpour in Toledo Aug. 16 damaged a section of wood block paving six blocks long on Jefferson St., 1,200 ft. on Monroe St., a like amount on Bancroft St. and on ten other isolated spots. Blocks were found floated as far away as six squares and two solid squares of Jefferson St. floated to Madison St., one block south, where many were found undamaged in cellars. It is estimated that thirty cellar walls under small frame houses located in depressions caved in.

SAND-CEMENT CUSHION CAME AWAY IN SMALL SLABS

Damage to private property was greatest in the downtown district and was confined mostly to wetting goods stored in cellars. The *Toledo Blade* lost $10,000 worth of paper. The Broadway water pumping station ran for four hours with the pumps submerged. Other utility stations and private power plants had similar difficulties of short duration. No lives were lost.

While many of the older sewers in the downtown districts are admittedly underdesigned to care for extraordinary rains, sewers built under present assumptions of design, viz., a 1-in. per hour rainfall with a 50 per cent runoff factor, would be decidedly inadequate. However D. H. Goodwillie, director of public service, states that much less water would have run down the streets had it been able to pass the clogged inlets.



ASPHALT BINDER COURSE READY FOR ROLLING TO RECEIVE WOOD BLOCK SURFACE

From the Toledo Weather Bureau the following records have been obtained as to the intensities which have not been exceeded since the bureau was established in 1871:

TABLE I. GREATEST INTENSITY IN GIVEN PERIOD

Time	Aug. 16	Highest Record Since 1903	
5 min.	0.65 in.	0.54 in.	July 13, 1909
10 min.	1.25 in.	0.91 in.	July 13, 1909
15 min.	1.78 in.	1.08 in.	July 13, 1909
30 min.	2.87 in.	1.89 in.	June 24, 1911
1 hour	3.58 in.	2.14 in.	June 24, 1911
2 hours	3.65 in.	2.24 in.	June 24, 1911

The rain started at 7:06 a.m. and ended at 8:35 a.m. In the 24-hour period 4.55 in. fell, rain actually falling for five hours and 24 minutes. It continued in excess of 1 in. per hour for 46 minutes, when 3.40 in. fell, being therefore many times the rate for which the sewers were designed.

For eight minutes after the rain started the Weather Bureau reports 0.01 in. fell and the rate then became "excessive." The five-minute accumulation record thereafter for an hour is as follows:

Minutes	Accumulation	Minutes	Accumulation
5	0.09 in.	35	2.34 in.
10	0.12	40	2.93
15	0.32	45	3.20
20	0.75	50	3.38
25	1.17	55	3.49
30	1.74	60	3.58

Repairs to pavements were started immediately by the city, the wood blocks being hauled back to the various streets and piled on the sidewalks and parkways. All of the wood blocks for six blocks on Jefferson St. were removed, since that part of the pavement which had not been floated was badly disturbed and was loose previous to the flood.

Jefferson St. paving had been down six years. It was laid with 3½ in. lug blocks preserved with 16 lb. creosote on a sand-cement cushion and the joints filled with sand. The blocks are in good condition and Mr. Goodwillie estimates 75 per cent of them will be salvaged.

A new method of laying is being used partly because of the difficulty of obtaining cement for the standard sand-cement cushion. After removal of the sand-cement cushion, which came away in pieces of from 6 to 12 in. across, the irregularities in the concrete base are being filled and a smooth grade being made by a ¾- to 1-in. layer of asphalt binder. It is being placed and rolled exactly as for a wearing surface of asphalt. The blocks are then placed after cleaning and a squeegee coat of mastic of sand and tar pitch brushed into the joints.

POURING HOT TAR MASTIC OVER RELAID WOOD BLOCKS

The engineers are of the opinion this filler will adhere much more closely to the asphalt binder and form a better bottom seal against water than if placed on a sand-cement cushion.

Monroe St. paving is 16 years old. It was laid on a poorly finished rough concrete base which shows distinct wear under the wheel tracks. Within two years it will have to be repaved anyway, so the three places aggregating 1,200 ft. will be replaced with a sand-cement cushion, utilizing the recovered 4-in. blocks.

On Bancroft St. three intersections are gone. The paving is eight years old and the blocks were laid on an old concrete foundation which had been patched in many places. In consequence the sand-cement cushion had cracked badly and had given much trouble, mostly due, according to Mr. Goodwillie, to the patched foundation. It will be repaired with an asphalt binder cushion in the same manner as Jefferson St.

As to the flotation propensities Mr. Goodwillie says there seemed to be no consistent reasons assignable. The lowest spot in Robinwood Ave., under 2 ft. of water and laid on a plain sand cushion never moved, while two blocks away on the same street under similar conditions of paving a large area was floated out of place.

The city let contracts for the Jefferson St. job at \$35,000, Monroe St. at \$18,000, and Bancroft St. at \$12,000. A total of \$105,000 is estimated to complete all of the daamged pavements.

Peru Passes New Road Law

The Peruvian Congress recently passed a law making it compulsory for all males from 18 to 60 years of age to work on the public highways for a certain number of days per year. However, examptions may be secured on condition that payment be made to the Government of a certain sum of money, which sum shall be fixed for each district. At the present time there are but 1,040 mi. of road in the Republic of Peru, while 391 mi. additional are projected. Trade Commissioner Jackson expresses the opinion that practically all the laborers in Peru at the present time have enough money to pay cash instead of doing the work on the roads; therefore it is expected that the bulk of the returns from this act will be in money rather than in labor. The estimate of returns was set at \$2,500,000 per year, and the Minister of Hacienda states that already the collections are running above that rate.—*Commerce Reports.*

Bridge Floor With Steel Ties Bedded in Concrete

Shallow Solid Floor Design on Track Elevation—Girders Have Concrete Casing—Rail Bolts Are Clear of Ties

A REINFORCED concrete slab encasing and supported by transverse floor beams and having steel ties embedded in it is the novel floor construction adopted by the Cleveland, Cincinnati, Chicago, & St. Louis Ry. for some of its track elevation bridges at Indianapolis, Ind. These are double-track triple girder through bridges built in 1919 at the east side of the city, on the Chicago-Cincinnati division (see *Engineering News-Record*, Aug. 7, 1919, p. 265). The object of ths design is to obtain a solid waterproof floor of minimum depth.

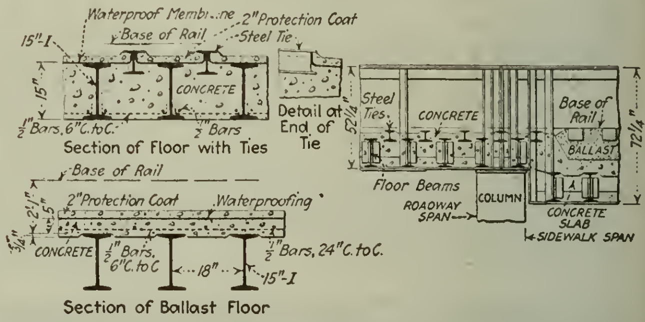


FIG. 1. BRIDGE FLOOR HAS STEEL TIES EMBEDDED IN CONCRETE

Framed between the girders are 15-in. I-beams spaced about 18 in. c. to c. Transverse bars having their ends bent up vertically are laid on the bottom flanges of the I-beams, and in the corners of the bent bars are laid longitudinal bars. Concrete is filled between the beams, flush with the top and bottom flanges, and in this concrete the 6-in. steel ties of H section are embedded to about half their depth. One of the bridges is on a curve and the ties are inclined in the concrete to give the required superelevation. The concrete is a 1:2:4 mix, with 20 lb. of hydrated lime per barrel of cement.

After the concrete had set it was covered with a waterproofing membrane, this being carried under the top flanges of the steel ties and flashed. Upon this

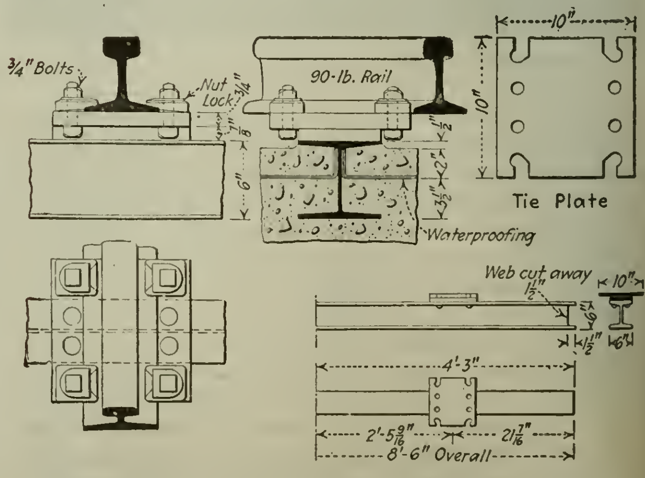


FIG. 2. RAIL FASTENINGS ON BRIDGE FLOOR

membrane is laid a 2-in. protective course of 1:2 cement grout, which is given a smooth sidewalk finish. The tops of the ties are ½ in. above this finished surface, but the grout is filled in under their flanges, as shown.

Bolted clip fastenings of unusual arrangement secure the rails, which are of the 90-lb. A. S. C. E. section. The 6-in. steel ties are 8½ ft. long and have at each rail seat two plates secured by rivets which are countersunk in the top plate. The lower plate is a ⅞-in. filler, 6 x 10 in., and the upper plate is 10 x 10 in., ¾-in. thick, with slotted holes for the track bolts. The slots are so arranged as to give lateral support to the bolts and

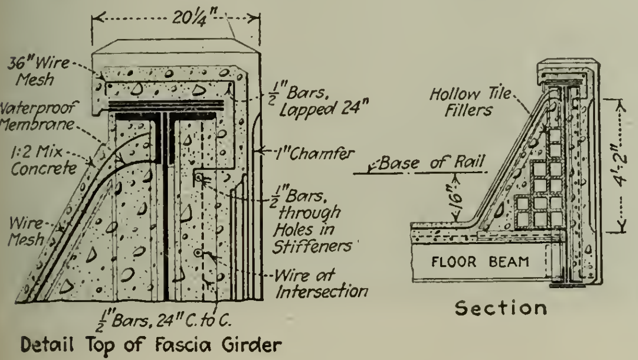


FIG. 3. CONCRETE CASING OF GIRDERS

to permit of their renewal without disturbing the concrete.

This floor construction is used only on the roadway spans, a ballasted floor being used for the sidewalk spans and for the triangular portions between the girders and abutments of skew bridges. For these parts of the floor a waterproofed 7-in. reinforced-concrete slab is laid upon the I-beams, having its top 18 in. below the base of the rail.

Concrete casing is used on the columns and girders of these bridges, for protection of the steel and to give an architectural finish to the structure, as required by the city. The columns as concreted are of octagonal section, with vertical bars at the corners and hoops spaced 12 in. apart. On the inside of each girder the concrete is filled to the clearance line, hollow tile backing being placed in the concrete to reduce the weight. This filling is packed under flashing angles on the top flange of the girder, and the middle girder has the top surface of its flange uncovered. For the exposed side of each outside girder the concrete is shaped to form a paneled fascia girder and is carried over the top flange.

The type of floor construction described above weighs about 2,100 lb. per sq.yd. (for I-beams, ties, rods and concrete). Its details are calculated for Cooper's E-60 engine loading. It was designed under the direction of C. A. Paquette, chief engineer, and J. B. Hunley, engineer of bridges, of the Cleveland, Cincinnati, Chicago & St. Louis Ry.

Further Delay to Channel Tunnel Project

A recent statement of the British government to Parliament indicates that no favorable decision on the Channel tunnel project has been reached as yet. A recent re-examination of the proposed tunnel enterprise by military and naval authorities appears to have led to conflicting opinions, and considerable further delay in the decision on the project is therefore expected.

Notes from Foreign Fields

FROM LONDON TO GLASGOW

BY E. J. Mehren

EDITOR ENGINEERING NEWS-RECORD

IF ONE grows enthusiastic over Brussels, what shall one say of Paris? If Brussels is beautiful, Paris is magnificent. In a day or so one makes the acquaintance of the business district and of that much-frequented section lying just north of the Louvre and the Tuilleries. Judging by other cities this section should be the sum total of the city's fine neighborhood—with possibly a fashionable residential section and few small parks elsewhere. Not so with Paris. The broad avenues, the tree-lined boulevards, the high-class well-kept buildings, the good pavements, the squares, the monuments, the clean streets are everywhere. Paris is the only homogeneous large city, structurally speaking, I have ever seen. As an American remarked one night as we watched the moonlit city from the Concorde Bridge, "Isn't it satisfying to see a city that is completed?"

AVENUE BOIS BOLOGNE—LOOKING WEST

Undoubtedly the vistas in Paris are not surpassed anywhere. To stand in the main avenue of the Garden of the Tuilleries as the sun is setting, to look eastward, where the view is closed by the Arc de Carousel and the Louvre, then westward past leaping fountains, through the Place de la Concorde to the Arc de Triomphe, through which at that hour the sun casts its golden rays, is to see the highest art of the city planner.

THE OLD CITY ISLAND AND THE SEINE, S. E. FROM THE LOUVRE, PARIS

To stand again in the Place de la Concorde, that greatest of public squares, to drink in its magnificent extent, to range with the eye from the Grecian portico of the Chamber of Deputies on the south to that wonder of classical architecture, the Church of the Madeleine, on the north, is to have gained a standard by which all planning of squares is to be judged.

One could go on and describe the whorl of boulevards starting from the Arc de Triomphe in the Place de L'Etoile, the sloping gardens from the Trocadero to the Eiffel Tower, the plan of the boulevards, a dozen other magnificently planned features, but the resulting impression on the reader would be merely to accentuate what is comprehended in the phrase, the city magnificent.

One is tempted to ask when we shall do our city planning as well. The answer, of course, is that we shall never do it so well. The genius of a race is here expressed in its capital city, and that genius is artistic. We need not belittle our efforts. Our genius lies along different lines. We shall continue to build great cities —great in population, in commercial activity—but we shall not make them uniformly beautiful. We shall make them sanitary, we shall care well for the traffic, we shall have here and there beauty spots, but we shall not have cities that bear the artistic touch of Paris.

But if we cannot expect our average alderman, who is, after all, an expression of the average citizen, to think in terms of Parisian planning, we can, at least, demand that those responsible for the planning of the city of Washington show a great deal of liberality in the beautifying of the capital. We have a good foundation, but it is a foundation merely. We need, for example, half a dozen new great buildings for the departments. We should have them in fine settings, not fronting on narrow, built-up streets, as does the Interior Building. Should not a first requisite for service on the congressional committees in charge of District matters be a trip to Paris? That sounds like an extravagant suggestion, and it might be for two-year members of the House, but it would probably pay with six-year senators.

The Seine.—To an engineer the Seine affords an interesting study. The bridges are of great variety, while the quays are a constant surprise because of their cleanliness and their failure to detract from the land-

BASTILE MONUMENT


THE PONT AND PLACE DE LA CONCORDE FROM THE CHAMBER OF DEPUTIES

Wood block has become the favorite pavement in recent years, the area so paved having increased from 428,000 sq.m. in 1887 to 2,473,000 sq.m. today. In the same period the area in asphalt (rock asphalt) has increased from 302,000 sq.m. to 754,000 sq.m., while the area in stone block has decreased from 6,286,000 to 5,347,000, and that in macadam from 1,563,000 to 840,000. Waterbound macadam is considered entirely unsuited for Parisian conditions and is being replaced as rapidly as possible.

Despite the increase in the use of wood block and the decrease of stone, the latter is considered the normal type of pavement because of its lower cost, life and maintenance expenses being considered, the life averaging 22 years. Wood block and asphalt are used where noise is objectionable—wood block in the business center and in the de luxe residential sections, asphalt on narrow streets, with poor air circulation, where the superior resistance (compared with wood) to moisture and atmospheric changes are believed to recommend it. Asphalt is not used on grades of more than 2 per cent, wood block not on grades over 4 per cent. On steeper grades stone block is laid. The life of wood block has been 10 years, of asphalt 15 years.

Six-inch concrete foundations are used for wood-block and asphalt pavements, and for stone block where there are tramways, where the traffic is very heavy or where the subsoil is bad. Normally, though, stone-block are laid on sand on a rolled subgrade or on reshaped old macadam.

The street cleaning work I had not time to inquire about, but one feature was much in evidence—the flushing of the gutters. Water connections are provided at intervals along the curbs, and in the early morning hours, particularly, goodly flows of water are allowed to run down the gutters, the sweeping of the night before being carried by the stream, aided by long brooms, often manipulated by women.

scape. A stream through any of our cities serves one chief purpose, besides that of carrying ships: its banks are ideal for warehouses, factories and railroad tracks. They are the last place one would look for beauty, while our bridges too often are useful only, not ornamental as well.

At Paris, the Seine is tree-planted for its full length and streets run along both banks. The quays are stone paved, sloping upward from the water's edge to stone retaining walls which support the parkways and streets. It is a place to loiter and to catch vistas made by the winding stream.

The bridges are designed to fit into the picture. As bridging problems they are simple. The stream is shallow and not swift. Between banks the width is 500 ft. more or less, while the elevation of the paralleling streets is such that there is ample clearance for the shipping (barges and tugs) without approach ramps. With such a location and with appearance a factor the arch is the natural, and actual, solution. Most of them are of stone. Some are dependent solely on their proportions for effectiveness; others are highly ornamented. There are quite a number of decked steel-arch structures, and at a point near the west end of the city, where ground conditions favor a different type, there are two through steel-arch bridges.

Pavements

At the present time the pavements in Paris, due to enforced neglect during the war, are in bad condition. Repairs are in progress, but it will take a long time to get back to pre-war standards.

Traffic is dense, greater than that of London, I should say, and comparable to that of our American cities, but the average weight of vehicles is not as great as that of London or of American cities. Compared with our traffic or London's there are very few motor trucks, but taxicabs are more numerous than the proverbial bees around the honey jar. In the heavy vehicle class are the omnibuses. Traffic figures would be very interesting, but here, as in London, there are no recent traffic counts.

THE PARIS SUBWAYS

The average American's conception of a subway system is probably based on that of New York. To him a "subway" is a long high-speed underground railway, with express as well as local service. Philadelphians and Bostonians have somewhat different conceptions, based on the congested-area subway plan in those cities. The Paris system is quite different from both of these types—which is only another way of saying that conditions here are different than they are in New York or Boston.

Paris, unlike other Old-World cities, has not grown beyond its walls. Elsewhere in Europe the old limits have long since been overstepped and the suburbs have been absorbed by the expanding municipalities. Paris is,

roughly, elliptical, with a major axis (east and west) of about 11 km. (6.6 miles) and a north-and-south axis of about 9 km. (5.4 miles). Across this ellipse is a network of subway lines, six extending entirely across the city, while one of them, No. 2, makes a complete circuit, at a distance of about 2 km. (1.2 miles) from the city wall. In addition there is a short connecting subway, and several of the lines have branches at their outer ends, the Nord-Sud, for example, having three branches in the northern part of the city. The longest cross-city line, No. 4, a north and south line, is 11.4 km. The total length of the circular line, operated in two sections, is 23.2 km. The total length of the subways, all double-tracked, is just 100 km. As in our cities the tubes themselves are built and owned by the city, the operating company furnishing the equipment and the power houses.

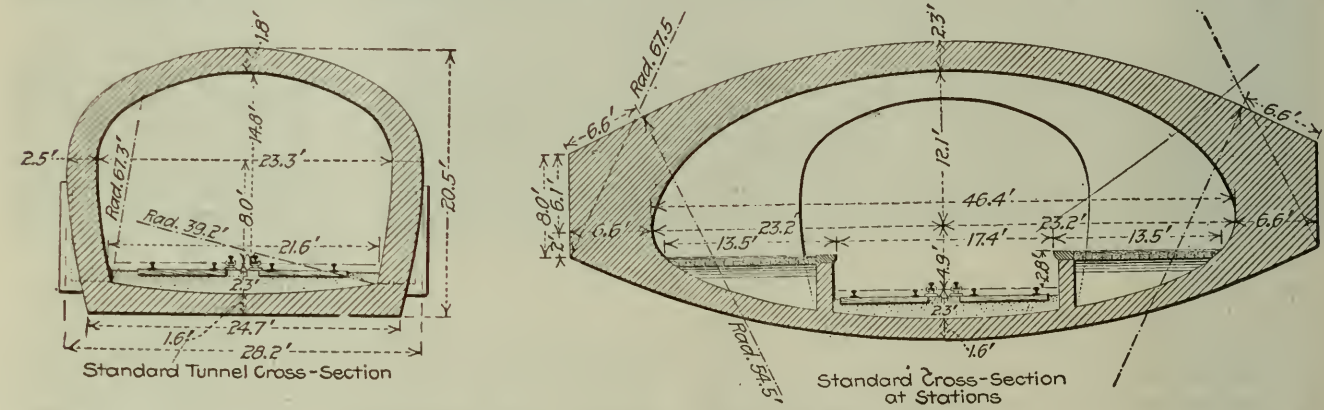
Since the lines are only double-track there is no express service, but such service is hardly called for where the maximum length of line is only 6.6 miles, particularly since the great majority of passengers will ride only half the distance, i.e., from the outskirts to the center of the city or vice versa.

With the exception of parts of the circular line the system is entirely in tunnel, uniform cross-sections for tunnel and station, shown herewith, being used throughout.

The car arrangement differs from that of other cities in that in the second-class cars (there is one first-class and four second-class cars to a train) most of the space is devoted to standing room—a feature justified also by relatively short trips. In the second-class cars there are only 13 seats, while there is standing room for 108 people. On the other hand, the first-class cars provide 33 seats and standing room for 46 passengers.

Contrary to the practically universal rule in Europe, fares are on the flat, not the zone, basis. The second-class fare is 30 centimes (normally, about 6 cents) and the first-class fare 50 centimes (normally about 10 cents). Transfers are allowed in any direction without the payment of an extra fare. The present fares are 5 cm. more than the pre-war rates, and, as a result, there has been a slight reduction in traffic. The total revenue, however, has gone up.

Trains consist of five cars manned by a crew of four, a motorman and one guard in each of the first, third and last coaches. The guard in the center coach (first-class) has no other function than to see that none but holders of first-class tickets ride in that car. He punches the ticket as a check. The front and rear guards step to the platform when the train stops. The rear guard blows a whistle when all at this end have left or entered the cars, while a whistle blast from the front guard when his end is clear notifies the motorman to proceed. Doors are opened by the passengers themselves, but closed by the guards with an electric pneumatic mechanism. Admission to the station platform is controlled by a guard, generally a woman, who punches each ticket and, when a train pulls in during rush hours, closes a gate at the foot of the entrance stairway to prevent late arrivals from delaying the departure of the train by a last minute rush.



STANDARD CROSS SECTIONS OF THE PARIS SUBWAY

In general the service is quite satisfactory. The atmosphere is usually quite humid and, therefore, not very pleasant, the humidity being due, in large part at least, to the practice of constantly sprinkling the platforms to keep down the dust. So far as I know we have never in our subways found the dust nuisance serious.

The transfer connections between different routes are often exceedingly tortuous, and after threading them one is inclined to be more indulgent toward the horribly inconvenient Lexington Avenue-Forty-second Street and Seventh Avenue-Broadway connections at New York. No connection I found in Paris, though, was worse than either of these.

One feature is to be very highly commended—the excellent sign system. In this respect our own Boston-Cambridge subway is above criticism. At the entrance stairway of each station are two enameled signs giving in large white letters on a blue background the terminal station and the intermediate stations for the respective directions. Similar signs are found beyond the ticket booths, each appropriately placed at the proper stairway. On the station platform itself is a large sign with the name of the terminal station—this being more indicative than compass points because the lines run at every angle to the meridian. In addition in each car small enameled signs are found on the doors giving the name of each station in its proper geographical order, together with the name and number of the subways which intersect the line at transfer points. In many cases, also, a diagram of the line, with large lettering, is hung in the center of the car. A total stranger supplied with a pocket map can go anywhere by the subway system and find his way without asking questions. He can check up his progress by watching the car-door and the station signs.

Our subway operators may well copy the Paris subways in this respect.

Paris, June 17.

Letters to the Editor

Plight of Railway Technical Men

Sir—In a letter in your issue of Aug. 5, p. 279, by Walter J. Sykes, several pertinent inquiries are made in reference to the apparent oversight on the part of the Railway Labor Board in failing to consider the salaries of the railroad technical employees. Furthermore, Mr. Sykes raises the question why the 57 different engineering societies did not make an effort to look after the interest of their members employed by the railroads.

Shorn of all subterfuge, the Railway Labor Board did not provide for the railroad technical men as they were not properly organized along economic lines to present a case for their particular group. It is unfair to the other engineering societies to accuse them of dereliction, as they are not organized to look after the economic welfare of the members but are solely engaged in the promotion of technical education along engineering lines. Consequently, they are not in a position to discuss intelligently a question of wages and conditions, as was done by the representatives of the Brotherhood and the affiliated American Federation of Labor bodies.

This is as it should be. The old homily, "Let the shoemaker stick to his last" holds good in this instance. By all means let the technical men support their "technical" societies and "technical" publication in order to keep abreast of recent engineering methods, and if perchance he is interested in improving his material welfare, let him organize along trade union lines.

It is utterly impossible to blend these two objectives into one common organization and do justice to either. Let any bona fide technical society attempt it and it will immediately stultify its sphere of influence. The reason: In the engineering societies we have employer and employee meeting on common ground so far as educational work is concerned. Just presume what would happen at such a gathering if the question of wages and conditions were discussed.

If, therefore, the railroad technical men are actually concerned in making some substantial material progress as one will infer from the letter of Mr. Sykes, let them affiliate with some subordinate body of the American Federation of Labor. By so doing they will openly proclaim in unmistakable terms that they are dissatisfied with their present condition and are going after those things which make life worth while and will assure to them and their families the opportunity to live with some reasonable degree of comfort.

Washington, D. C. L. C. Roslyn.

Rapid Progress in Stadia Work

Sir—I was very much interested in the article of H. R. Randall, published in *Engineering News-Record*, July 22, p. 150, giving some records of rapid progress on topographic surveys.

Our firm has the engineering work on the Toole County Irrigation District, and a part of the work consists in taking the topography on about 400,000 acres. As both the writer and the engineer who has charge of that part of the work for us have had considerable experience in stadia work we use that method. The lands being surveyed have a comparatively uniform slope, and there are no trees nor underbush. Stadia parties are made up of five men—transitmen, recorder and three rodmen. Automobiles are used to carry the parties to and from the field, and the instrument man and recorder from station to station. The lines of the Cadastral Survey are used as base lines. Elevations were first established with a Wye-level for a control line. These lines are from 4 to 6 miles apart. All the traverses are in closed circuits, the allowable limit of error in closures being 1 ft. in elevation for a complete circuit and 30 ft. in line and distance per mile. As only every other station is occupied it means that instruments must be kept in absolute adjustment, and the instrument man can make no mistake. When a circuit doesn't close within the allowable limit it must be rerun. All vertical angles are read to minutes, distances to the nearest 5 ft., angles to the nearest 5 minutes on the traverse and the nearest degree on side shots.

This work was begun last October and carried on until Dec. 15. During that time 60,000 acres were surveyed with two parties averaging about 480 acres per day per party; of course much time was lost on account of weather conditions, so probably an average of a thousand acres was surveyed for each day the parties worked. We now have four parties in the field, and we are averaging 20,000 acres per party per month, and have hopes of increasing it to 25,000 acres per month.

The largest area covered up to now in one day's work with one party is 1,920 acres. Nine hundred and three shots were taken, thirteen stations occupied, and a strip 6 mi. long by one-half mile wide was surveyed. The error in closure for elevation for the circuit was 0.79 ft. The party worked 7 hr. and 40 min. The tract surveyed had one "draw" about 2 miles long within it. Ralph V. Buckner, with our firm, was the instrument man in charge of the party when this record was made. We plotted this day's work and found that the tract had been exceptionally well covered. Henry Gerharz.

Shelby, Mont. President Gerharz-Jaqueth Eng. Co.

Building Fills With Spreader Car

Sir—Referring to the article on the use of a spreader car in building fills in *Engineering News-Record* of Aug. 12, p. 329, this method was very good for the specific case described. But probably it would be a failure if used as suggested for filling beyond the 7-ft. height, as it would be impossible to maintain track for uninterrupted service while lifting from one bench to another. Furthermore, throwing the track from one side to another is useless and a waste of effort, not only in track work but for the spreader crew, as the fill will roll down the side of the embankment from the high position of the track.

Some years ago in Kansas City we placed 500,000 cu.yd. of earth for a double track railway fill 30 ft. wide on top with 1 : 1 slopes. A work track on center line with dump cars and spreader handled the job very successfully. A track gang continually jacking track gave us uninterrupted track facilities. L. C. Scott.

Cleveland, Ohio.

Why Water-Power Reports By Engineers Are Generally Favorable

Sir—The letter of Robert E. Horton in the issue of Aug. 12, p. 326, interests me very much. I heartily approve Mr. Horton's explanation, and join him in protesting against such assertions as he mentions that engineers invariably make favorable reports, either on water power, or other projects.

It is true that some young and inexperienced engineers appear to feel that it is their duty to write a glowing account of a project upon which they are called to report. And, unfortunately, there are many prospective clients not too scrupulous to attempt to tell an engineer in advance what kind of a report to write. However, the engineer of experience and good judgment, and that applies to most of those who report for investment bankers and investors, will not permit a client even to attempt to tell him what kind of a report he shall write. In our business we are particular to advise a client in advance that we are just as likely to write an unfavorable report, condemning the project entirely, as to write one that will be favorable. We tell him that the idea of a report is that we are to study the project and ascertain whether it is sound for financing or not, and then to set forth our findings in a clear and conclusive way so that others may understand it from perusal of our report. We do not know upon taking up a project, nor until the study is completed, what the conditions may be surrounding

the project. The appearances may be good but no conservative engineer will pronounce on any technical project without scientific investigation.

If a project is not sound and the engineers' report demonstrates the fact conclusively, the promoter should be glad to pay the fee to find that out, as it will probably prove to be the best money that could be spent on the project. That fee may save him thousands of dollars useless expenditure and wasted effort. Promoters are loath to take this view but the engineer should make this clear before undertaking to report.

It is the true explanation, that Mr. Horton advances, that unfavorable reports never see the light, and that is why thoughtless persons assume engineers always report favorably.

Speaking of water powers, one of the most difficult things to get a client to recognize, and indeed it may be said, to get the average engineer to consider, is that suitable physical conditions alone are not sufficient. They always begin by telling us about the wonderful gorge where the dam can be built and the great amount of water and the rocky formation, all of which may be quite good. But, they seem to ignore the very important fact that if this site is, as too often happens, far remote from commercial centers, the cost of delivering the power to market may be so great as to nullify the whole undertaking. We have a case of this description in our office at the present moment, the physical conditions for a hydro-electric installation being ideal. The cost, however, of a transmission system to deliver the moderate amount of power obtainable to a possible market would be so great that the revenues would hardly carry interest and depreciation on the investment for the transmission system, to say nothing of the cost of dam and station.

In other words, engineers need to regard a hydro-electric project more from the standpoint of an industrial undertaking, or a business, than from the point of view of an interesting construction job.

W. K. Palmer,
Consulting Engineer.
Kansas City, Mo.

Paving Cost Comparisons

Sir—My attention has been called to an error in a table of costs of paving in your issue of July 8, p. 76. The cost per square yard for complete asphalt pavement in Washington should have been \$5.06 instead of \$6.26, and the per cent increase over Chicago 21.9, instead of 50.8 per cent.

Julius G. Gabelman,
Chief Street Engineer,
Board of Local Improvements.
Chicago.

Reducing Impact Factors for Dead-Load Ratio: A New Formula

Sir—In *Engineering News-Record* of April 29, 1920, p. 874, I was interested to see an article on an impact formula applicable to ballasted and concrete girders. In this connection, I have been recently carrying out some investigation work and from the results obtained I consider that a factor dependent on the ratio of the dead to live loads should be included in the formula for impact allowance for all spans above 120 ft. This would give much more rational and correct results than the formulas now in use, which are dependent only on the loaded length of span.

I have recently submitted a proposal to the Indian Railway Bridge Committee (the latter has been formed by the Railway Board of the government of India to investigate and consider the revision of the existing bridge rules, specially that of impact allowance), for a new formula based on the ratio of dead to live loads and loaded length of structures above 120 ft. in length. The diagram attached shows the new formula, which is,

$$I = \left(1 + \frac{16}{28 + 0.3L - 3\sqrt{L}} - \sqrt[3]{\frac{D}{M}}\right)$$

where

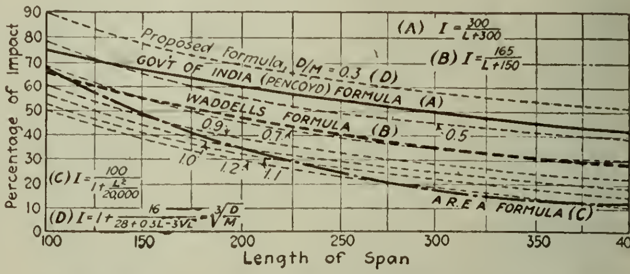
I = amount to be added to allow for impact

L = loaded length, in feet

D = dead load of the structure, ballast, permanent way etc., taken on a length L

M = equivalent uniform live load of train, taken over a length L

There are also graphed on the same diagram the Pencoyd. areas, and Waddell impact formulas.



VARIATION OF IMPACT WITH SPAN LENGTH, AND EFFECT OF DEAD-LOAD RATIO

Concerning the tests made by the bridge staff of the North Western Ry., I might say that in an open-deck truss of 120 ft., weighing 96 tons, with a train load of 250 tons, the difference in stress induced between static loading (the train at rest in a position giving maximum stress) and train traveling at critical speed has been found to be from 25 per cent to 30 per cent, whereas in the case of girders of the through type with cross-girders and ballasted floor, weighing 150 tons, and the same length and live loading as the above, the difference is only 12 per cent. The government of India bridge rules provide for the same increment for impact in each type of span.

In the case of the double-track bridge, length of each span 200 ft. clear, across the Jamna River near Saharanpur, the deflection taken under the static loading with two trains on a span was 0.75 in., while with the same trains running over the bridge in the same direction at a critical speed of 30 miles an hour the deflection at the center was 0.825 in., approximately 10 per cent greater than under static loading. The ratio of the dead load of the structure to the live is 0.59. In the Sara bridge, with spans 350 ft., the difference in deflection between static and moving loads is very small, less than 5 per cent. The ratio of the structure load to the live is 0.96.

If a formula similar to the one suggested were adopted on the North Western Ry. it would mean that existing large bridges which are of a through type with heavily ballasted floors, such as the Kotri Bridge, with 350-ft. spans, the Attock Bridge, with 308-ft. spans, the Adamwahan Bridge, with 257-ft. spans, and the Ferozepore Bridge, with 155-ft. spans, would be permitted to carry train loads 25 per cent greater than they are able to do at present, without much alteration or strengthening except to the floor systems and bracings.

W. T. Everall,
Bridge Engineer, North Western Ry.
Lahore, India.

Shrinkage of Earthwork

Sir—I have read with interest the article on "Shrinkage of Loosely Filled Earthwork in Embankment," by E. E. R. Tratman, in *Engineering News-Record* of June 24, 1920. In this article reference is made to the brief which the Public Utilities Commission of Illinois filed with the Interstate Commerce Commission in connection with the valuation of the property in Illinois of the Elgin, Joliet & Eastern Ry. Co. This brief deals with various valuation questions and contains a somewhat detailed discussion of shrinkage, based upon an exhaustive survey of the available literature on the subject.

In the valuation of the Elgin, Joliet & Eastern Ry., as in many others prepared by the Division of Valuation, Interstate Commerce Commission, an allowance of 10 per cent of grading quantities was made for so-called shrinkage,

meaning thereby the decrease in the volume of a settled embankment from the volume occupied in the original bed. To this general allowance the Illinois Commission entered vigorous protest, claiming there was no proof of its existence and that until such proof was forthcoming no allowance therefor should be made.

The research undertaken by me made plain the utter confusion that exists in the engineering profession concerning shrinkage, involving serious disagreement as to the amount or even its existence. This may be readily accounted for by the incongruity of the results obtained by various investigators and the far-reaching influence of the statements of Ellwood Morris made more than three-quarters of a century ago when railroads were in their infancy.

The shrinkage of earthwork, as herein contemplated, is contrary to my own experience on heavy sewer construction work, and nowhere can I find reliable experimental data to back up the statements in various textbooks and engineers' handbooks that shrinkage exists. Practically all of these statements appear to be based upon the Morris experiments.

Under present procedure of the Interstate Commerce Commission allowances for shrinkage of earthwork upon the railroads in the United States will aggregate an enormous sum, and I cannot bring myself to believe that such allowances should be made without unquestionable proof of their justice. So far as I have knowledge this proof has not been furnished. If shrinkage exists and its amount can be determined I believe the carriers are entitled to a proper allowance therefor, but I insist that proof of its justice must first be furnished.

I am in full accord with the suggestions in Mr. Tratman's article that action looking to the solution of the problem should be taken, and because of the importance of the matter I am of the opinion that the American Society of Civil Engineers could with profit undertake an impartial investigation of the whole matter. Academic discussions are fruitless, and attempts to settle the matter by measurements of existing embankments are worthless.

May the publicity you have given the matter result in research that will lead to the final determination of the dispute.

Chicago.

WALTER A. SHAW,
Commissioner, Public Utilities
Commission of Illinois.

Sir—In the letters of Messrs. Tripp and Ferry in *Engineering News-Record*, Aug. 12 and 19, are given data concerning the shrinkage of the earth in embankments, intended to contradict my statements in the issue of July 15, while they are adding proofs in support of my assertions. The facts ascertained by Mr. Ferry are very useful and interesting, on account of his having furnished positive data concerning this vexed question; and instead of relying all the time on abstract reasoning we have some correct measurements on which to base our discussion.

Mr. Ferry claims to have proven in the most convincing manner the shrinkage of the earth in the embankments, because by measuring correctly the one he built for the "Yale Bowl" he ascertained a decrease of 7 per cent in volume when compared with the cut. But in explaining the process of construction he says the distance of hauling never was over 100 feet, the loss in transportation was therefore negligible. In moving loose earth for a distance of nearly 100 feet by means of drag scrapers a great deal is lost in transportation, and it is not a negligible quantity indeed. Everyone has seen the earth falling out of the scrapers from the irregular pulling of the horses, and from the undulations of the surface ground which is not so smooth as a billard table, causing at every instance the fall of some material from the scrapers. Consequently the loss neglected by Mr. Ferry will certainly amount to 3 or 4 per cent at the very least.

Mr. Ferry has failed to notice the quantity of earth placed in the embankment, which was carried away by water. The "Yale Bowl," like Rome, was not built in a day, and before it was completed the embankment must have seen many rainy days and severe storms, and on each of these occasions, a large quantity of freshly deposited earth must have been washed away. None has been able so far to measure correctly such a quantity, but it is generally admitted that it is a great deal larger than what is lost in transportation.

Concerning the statement of Mr. Tripp, that he employed 115 cu.yd. to fill in a space of 100 cu.yd., although the data are very undetermined: This may give some light in regard to the losses in transportation. Notwithstanding the fact that Mr. Tripp has not given any information about the method used in measuring the 115 cu.yd. required for the fill, the means of transportation employed and the distance of hauling we may suppose that the earth was moved by ordinary carts, and the distance of hauling much greater than at Yale. Assuming, however, with Mr. Ferry the "earth shrinkage" of 7 per cent, the difference of 8 per cent must have certainly been lost in transportation.

Since the quantity of earth washed away from freshly constructed embankments is greater than the quantity lost in the ordinary transportation; thus at the "Yale Bowl" more than 8 per cent of the earth was carried away by erosion. Coming down to figures; if, at the "Yale Bowl" the loss on account of erosion was only 8 per cent, added to the minimum of 3 per cent lost in transportation, we have a total loss of 11 per cent (but Mr. Ferry has carefully measured a decrease in the embankment of only 7 per cent compared with the cut), there is an increase of 4 per cent, which proves my contention that the earth does not shrink but, if finally found of smaller volume in the embankment than in the cut, it is due to the losses in transportation and by erosion.

The embankment at Yale, notwithstanding it was so well constructed, settled for an average of ¾ of an inch, and the settlement was noticeable after two years, while no mention is made of any settling in the natural bank; this seems in contradiction with the statement that the material was more loose in its natural position than in the embankment. The settlement of the embankment is explained by the presence of voids which have been greatly reduced by sprinkling and rolling the deposited earth, voids that are not so numerous in the earth in its natural position. There are soils that are very loose, but Mr. Ferry would have certainly discarded them in the construction of the embankment for the "Yale Bowl." The additional evidence he gives further to demonstrate the shrinkage of the earth by comparing the consistency of the material in the natural position and in the embankment, by the effort required in driving stakes, is too empirical. It reminds one of a patent granted in 1915 by a South American Republic to an inventor of a new method of reinforcing concrete. Among the sworn statements the inventor claimed to have constructed slabs of reinforced concrete of every variety in existence, and with a sledge hammer to have smashed every one except his own. No engineer would be satisfied with such an athletic performance, and yet it passed the examination of the "experts" and the patent was granted. The cohesive force of the earth should have been determined in a more scientific manner to be considered as a proof of shrinkage.

In conclusion the decrease of volume of the embankment at Yale as compared with the one measured in place is due: (1) To the losses in transportation which have been neglected by Mr. Ferry; (2) to the quantity of material carried away by erosion, which is greater than 8 per cent. But neither Mr. Ferry nor anybody else has been able to measure correctly. These two quantities added to the volume of the embankment would give a total quantity larger than measured in place, which will prove my assertion that the earth in the embankment (including the dispersed quantities) is always found of larger volume than in the cut, or in other words the earth does not shrink.

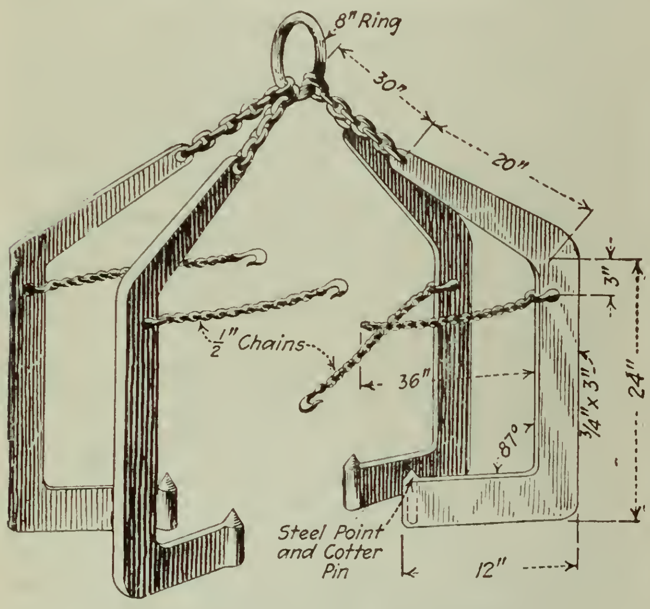
New York City.

CHARLES PRELINI.

HINTS FOR THE CONTRACTOR

Four-Point Grab for Handling Large Rocks Superior to Tongs

EIGHT-TON rocks have been handled by a four-point grab, which has been found superior to tongs, at the pits of the Cornwall Ore Bank Co., Cornwall, Pa. As described by H. H. Hunner, in *Engineering and Mining Journal*, July 17, 1920, p. 117, this grab is easy to make, convenient for two men to handle, and is quickly attached to irregular chunks lying at random in a pile. Four times out of five it will release itself when the chunk is deposited on the stockpile. The



GRAB FOR HANDLING LARGE ROCKS

material for the legs is ¾ x 3 in., but Mr. Hunner recommends using ⅞ x 3 in., or 1 x 3 in., when the apparatus is designed to handle chunks weighing more than seven tons, as hooks of the size shown in the figure have in practice required to be straightened out once or twice. The lower chains, three of which have hooks on the end, are pulled up snug and cross-tied after the legs are worked under the chunk at points convenient to get at. On round chunks, three legs are usually sufficient to make a lift, but in moving long slabs the four points of support are necessary.

Wood Panel Paving for Track Crossings in Removable Units

AS AN improvement upon ordinary plank paving at track intersections on public highways the Wilkes-Barre Ry., of Wilkes-Barre, Pa., is using removable unit panels. A four-sided frame of the proper size and angle is built of 3 x ⅜-in. Z-bars, welded together at the corners, the bottom flanges being inward and having welded to them lugs which rest on the knee braces at the corners of the track crossing. This frame is filled with transverse wood strips 3 x 3 in., which rest on the Z-bar flanges and are nailed together, a wedge-shaped strip being driven at the middle of the panel to make a tight fit. The panel is given a brush coat of preservative and the exposed flanges of the Z-bars are roughened by means of a welding torch so that horses will not slip. When track maintenance or repair work has to be done at the crossing the panel is readily removed and replaced. According to the ELECTRIC RAILWAY JOURNAL some of these panels have been in use for five years at crossings of steam and electric lines on highways having heavy motor truck traffic.

Essentials of a Rental Contract

ALTHOUGH some contractors are committed to a policy of not renting idle equipment because of careless handling it may receive at the hands of the lessee, excessive depreciation may be even exceeded by storage, interest and taxes. The conditions of a lease will be capable of determining whether the transaction entails profit or loss. A number of contingencies, frequently escaping notice, are set forth in the following essential provisions recommended by the committee on methods of the Associated General Contractors of America:

1. Description of equipment.
2. Identification.
3. Proposed use.
4. Where to be used.
5. Circumstances and method of transportation.
6. By whom transportation charges are to be paid.
7. Date and duration of the rental period.
8. Responsibility of lessee covering theft and other circumstances from the time equipment leaves lessor's yards until returned.
9. Payment of fire insurance by the lessor.
10. Payment of liability insurance by the lessee.
11. Security of the lessee.
12. Protection of lessor by lessee against all damages through use of equipment.
13. Date shipment is to be made.
14. Notice of release of equipment.
15. Maintenance of equipment by lessee and return of equipment by lessee in its original condition less usual wear and tear.
16. Approval of operator by lessor.
17. Payment of traveling expenses and wages of operator by lessee if operator is furnished by lessor.
18. Payment of inspection by lessee if machine proves satisfactory, payment by lessor if machine is unsatisfactory. Statement determining who shall make inspection.
19. Number of shifts upon which his lease is based. Payment of 50 per cent more for double shift.
20. Provision for payment by the tenth day of each month for work of preceding month.
21. Engineer's estimates basis of rental rates per unit.
22. Optional purchase clause where desired, clause to state per cent of rental which may apply on purchase price, difference to be paid by lessee within certain number of days.
23. Retention of title by lessor.
24. Payment for loading and unloading at lessor's yards by lessor.
25. Right of lessor to inspect without becoming trespasser.
26. Failure in payment giving lessor right to take possession of machine without becoming trespasser.

News of the Week

New York, September 2, 1920

Civil Engineers' "Proceedings" Sharply Curtailed

With the August number of the *Proceedings* of the American Society of Civil Engineers, issued during the past week, a far-reaching change in the publications of the Society has been initiated. Papers and discussions will no longer be published in *Proceedings*. The Publication Committee announces that it "has decided to omit the publication of formal papers (except in the case of short and timely papers of wide general interest, and reports of special committees) and discussions thereon, as well as memoirs. In place of the papers, synopses only will appear in *Proceeedings*, but the complete papers and subsequently the discussion thereon will be published in pamphlet form for distribution to such members as signify their desire for them. A suitable blank is printed on a perforated page at the end of *Proceedings* for use of members in ordering copies of papers and discussions. Heavily increased publication costs are the reason for the change. Besides papers and discussions, the retrenchment policy has eliminated the section of notices of new books, the index of current engineering literature, and memoirs of deceased members.

The change made is of particular significance, because the publication of papers and discussions has been one of the principal means of developing technical discussion in the society to its consistently maintained high standard. The committee invites suggestions on increasing the revenues and changing *Proceedings* still further. It asks whether the size of the publication shall be increased to 9 x 12 in., whether the policy of accepting advertising shall be adopted, whether editorial comment, reports of engineering research and publication of employment notices shall be added to the matter now contained in *Proceedings*. Concerning these matters the committee states that it did not wish to enter into experiment on its own judgment but "decided to adopt only conservative and reliable methods of securing economy, and proceed cautiously with more radical changes in *Proceedings*."

State of Maryland Purchases Road Commission Bonds

The Maryland State Roads Commission will have money available for road construction through the recent decision of the State Department of Public Works to invest in $1,000,000 worth of the roads commission's 1920 bonds. The bonds will be bought at par for the benefit of the sinking fund.

Associated Contractors' Headquarters Transferred to Washington

Effective Sept. 1, the headquarters of the Association of General Contractors was transferred from Chicago to Washington. The work of the organization will be expanded. The program for this expansion is now being prepared and will be announced in the near future. A branch office of the association will be maintained in Chicago. Washington will be headquarters of both Gen. R. C. Marshall, Jr., general manager, and Col. William Couper, assistant general manager.

Government Dredging May Be Stopped by Coal Shortage

Dredging operations being conducted by the Corps of Engineers are at the point of having to suspend, due to lack of coal. Gen. Harry Taylor, assistant to the Chief of Engineers, has returned from a trip to the coast during which he investigated the problem. The situation is worst at Norfolk and Philadelphia. It happens that the dredges at these ports are working within sight of thousands of cars of coal held on sidings. Contractors are being forced to pay $15 to $18 a ton for such coal as they can secure. Since fuel represents one-fourth of the total expense of dredging operations, General Taylor calls attention to the results which this is certain to have on the cost of work.

Winter Movement of Road Materials for 1921 Projects Planned

Reports to the Bureau of Public Roads indicate that the policy is becoming general to transport road materials before the contract is let. With the bulk of the materials on the ground, it is found that much more satisfactory bids can be obtained. In carrying out this policy, a number of states have reported definite plans to transport materials throughout the winter and spring to the extent that transportation may be available.

Ordinarily, 85 per cent of the highway work in the United States is suspended with the advent of cold weather. Reports reaching the Bureau of Public Roads indicate that much more road work will be done this winter than ever before, due to the determination of most of the Southern states to push road-building operations throughout the winter. Labor is more plentiful in the South during the winter months and it is believed that sufficient cars can be secured to keep most of the projects going.

Colorado River Regulation and Utilization

League of Southwest Considers Subject at Annual Meeting—Address by Arthur P. Davis

Reported by A. Lincoln Fellows, Senior Irrigation Engineer, U. S. Department of Agriculture, Denver, Col.

Upon invitation of the Governor of Colorado, the League of the Southwest, comprising the states drained in part by the Colorado River and its tributaries, met at Denver on Aug. 25 to 27 for the further consideration of plans for work in connection with the proposed regulation and utilization of the waters of the Colorado River basin, mentioned in *Engineering News-Record*, Aug. 19, p. 380. There were present the governors of Arizona, Utah and Colorado and representatives of the governors of Wyoming, New Mexico, Nevada and California—those seven states making up the league—and the state engineers of several of the states and others interested in the subjects under consideration. Governor Thomas E. Campbell of Arizona acted as chairman throughout the sessions.

The outstanding features of the meeting were the addresses of Arthur P. Davis, Director of the U. S. Reclamation Service, Ex-Gov. E. M. Ammons of Colorado, and Frank C. Emerson, State Engineer of Wyoming. Mr. Davis spoke particularly of the problems involved, irrigation possibilities, power development and flood regulation. He stated it to be his opinion, based on a study of the Colorado River covering some thirty years, that, generally speaking, there need be no apprehension as to restriction of development along any lines, either in the headwaters or in the lower valleys, provided that the main regulating reservoir is located in the lower part of the basin, since the water supply, adequately regulated, would be sufficient for the needs of all. He also said that the investigations at Boulder dam-site, mentioned in the article to which reference has been made, were by no means complete and it was impossible as yet to say whether this was the best site or not, or whether it was even feasible, but that sufficient investigation should be made to demonstrate what was really the best plan to be followed. It was shown that it was possible to irrigate several millions of acres in addition to what is now irrigated, and at the same time furnish the necessary protection from floods to the Imperial Valley, while in no way impeding development to the greatest practicable extent of the power possibilities on the

headwaters, amounting to millions of electrical horsepower. An especially important point brought out later in discussions was that interstate litigation was more likely to result without than with such regulation. Former Governor Ammons and State Engineer Emerson agreed with Mr. Davis as to the importance of regulation and the protection of the Imperial Valley but urged that every precaution be taken against the possibility of interfering in any way with the work of developing the resources higher up on the streams.

In general the discussions were marked by a spirit of harmony and the resolutions presented by the Resolutions Committee were passed without a dissenting voice. These resolutions favored in brief: (1) The policies set forth in previous meetings of the League. (2) Full development of the resources of the Colorado River Basin, in view of the statements made by Director Davis, due care being taken that no storage project on the lower stream should be permitted to jeopardize those on the tributaries. (3) The formation of a Colorado River Engineering Commission made up of the state engineers, or officers having equivalent positions, of the seven states immediately affected, and the Director and Chief Engineer of the Reclamation Service, this Commission to meet from time to time to consider the engineering problems presented. (4) Appropriation by Congress of the funds estimated by the Reclamation Service as necessary to make investigations sufficiently complete to warrant arrival at definite conclusions.

A report of the Ways and Means Committee was also made and approved, the most important feature of which was the acceptance of offices for headquarters in the Capitol of Arizona at Phoenix and the selection of Sims Ely, secretary, Resources Board, as executive secretary of the League.

The meeting adjourned, subject to call at a time and place to be determined by the executive committee.

Public Roads Head Sees Danger in Federal Appropriation Lapse

Unless Federal action is taken during the current fiscal year concerning Federal aid in road building, the resulting uncertainty as to the future of this work will seriously handicap the states and cause the entire road-building program to suffer a serious setback, according to Thomas H. MacDonald, chief of the Bureau of Public Roads. In discussing the need of Federal action this year, Mr. MacDonald points out that the last installments of Federal aid funds—$100,000,000—became available July 1, 1920. When to this is added at least an equal amount of state funds, as required by law if states are to secure Federal aid, funds will be available sufficient to carry the road construction program forward for the current year. But Mr. MacDonald points out that the states should know at least a year in advance what funds are to be available in order that plans can be made for future construction.

Since, in the past five years, highway departments have accustomed themselves to planning and executing extensive programs, partly through availability of Federal funds, a lapse in Federal appropriations might result seriously, is Mr. MacDonald's view.

Technical Institute To Be Founded by Ford Company

An educational department is to be established by the Ford Motor Co., to be known as the Ford Technical Institute, with university rank, to grant degrees in mechanical, electrical, and chemical engineering, according to announcement made in Detroit, Aug. 26.

It is planned to make complete courses available to the more than 75,000 employees of the Ford company without charge. An academic department will be established and complete laboratories will be provided, according to the announcement.

Rail Executives Ask Additional Construction Funds

Additional funds for construction are included in the revised and final report of the Association of Railway Executives to the Interstate Commerce Commission embracing recommendations as to the apportionment of the $300,000,000 revolving fund established by the Transportation Act to aid in the rehabilitation of the railroads.

New recommendations make provision for the following work:

Baltimore & Ohio Co., additional main tracks, yard tracks, sidings, interlockers, telephone train dispatching, shop machinery, bridges, trestles, culverts, heavier rail, $5,000,000.

Boston & Maine, retaining walls and riprapping, renewal of bridges, automatic signals, extensions to sidings, interlockers, improved water supply, engine house and yard facilities, $2,188,564.

Chicago & Eastern Illinois, shop machinery, improvements to trestles, $502,060.

Chicago Junction Railway, yards and car shop, $1,100,000.

Chicago, Milwaukee & St. Paul, ballast, rail, bridges, yard tracks and sidings, fuel stations, water stations, shop buildings, shop machinery and tools, track elevations, $4,940,000.

Chicago, Rock Island & Pacific Railway, additional yard tracks and sidings, shop machinery and tools, ballast, bank widening rails, bridges, $5,000,000.

Missouri Pacific Railroad, rails, bridges, trestles, additional yard tracks, signals and interlockers, telegraph and telephone lines, fuel and water stations, shop buildings, engine houses, shop machinery, tools, wharves, and docks $2,843,179.

New York Central Lines — Allocated as follows: New York Central (including Boston and Albany) Railroad, $12.101.928. Engine terminals and facilities, freight yards and yard facilities, sidings and extensions, interlockers, shop machinery and miscellaneous betterments, $5,500,000.

Cleveland, Cincinnati, Chicago and St. Louis, double tracking, passing and storage tracks, shop tools, machinery and signals, $4,560,101.

These, and other minor projects, increase the total outlay from the revolving fund for construction purposes from $35,050,289 to $78,349,289. The preliminary report of the Association of Railway Executives was submitted to the Interstate Commerce Commission June 26.

Engineering Foundation Solicits Gifts

A general appeal for donations is being issued by the Engineering Foundation with a view to increasing its fund for the support of research in science and engineering. At present the Foundation has a fund of $300,000, with assurance of $250,000 more. However, it wishes to increase this fund to at least $1,000,000. The appeal says, "The first million should be rounded out this year and other millions should follow."

The United Engineering Society is the custodian of the principal of the Foundation endowment, but the income is administered by the Foundation itself. Charles F. Rand, chairman of the Foundation, states that gifts of $1,000 or more are desired, and that each person giving $250,000 or more will be honored as a Founder.

Work done by the Foundation up to the present includes initiating and investigation of fatigue phenomena of metals (now in progress), financing a hydraulic research for the development of an improved type of measuring weir, participating in a study of spray camouflage of ships, supporting a study of mental hygiene of industry, and supporting a research into the wear of gears.

Notes from the Corps of Engineers

Col. Spencer Crosby, in addition to his duties as division engineer of the southeastern division, will take over temporarily the work of the Jacksonville district.

Col. Edward H. Schulz, who has been in charge of the Milwaukee district, has been ordered to take over the Seattle district.

Lt.-Col. J. A. Woodruff, who has been in charge of the Seattle district, has been ordered to Camp Humphreys for duty at the Engineer School.

Col. Lytle Brown, now at Florence, Ala., has been ordered to Camp Travis, Tex., to take command of the second engineers. In order to comply with the provisions of the Army Reorganization Act that officers must have at least one year out of five with troops, many of the more experienced officers of the Corps of Engineers are being assigned to commands at camps. This is having the effect of adding materially to the dearth of engineer officers. The extent of this situation may be judged by a concrete instance. Col. Fred W. Alstaetter, in charge of the Savannah district, was retired last week on account of physical disability, but it was necessary to call him to active duty the following day because there was no officer to put in his place.

With the abolition of the old military departments and the substitution of "corps areas," the title of department engineer is dropped and the engineer officer in the same relative position now will be known as "corps area engineer."

Charles Whiting Baker to Develop New Field

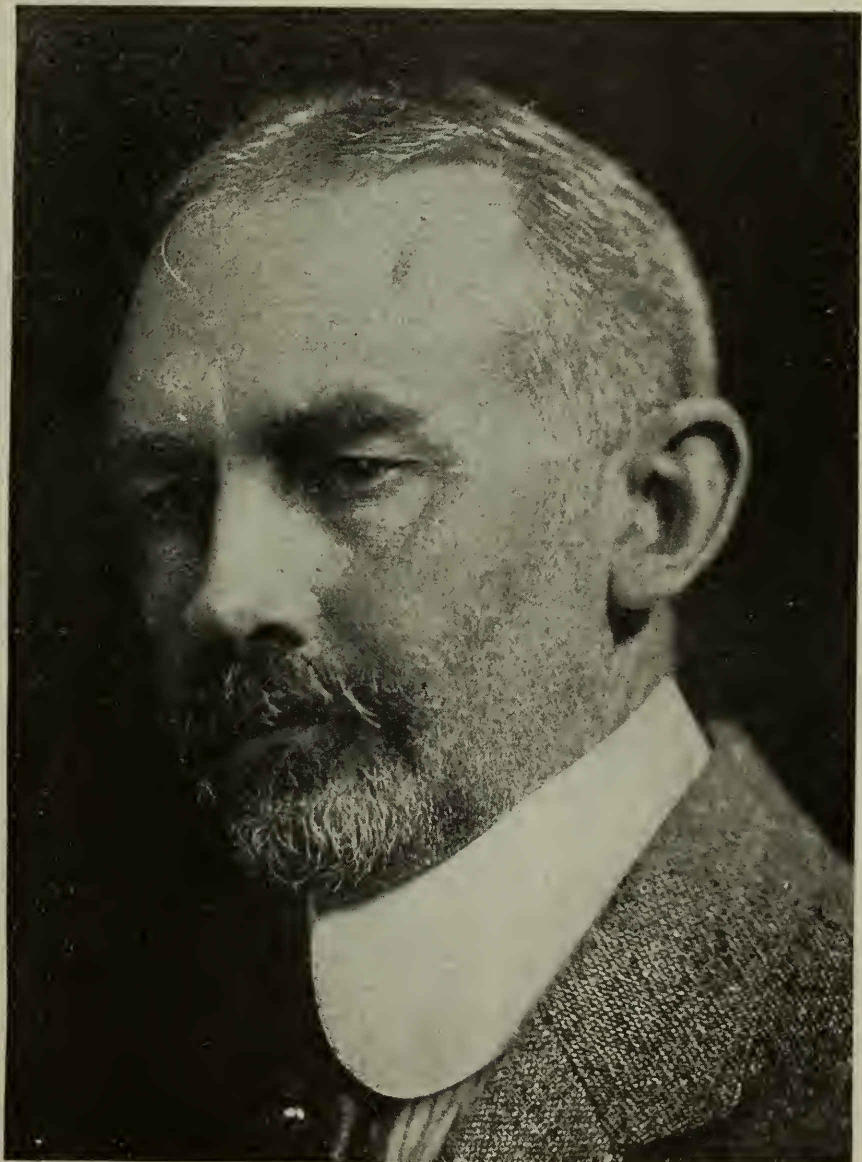
Leaves Editorial Desk After Brilliant Journalistic Career—Will Direct Engineering Business Exchange

Charles Whiting Baker, Consulting Editor of *Engineering News-Record* retires from technical journalism on Sept. 1, 1920, to take up the development of a new engineering service. This step brings to a close a notable career as editor and engineering writer. Mr. Baker has been identified with the field he now leaves during substantially his entire technical career, and since succeeding Arthur M. Wellington as editor of *Engineering News* in 1895 he has been known throughout the technical world as a leader in engineering thought. The thorough knowledge of professional work and the wide personal acquaintance with engineers acquired in the course of his editorial career promise to find effective application in the new field of labor he enters, development of the Engineering Business Exchange.

Outlining the work of the new service, of which he becomes Managing Director, Mr. Baker states that under present conditions many a professional or industrial business in the engineering field becomes unprofitable or is sold at a loss of value because means are wanting for finding the right man to take it over and build it up to large success. On the other hand, men able to carry responsibility in the ownership or direction of an engineering business continue to work in subordinate capacity in an organization holding little promise for them. It is to establish an agency through which the two classes of parties can come together under full assurance of competent guardianship of their several interests that the Engineering Business Exchange has been organized.

"C. W.," as he is familiarly known among his colleagues of the fountain pen and the copy basket, has been connected throughout his editorial career with *Engineering News-Record* and its predecessor, *Engineering News*. His inborn instincts for journalism drew him into the work almost immediately at the end of his college period. It was his writing of a number of technical articles for *Engineering News* while studying at the University of Vermont that induced the late George H. Frost, its publisher, to offer him a position on the editorial staff immediately after his graduation in 1886. Instead of accepting this position, however, he went to the Baldwin Locomotive Works, but within a year, Mr. Frost's offer being repeated, he accepted it and became assistant to the noted Arthur Mellen Wellington, who had assumed the editorship of the paper a short time before.

Matching the restless activity of his chief with his own high-pressure style of working, "C. W." rapidly made himself an integral part of the *News* machine, so that it was a logical happening when upon Mr. Wellington's death eight years later the youthful assistant was called to succeed him. Together with D. McN. Stauffer, Frederic P. Burt, M. N. Baker, and a group of junior colleagues, he continued the development of the paper initiated by Wellington. In 1911, when Mr. Frost, wishing to retire, transferred his journal to John A. Hill, Mr. Baker performed in remarkably short time the difficult task of transforming *Engineering News* so as to adapt it to the specialized requirements of the new group of technical journals which the paper had joined in the Hill Publishing Co. Five years later, when the Hill company and the McGraw Publishing Co. joined hands, Mr. Baker's long services were recognized by his promotion to the post of Consulting Editor to the new consolidated journal, *Engineering News-Record*. His elaborate special studies carried out in this connection have become widely known. The most recent are "The Railway Problem" and "What Is the Future of Inland Water Transportation?"



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CHARLES WHITING BAKER

Although the absorbing character of the editorial vocation gives little time for other writing, Mr. Baker finds leisure for occasional literary and philosophic work. He is the author of a thoughtful study of one of the great economic problems of the country, published under the title "Monopolies and the People." In addition, he is also distinguished as an inventor, having devised and patented at different times a new steam separator, a steel wheelway for city streets, a new light railway system (the "Economic Railway"), and an improved oil engine. He has held a number of offices of public trust, and since 1913 has been a member of the Palisades Interstate Park Commission of New York and New Jersey. His election to the vice-presidency of the American Society of Mechanical Engineers, 1909-1911, was an incidental tribute to his long-continued work for the improvement of technical societies.

Report of Federal Electric Railway Commission

Restore Credit, Dewater Stock, Lift Pavement Burdens, Meet Extension Costs by Assessments

Acting on suggestions made by the Secretaries of Commerce and Labor, President Wilson appointed a Federal Electric Railway Commission on May 31, 1919, to investigate the street railway situation. The Commission, as suggested to the president, was composed of eight representatives of different organizations. The men chosen by the President, together with the organizations, were as follows:

Charles E. Elmquist, president and general solicitor of the National Association of Railway & Utilities Commissioners.

Edwin F. Sweet, Assistant Secretary of Commerce, representing the Department of Commerce.

Philip R. Gadsdon, representing the American Electric Railway Association.

Royal Meeker, Commissioner of Labor Statistics, Department of Labor, representing that Department.

Louis B. Wehle, general counsel of the War Finance Corporation, representing the Treasury Department.

Charles W. Beall, of Harris, Forbes & Company, New York, bankers, representing the Investment Bankers' Association of America.

William D. Mahon, president of Amalgamated Association of Street & Electric Railway Employees of America, representing that association.

George L. Baker, Mayor of Portland, Oregon, representing the American Cities' League of Mayors.

The report of the Commission, submitted July 28, and made public late in August is published in full in the *Electric Railway Journal* of Aug. 28. The conclusion and recommendations of the report follow:

1. The electric railway furnishing transportation upon rails is an essential public utility, and should have the sympathetic understanding and co-operation of the public if it is to continue to perform a useful public service.
2. The electric railway has been, and will continue to be, a public utility, subject to public control as to the extent and character of the service it renders, and as to the rates it charges for such service.
3. It is of the highest importance that both the total cost of the service and the cost to the individuals who use it shall be kept as low as possible without injustice to those who take part in producing it.
4. The electric railway industry as it now exists, is without financial credit, and is not properly performing its public function.
5. This condition is the result of early financial mismanagement and economic causes, accentuated by existing high price levels of labor and materials, and of the failure of the uniform unit fare of five cents, prescribed either by statute or by local franchise ordinances or contracts to provide the necessary revenues to pay operating costs and to maintain the property upon a reasonable basis.
6. The industry can be restored to a normal basis only by the introduction of economies in operation, improving its tracks, equipment and service, and securing a reasonable return upon the fair value of its property used in the public service when honestly and efficiently managed.
7. The electric railways must expand to meet the growing needs of their communities; therefore, the first essential is to restore credit in order to obtain necessary new capital for the extension and improvement of service.
8. Restoration of credit involves a readjustment of relations which will remove public antagonism, provide public co-operation, and insure to the investor the integrity of his investment and a fair rate of return thereon.
9. Effective public co-operation should be exercised by eliminating, in so far as it is practicable, special assessments for sprinkling, paving, and for the construction and maintenance of bridges which are used by the public for highway purposes.
10. Extensions into new territory resulting in special benefits to the property in that vicinity should be paid for by assessments on such property in proportion to the benefits received, and that the amount of such assessments should not be added to the physical value of the corporate property.
11. The great increase in the use of private automobiles, the jitney and motor buses, has introduced a serious, although not a fatal, competition to the electric railway. These forms of public motor conveyance when operated as public carriers, should properly be subject to equivalent regulatory provisions.
12. The full co-operation of labor is essential to the highest prosperity and the usefulness of the industry. The employees engaged in this occupation should have a living wage and humane hours of labor and working conditions. They should have the right to deal collectively with their employers, through committees or representatives of their own selection. All labor disputes should be settled voluntarily or by arbitration, and the award of such a board should be final and binding upon both parties. It is intolerable that the transportation service of a city should be subject to occasional paralysis, whether by strikes or by lockouts.
13. A private industry should not be subsidized by public funds, unless it is imperatively necessary for the preservation of an essential service, and then only as an emergency measure.
14. Unless the usefulness of the electric railways is to be sacrificed, public control must be flexible enough to enable them to secure sufficient revenues to pay the entire cost of the service rendered, including the necessary cost of both capital and labor.
15. There can be no satisfactory solution of the electric railway problem which does not include the fair valuation of the property employed in the public service, and where that is done, the companies should voluntarily reduce any excessive capitalization to the basis of such value.
16. There is no insuperable objection to a large, wideawake city having exclusive jurisdiction over the rates and services of public utilities.
17. The necessity for scientific and successful regulation of systems, whether large or small, and especially those which operate through several cities and villages and in rural territory, leads to the conclusion that local regulation should generally be subject to the superior authority of the State, whether as a matter of original jurisdiction or through the medium of appeal.
18. Cost-of-service contracts are in the experimental stage, but where tried, they seem to have secured a fair return upon capital, established credit, and effected reasonably satisfactory public service. Such contracts may safely be entered into where the public right eventually to acquire the property is safeguarded.
19. The right of the public to own and operate public utilities should be recognized, and legal obstacles in the way of its exercise should be removed.
20. While eventually it might become expedient for the public to own and operate electric railways, there is nothing in the experience thus far obtained in this country which will justify the assertion that it will result in better or cheaper service than privately operated utilities could afford if properly regulated.
21. Public ownership and operation of local transportation systems, whether or not it be considered ultimately desirable, is now, because of constitutional and statutory prohibitions, financial and legal obstacles, the present degree of responsibility of our local governments, and the state of public opinion, practicable in so few instances, that private ownership and operation must as a general rule be continued for an extended period.
22. If the reforms incident to public regulation which we suggest in this report should not result in making private ownership satisfactory to the public, such reforms should at least enable public ownership to be established upon a just and equitable basis.

Publicity Contest of A. A. E. Started Sept. 1.

The 1921 publicity contest of the American Association of Engineers during the period Sept. 1, 1920, to March 1, 1921, will duplicate the one held last year. The grand prize is a silver cup for the greatest number of column-inches of local newspaper publicity. The competition between chapters is divided into five divisions based on the population of the city in which the chapter is located. The five chapters winning division prizes (framed certificates of award) will compete for the grand prize on the basis of quality of publicity.

Move Started To Better Car Service in the West

Circular letters have been issued from the office of the General Manager of the Associated General Contractors of America inviting contractors, whether members of the association or not, to submit facts regarding their transportation needs. The circular letter requests specific notes upon the following points: Point of shipment, railroad over which material is to be shipped, point of delivery, type of car required, number of cars needed per day and total number of cars needed. Any additional information the contractor may wish to give may be included in the reply.

These circular letters are issued for the purpose of providing information to the various special car service committees consisting of representatives of the railroads and representatives of the leading contractors, manufacturers and dealers, recently formed to improve car service for construction interests in the territories served by the main railroad lines East of the Mississippi River. Inasmuch as Transportation Order 7, as modified by Order 9, granting priority to coal shipments, has been extended another thirty days to September 18 by the Interstate Commerce Commission, all co-operation possible is deemed necessary between railroad representatives and those of the construction industry to secure movement of construction materials.

Road Material Situation Becomes Worse in West

While transportation conditions, as affecting road materials, have improved east of the Mississippi River, the situation in the West has become so acute that the Bureau of Public Roads recently sent engineers to St. Louis to confer with representatives of the western carriers. So many open-top cars have been drawn east of the Mississippi that the shortage in the West is reported to have assumed as serious proportions as had been experienced in the East. Steps were taken looking to the return of cars and to provide for greater efficiency in the use of such cars as remained in the hands of western lines.

Devil's Gate Dam Undergoes Successful "Christening"

The highway over the Devil's Gate Dam, construction of which was described in *Engineering News-Record*, July 29, p. 202, was open to the public on Aug. 18. An engineer among the

crowd which attended the ceremonies states that "some 50 watermelons were broken on the bow by Little Miss Bent Brothers. It was one of the most successful christenings I ever saw."

Large Damage in Bridge Floor Fire Quickly Repaired

On Aug. 22 fire started in the wooden flooring of the vehicle roadway over the Victoria Bridge over the St. Lawrence River at Montreal, and the larger part of the decking on 14 spans was destroyed. To provide for vehicle traffic a temporary ferry service was established. The Grand Trunk Ry. officials started repairs at once and brought their full resources of material and labor supply to bear on the job. Late on Aug. 26 the roadway was again ready for traffic. The loss caused by the fire was appraised at about $300,000, most of which was in floor lumber, though some steel stringers also were damaged by the heat and had to be replaced.

Fall Meeting of The American Chemical Society

The general sessions of the Reconstruction Meeting of the American Chemical Society, which will be held in Chicago, Sept. 6 to 9, will include addresses by Thomas E. Wilson, president of Wilson & Co., Chicago, on "The Value of Technical Training in the Reconstruction of Industries," and by Prof. H. P. Talbot on "Relation of Educational Institutions to the Industries." The Division of Water, Sewage and Sanitation of the society also includes four articles as follows: A. S. Behrman, "Water Softening for the Manufacture of Raw Water Ice"; H. E. Jordan, "Specifications for Glass Ware for Water Works Laboratories"; W. D. Collins, "Hardness of Surface Waters in the United States," and Edward Bartow, "The New Sewage Testing Station of the Illinois State Water Survey Division. A fuels symposium, under the chairmanship of A. C. Fieldner, supervising chemist, Bureau of Mines, includes 12 papers on various phases of fuel supply, carbonization of coal, city gas supply and fuel conservation.

The headquarters of the society will be the Congress Hotel, Chicago.

A. A. E. Admits Founder Society Members Without References

The national executive committee of the American Association of Engineers has voted that applicants for membership who are members of one of the four national technical societies need not furnish five references as heretofore required. The action was taken as one means of reducing the duplication of society effort and on the request for such action by members of the technical societies who felt that further investigation of their records already on file was unnecessary.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston; Holyoke, Mass., Sept. 7-10.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Sept. 13-17.

SOUTHWEST WATER WORKS ASSOCIATION, Waco, Tex.; New Orleans, La., Sept, 20-23.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA, Sterling, Ill.; St. Louis, Sept. 21-23.

AMERICAN ASSOCIATION OF PORT AUTHORITIES, Montreal; Chicago, Sept. 30-Oct. 2.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Valparaiso, Ind.; St. Louis, Oct. 10-15.

The Colorado Society of Engineers will hold a convention Sept. 9, 10 and 11 coincident with meetings of the American Institute of Mining Engineers, the American Mining Congress, the International First Aid and Mine Rescue Meet and possibly other mining societies.

The San Francisco Section of Members, Am. Soc. C. E., at its bimonthly meeting, on Aug. 17, listened to a paper on "River and Harbor Improvements on the Pacific Coast" by Col. E. Eveleth Winslow, Corps of Engineers, U. S. A.

The Western States Reclamation Association held a convention at Boise, Idaho, Aug. 20-21, at which the speakers outlined the work the association had before it in putting through a program which will irrigate millions of acres of arid Western lands. Committees were appointed on finance, publicity and legislation. Plans for bringing the attention of Congress to the need of reclamation also were prepared. Most of the Western states were represented by their governors or accredited representatives.

The Southern California Section of Members, Am. Soc. C. E., at its meeting in Los Angeles, Aug. 2, was addressed by President Arthur P. Davis, who spoke on the work of the Committee on Development and the Joint Conference Committee and outlined the work of the American Society of Civil Engineers coming under his knowledge during his 28 years of membership. He pointed out "Service with Co-operation" as the proper keynote for the proposed Federation of American Engineering Societies. Mr. Hawgood reported on the progress of the Joint Committee's work on the constitution of the proposed State Engineering Council.

The Colorado Section of Members, Am. Soc. C. E. met, Aug. 26, at an informal dinner in Denver in honor of the president of the society, Arthur P. Davis, director of the U. S. Reclamation Service. An interesting feature was the presence, through general invitation, of members of the other Founder Societies and also of the American Association of Engineers and the Colorado Society of Engineers. President Davis forcefully presented the claims of the engineering profession to proper public recognition and urged upon all engineers the adoption of the principles of progressivism and co-operation. He especially advocated united action by all engineering societies; and in particular urged upon the members of the American Society of Civil Engineers that the strongest possible vote be cast in favor of the society's becoming one of the charter members of the recently organized Federated American Engineering Societies.

The North Carolina Society of Engineers, at its annual convention, held at Asheville, N. C., Aug. 12-14, appointed a special committee, composed of Charles E. Waddell, chairman, Asheville; H. W. Kueffner, city engineer of Durham; Curtis A. Mees, consulting engineer, Charlotte; Major E. W. Myers, hydraulic engineer, Greensboro; and Dr. W. C. Riddick, head of the state society and president of the A. & E. College, to draft a law making obligatory the licensing by the state of engineers and land surveyors, for presentation to the legislature. Announcement was made that the election of officers will take place at the meeting of the society at Raleigh next January. Plans were made, also, to redraft the constitution of the society so that it may be affiliated with the American Association of Engineers. The Thursday night gathering was featured by the presentation of a charter to the Asheville Chapter of the American Association of Engineers by Wythe M. Peyton, president of the newly formed chapter. The last day of the convention was given over to the entertainment of the guests, who were taken through the Biltmore estate and the Government Oteen Hospital.

Personal Notes

J. W. Beardsley, of Rochester, N. Y., has been selected as the engineer member of a road commission of five members, appointed by the Panamian Government, which will have charge of a comprehensive road construction program to begin immediately. The work will cost about $7,000,000 and will require five years or more for completion.

Thomas H. Healy, until recently in the employ of the Philadelphia & Reading Railway Co., as roadway assistant engineer in its valuation department, in which capacity he had charge of roadway, and also the bridge and building inventory parties working

in conjunction with the Interstate Commerce Commission's field parties, is now in the service of New York Central Lines West, with the title of assistant engineer, compiling the reports required under Valuation Order No. 3. He has been assigned to the office of the division engineer of the Michigan division, with headquarters at Toledo.

W. H. RILEY, formerly in the drafting department of the American Bridge Co., Gary, Ind., is now in charge of the drafting department of the home office of W. Austin Smith, consulting engineer, at Huntington, W. Va. Mr. Smith is conducting a general municipal engineering practice covering parts of West Virginia, Kentucky and Ohio. The home office makes the general and detailed plans and all standard plans from data sent in from the field offices.

COL. ROBERT ISHAM RANDOLPH, secretary of Isham Randolph & Co., Chicago, is Republican candidate for trustee of the sanitary district of Chicago. Col. Randolph has been secretary of the Internal Improvement Commission of Illinois and of the Rivers and Lakes Commission of Illinois. During the war, as colonel, he organized the 535th Engineers at Camp Lee, took that regiment to France and served in the San Mihiel sector with the Second Army, A. E. F.

BRIG.-GEN. HENRY JERVEY has been assigned as director of the Operations Division of the General Staff of the War Department. Prior to his assignment to General Staff duties, General Jervey served in the Corps of Engineers.

KARL RIDDLE has resigned as resident engineer on a Federal Aid road project in Dickinson County, Kan., to accept a position as city manager of South Palm Beach, Fla. He has for several years been engineer of Dickinson County and city engineer of Abilene, Kan. He is a member of the firm of Riddle & Riddle, consulting engineers.

HARLAND BARTHOLOMEW announces the opening of new offices in the Compton Building, St. Louis, Mo., for professional practice in city planning and allied subjects. Mr. Bartholomew and his staff will give special attention to the preparation of city plans, zoning ordinances, park and playground designs, to land subdivision and special landscape problems. In addition to his new interest, Mr. Bartholomew will continue to serve as engineer to the City Plan Commission of St. Louis.

CAPT. H. M. GLEASON, Construction Corps, U. S. Navy, stationed at Mare Island Navy Yard, has resigned to accept the position of assistant to the president of the Chase Co., of Waterbury, Conn. Capt. Gleason entered the U. S. Naval Academy in 1895 and has served in the Navy ever since. He has been in charge of naval construction at Mare Island since Dec. 1, 1910, and during that period had immediate charge of the construction of 22 naval vessels and numerous smaller craft. Some of the ships constructed in this time are the battleship "California," the destroyer "Ward," with a world's record of 17½ days from the laying of keel to launching, and the electrically-driven fleet collier "Jupiter."

T. C. MORRIS has resigned as resident engineer, building division, Panama Canal, and is now associated with Lockwood, Greene & Co., as engineer in the Detroit office.

S. M. SMITH, recently principal assistant engineer of the Wabash Railway Co., has been appointed resident bridge engineer with the same company on the reconstruction of its draw span across the Rouge River at Detroit, Mich.

CHARLES WARREN HUNT became secretary emeritus of the American Society of Civil Engineers on July 28.

MAJOR W. J. POWELL has resigned as engineer of Dallas County, Texas.

FRED C. DUNLAP, chief of the Bureau of Highways, Philadelphia, has been placed in charge also of the city's street cleaning bureau, relieving John H. Neeson, assistant chief engineer of the Highway Bureau, who has been acting chief of the street cleaning bureau since the resignation of Lt.-Col. Earl B. Morden.

CAPT. A. H. SJOVALL, formerly in charge of engineering work at Camp Devens, has been made assistant city engineer of New Britain, Conn.

OBITUARY

PAUL B. REGNIER, engineer for the California State Highway Commission and sergeant in the 91st Division during the war, was drowned near Dunsmuir, Cal., Aug. 9.

WILLIAM W. FELLOWS, for many years chief engineer of the Bangor, Me., water-works, and member of the water board of that city, died Aug. 8 in that city. He was born in Bangor, Sept. 6, 1835. When the city water-works were built, in 1874, he assisted in the installation of the machinery, and was later made chief engineer. After concluding his active connection with the water-works, he was elected a member of the water board, serving from 1904 to 1907.

JOHN PERRY, emeritus professor of mechanics and mathematics at the Royal College of Science, South Kensington, England, died Aug. 4. He was born in Ulster, Feb. 14, 1850, and received his education at Queens College, Belfast. Professor Perry began his educational career as assistant master at Clifton College, followed by several years' residence in Japan as a professor of engineering, and was professor of engineering and mathematics at the City and Guilds of London Technical College, Finsbury, from 1881 to 1896. He was also a past-president of the Institution of Electrical Engineers and of the Physical Society of London. Professor Perry was noted for his radicalism in practicing and demanding the application of direct teaching, especially in physical science and mathematics. Some of the books of which he was author are "The Steam Engine," "Practical Mechanics," "Spinning Tops," "Cantor Lectures," Hydraulics," "Calculus," "Applied Mechanics," "Steam," "Practical Mathematics," and "England's Neglect of Science."

JOHN GEORGE LEYNER, of Denver, was killed in an automobile accident near that city, Aug. 5. Mr. Leyner was a pioneer in rock drilling and mining appliances. Through his inventions the rock drill passed from the percussive stage, involving machinery of heavy weights, to the hammer stage, where the rock drill has become a thing but little larger than a pneumatic tool. In 1902 he incorporated the Leyner Engineering Works and built shops at Littleton, Col. His patents and inventions were taken over, in 1911, by the Ingersoll-Rand Co., the works transferred to Phillipsburg, and the Leyner-Ingersoll type of drill was from that time a standard. Mr. Leyner's other inventions include the drill sharpener, now widely used throughout the world. It has been estimated that this sharpener is used for sharpening about 90 per cent of all the machine-sharpened steel in the world. He also invented the "Little Tugger" hoist used in mines and ship yards. He built the original machines used for producing shredded wheat, and his latest invention was the "Linapede" or Leyner farm tractor, on which he was engaged at the time of his death. Mr. Leyner was born in Boulder County, Col., in 1860.

BUSINESS NOTES

JULIUS JANES, formerly president of the Standard Steel Castings Co., Cleveland, has recently concluded an arrangement with the Farrell-Cheek Steel Foundry Co., Sandusky, Ohio, by which he will be the sales representative of that organization in Cleveland and Cuyahoga County, Ohio.

DOW & SMITH, chemical engineers and paving consultants, New York City, announce the opening of a branch office at Columbia, S. C., in charge of T. Keith Legaré, district engineer. Mr. Legaré was formerly connected with the city engineering department of Columbia for 11 years.

A. B. WAY, recently secretary and general manager of the Bridgeport Chain Co., has become affiliated with the Chain Products Co., Cleveland, as district sales manager for New England, with headquarters at the company's New York office.

A Consolidation of Engineering News and Engineering Record | McGraw-Hill Company, Inc.—JAMES H. MCGRAW, *President*

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

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Competition for Jobs

IS LABOR shortage coming to an end? The question is suggested by the recruiting of 3,000 men from other towns to run the cars and trains of the Brooklyn (N. Y.) Rapid Transit Company, whose employees are on strike. A year ago such a force could not have been recruited except at wages that no manager of a property would have dared to pay. He would have had to bid for men already employed. The recruits now are men out of work; factory hands mostly, coming from plants which have shut down. No one enjoys the prospect of seeing men out of work, but unemployment seems to be the necessary remedy for the present situation. Unlimited power always leads to excesses. Labor has had it in recent years, and there has come the crying abuse of loafing, of lowered production. With decrease in demand for workers that unlimited power will be lost. Competition for worth-while places will bring workmen to their senses and we shall get on an upward course again. The Brooklyn experience indicates that the remedial process is beginning.

Program for Railroad Efficiency

FOLLOWING charges recently made before the Senate Reconstruction Committee that the railroads were chiefly to blame for the housing shortage as a result of embargoes against building materials, the construction industry as a whole will take a lively interest in the ambitious program of the Association of Railway Executives for greatly increasing railroad operating efficiency. The operators frankly recognize that shortage of equipment cannot be made up for so long a time that relief must be sought in the more effective use of existing cars. To this end a program has been launched to bring daily freight car movement up to 30 miles and the loading up to thirty tons, with reduction of bad-order equipment to a minimum. The importance of this program may be realized from the fact that if its aims were attained there would result an increase of more than forty per cent in the carrying capacity of our railroads. To this end the railroad managers are seeking the co-operation of shippers and consignees and their efforts appear to be meeting with response. We believe that the seriousness with which the leading railroad operators of the country have undertaken this program is significant not only because of the possible results but because it is expressive of the conviction that private operation is on trial for its life and that the question of outright Government ownership is by no means dead. Such sentiment may have served as a background for the unprecedented request of railroad interests, recently made to the Interstate Commerce Commission, for a reduction of shipping rates on the Lakes as a means of diverting rail traffic to the waterways. There appears no doubt that railroad managers are making a supreme effort to give something that approaches adequate service, even with the shortage of available facilities.

Lack of Co-Ordination in Civil Engineers' Amendments

AS POINTED out and emphasized at the meeting of the American Society of Civil Engineers in New York last week, the amendments to the constitution sent to letter ballot by order of the Portland convention were not studied with reference to the constitution as a whole. If adopted, at least one other amendment to the constitution will have to be made, another section will need reconsideration, while the status of certain nominees for office becomes, so some believe at least, debatable.

The clause requiring that 25 votes must be cast in the board of direction to constitute an election to membership in the society must be changed if there are to be only 24 members of the board, as one of the amendments provides.

The provision that three members of the finance committee and two members of the library and of the publication committee shall be from District 1 will need to be reconsidered. Otherwise two of the New York directors, under the amended constitution, would be on all three committees and the other one on two—rather a heavy assignment. Against a change of this provision is the solid argument that for effectiveness committees should have strong representation in the headquarters' city.

The alleged debatable question will arise over the status of the two nominees recently named, but not announced, for New York directorships. If the amendments carry, they become effective Nov. 6. The offices for which these nominees are named would, accordingly, be abolished upon the expiration of the terms of the present incumbents.

Should the names of these nominees be put on the ballot, nevertheless? If so put, what would be their status if votes were cast for them? Obviously, a man cannot be elected to an office that does not exist, and votes cast for the placeless ones could hardly be construed as resurrecting the abolished directorships.

At the New York meeting much was made of this possible confusion and of the lack of agreement between the possible future number of directors and the number of votes required to elect to membership. The failure to co-ordinate the proposed amendments with the existing constitution is, of course, regrettable and an evidence of lack of that care which the changing of so important a document merits, but the speakers at New York overdrew, we believe, the seriousness of the situation.

An amendment regarding the number of votes required for election to membership could be adopted by March. The status of the New York nominees may

furnish the basis for debate if one wants to split hairs, but the fundamental principle appears to be clear. The heavy committee assignments of New York directors need not be considered as a serious element affecting the disposal of the amendments.

Some of the other argument advanced at the New York meeting is worthy of far more serious consideration than these regrettable lapses in co-ordination.

At the End of the Controversy

FOR two years the American Society of Civil Engineers has been a battleground of reorganization. The fight has waxed hot and, at times, acrimonius. As a result of the discussions, the society has arrived at the point of decision. There has been crystallization in two chief directions—toward a strengthening of the local sections and a democratization through a new method of electing officers. A vote on the enabling amendments is being taken. During the same period the federation idea has grown strong, and the society very soon is to vote on that, too.

Certainly on the federation it will be the last word. If the amendments fail, the alternatives in the hands of a committee will have to be considered at the annual meeting. They have, however, the general purport of those now submitted to ballot.

No matter, then, what the result of the ballot on the amendments, we are measurably near the termination of the long-drawn-out discussions—for which, the *Engineering News-Record* feels sure, the membership will be duly thankful. We have been "fed up on" discussion, we are growing tired of controversy, we should like to get to work and direct our energy into productive technical lines. We have given much thought and time to machinery and methods; now we would like to make the machine run. Soon there will be a machine of some kind, and even those who will be disappointed will be called upon to get aboard and help. If we will devote in the next two years to earnest technical work as much time and energy as we have given to controversy the society will progress rapidly, no matter if the machine should lack perfection.

In expressing this desire for peace and whole-hearted co-operation between all parties, the *Engineering News-Record* believes it is expressing a view widely shared by the members. Conciliation and counsels of co-operation usually come after a controversy is entirely finished, but we believe that it is well to prepare for the event. While using the utmost efforts to present their respective sides during the month that remains for balloting, we believe that the society will be the gainer if every member resolves to himself that even if he is disappointed he will put himself whole-heartedly into the work of sending the American Society of Civil Engineers ahead at a good, safe speed. It is a great organization, one that every member is proud of. Despite what may have been said in the heat of controversy, every member realizes its institutional character, and is honestly desirous of making it greater. As to the means, there is disagreement. If, however, we stick to the principle of maintaining the society's prestige while bettering its work we shall be on safe and common ground.

For maximum effectiveness, every member needs to give the society his full support. We face, if you will, an era of reconstruction in the society itself. For two years we have given little thought to its technical work. It has a financial difficulty to solve. Its publication committee is asking for a study of the problem of the *Proceedings*. Special committee work is at a low ebb. Is there any doubt that the society right now needs the best thought and work of its entire membership?

In advance of the counting of the ballots it would be an act of loyalty that the society deserves to promise it, within one's own heart, unqualified support no matter what the result.

The Grand Central Terminal—A Great Civic Development

Due to the constantly increasing land value of railway passenger terminals in the larger cities, the intensive development or utilization of these areas is of growing importance in railway economics. The most striking example of such development is the Grand Central Terminal in New York City, treated elsewhere in this issue. The very high land values justified not only the fullest development of the terminal buildings for offices, but the utilization of areas over the tracks for building purposes. This, indeed, is an extreme case; the great expense of such treatment would be justified only at a few passenger terminals here and abroad.

The term "Grand Central" no longer designates a mere railroad station, but a large and impressive civic center. The story of its development in the last twenty years is a romance. Where there were formerly smoking tracks and four-story buildings, there are large handsome structures—office buildings, stores, hotels, apartments and clubs. The terminal area itself, because of its attractiveness, has become the heart of a still greater development, radiating from it in every direction. In fact, the whole surrounding neighborhood now goes by the name of the Grand Central District, and is one of the chief business centers of the metropolis. As a civic as well as a railroad-terminal development, it is unique and stands as a monument to the foresight and ability of the New York Central's officers.

Reference to the remarkable development of the Grand Central area prompts some thoughts on the economic use of railroad terminal property. The New York Central's solution has been eminently successful and points the direction for terminal studies in other cities where land values are high.

Apparently, though, there is a wide difference of opinion as to the desirability of high or low buildings over both passenger stations and freight houses. The European custom of building hotels as a part of the station has gained little headway here. In New York the headhouses of the two great terminals represent the low type, although that of the Grand Central is built to carry a high office building. Of two modern terminals in Chicago, one has a skyscraper office building, while the other has a low headhouse of greater architectural pretentions, with the railroad offices in a separate building. In the case of freight terminals, the upper floor of the freight house is sometimes used for temporary storage, but in many cases it would seem advantageous to cover the site with a tall building having upper floors for warehouse or other purposes. The freight house of a terminal now under construction in Chicago will be surmounted by the general offices of the railway company. Nowhere in this country have

large hotels in connection with railroad passenger terminals been developed as at New York. Beside those in the Grand Central area, the Pennsylvania Hotel, opposite the Pennsylvania Station, is on railroad property and is connected to the station.

The possibility of producing revenue necessarily depends on local conditions. In New York the tide of business uptown helped the Grand Central situation materially, though the attractiveness of the terminal area itself accelerated the general uptown movement. The electrification was another favoring factor—a *sine qua non* of the whole scheme. In other large cities electrification would change the character of the adjacent areas so much as to invite elaborate development. With steam operation a railroad passenger yard or even the approach to a terminal is anything but attractive for high-class buildings.

While an imposing low-headhouse terminal is an excellent city adornment, the inclination of railway operators, with land values climbing, must perforce be directed to the most economic use of the areas available. In such studies the Grand Central solution is full of suggestion.

A Field for Experiment

WHEN a loaded motor truck pounding along the road at 15 or 20 miles an hour strikes a country highway bridge and bumps violently over its uneven floor the effect on the bridge obviously exceeds that of the same truck at rest. Unfortunately we do not know what the excess may amount to, especially under the unfavorable combinations of rough pavement and jolting truck that sometimes occur. In the absence of experimental data, the builders of highway bridges generally content themselves with ignoring the effect, or at most, whether flat or graduated (one state highway department uses 30 per cent) of a fixed fraction of the impact ratio customary in railroad bridge design.

In a proposal that steps be taken to increase the safety of highway bridges, made in these columns two weeks ago, the impact effect was referred to, but without mention of the fact that the effect has not been measured and that therefore we know practically nothing about it. The subject not only possesses technical interest independent of the matter of settling on bridge-design loadings, but under present-day service conditions it constitutes a practical problem of immediate importance. It ranks among the leading questions for experimental investigation in the whole field of bridge engineering.

Bridge impact under railroad trains has been measured in several series of elaborate experiments. From these it is known that although a train rolls smoothly along on steel rails yet in its progress across a bridge it gives rise to very considerable stresses superadded to those produced by the mere weight effect of engine and cars. This added stress has been discussed extensively, and several elaborate formulas have been devised for computing its amount for the various members of both long and short spans. Extra metal is provided in all new railway bridges to resist the impact stress. But these data and practices plainly have no meaning for highway bridge design, and it is therefore only natural that, lacking the results of actual measurements, designers of highway bridges have little respect for impact formulas.

Beyond doubt impact effects occur in highway bridges just as frequently as in railway bridges. But if we do not know their amount we cannot provide for them. So long as they remain unprovided for, they necessarily infringe to an unknown degree on the safety margin of the structures; in other words, impact tends to bring our highway bridges nearer their breaking-down point.

It is not impossible, moreover, that measurement would show abnormally high impact in highway bridges under some conditions. According to current notions, derived from railroad bridge service, impact effects range between zero and 100 per cent; in other words, the effect of a moving load is generally much less than twice the static effect of the same load. But can we safely assume that this would be the case in highway bridge service? On a rough floor, especially the worn planking of a medium-span road bridge twenty-five or thirty years old, a heavy truck moving at high speed has every chance of delivering violent blows to the structure. Impact additions of quite excessive amounts, compared with present conceptions, might then be produced. This possibility is a strong argument for the proposal that experimental study of impacts be undertaken.

To summarize the case: It will not be possible to estimate the capacities of highway bridges satisfactorily, or to construct new bridges with due economy and efficiency, until the impact effects occurring under motor trucks at speed are measured. The importance of this problem, its difficulty and its cost, warrant the suggestion that the highway departments of a number of states join in undertaking the investigation; their combined resources, together with those of the Bureau of Public Roads at Washington, would enable the study to be taken up on a scale proportional to the task.

Plainly, such study must be directed first of all toward getting a practical estimate of commonly occuring impact values, in order that at least rough data for judging of the safety of bridges may be available. But the work is by no means ended here. As the next step it will be necessary to determine how impact varies with speed. Few if any data on this phase of the subject have been obtained in railway bridge experiments, and in any case the conditions are so different in highway service as to make the question a new one. Roughly, perhaps, an increase with the square of the speed is to be expected, in view of the direct blow and shock effect forming part of the live-load action on a highway bridge. Whether the existence of critical speeds, observed in railway bridge experiments, would complicate the problem is an open question; but if there is such a thing as critical speed in highway bridge service it is likely to be not a fixed quantity but a variable, depending on the particular vehicle and its path across the bridge.

Maximum impact effects doubtless occur in the floor members. Since the floors of old highway bridges are also the most seriously overstressed under static loading, the rapid growth of truck traffic in the absence of load and speed control makes impact a question of very immediate moment. It is certain that, to maintain old bridges in reasonably safe service, many floors must be reinforced in the near future. Only through measurement of impact effects will it be possible to execute this reinforcement in such a way as to provide adequately for the action of traffic loads.

Part I

Study and experiment applied to the hydraulic fill operations of the Miami Conservancy District have developed:

(1) A manganese steel centrifugal pump which, compared with cast iron, has doubled the output life of pump shells and increased nearly tenfold the output life of pump runners.

(2) A new design of pump shell in white iron that has exhibited a resistance to wear which indicates an output life of 400,000 cu. yd. of heavy gravel and sand fill, or about double the life of a manganese steel shell under the same conditions.

(3) A high carbon steel, welded dredge pipe which has an output of four times the yardage of ordinary riveted steel dredge pipe.

(4) A sump and pump layout which eliminates priming and has materially reduced the loss of head at the suction.

(5) A practicable self-cleaning grizzly for screening heavy pit run glacial drift.

(6) Electric signaling systems which provide the pump operator with accurate knowledge of the conditions of flow in the pipe-line system and enable close synchronization of main pump and booster pump operation.

Combined with these outstanding developments there have been improvements in minor details of practice which give the work in the Miami River valley, besides its rank as the largest hydraulic fill dam construction operation in the world, a technical standing of significance to construction engineers and to contractors. From a careful personal study by the editor, corrected by the engineers of the Miami Conservancy District, a review of hydraulic fill practices and developments is given in a series of three articles.—EDITOR.

STRUCTURALLY the five dams which will protect the Miami River valley from floods are earth embankments pierced by outlets of concrete masonry. The embankments are being built by the hydraulic fill method. They vary in volume from about 865,000 to 3,500,000 cu.yd. and aggregate about 9,000,000 cu.yd. Each operation is a separate construction task involving individual problems of stream control, sequence of fill, borrow-pit development, transportation and plant layout. The common technical direction of the five operations and their simultaneous prosecution permits, however, the standardization, to a considerable degree, of processes and equipment.

General Conditions.—So far as it may be disclosed by dimensions and plans the construction required is indicated by the drawings of Fig. 1. As affecting the hydraulic fill operations certain characteristics of structure require attention. At two dams the outlet and the spillway are separate structures and the embankment is continuous across the valley, which complicates the problem of stream control, and at three dams the outlet and spillway are a single structure, which forms a notch in the dam and interrupts the continuity of the embankment, thus complicating the filling operations. Another influencing factor is the extended lateral dimension and the comparatively restricted heights of the fills. Referring to Fig. 1, and equalizing the horizontal and vertical scales, it is observed that except at Germantown the dams are wide flat fills across broad level valleys.

The geology of the dam locations also assumes importance in the construction problem. It has to be considered not merely in respect to securing safe foundations for the dam structures but also in respect to developing sources of materials suitable for hydraulic fill embankment and for concrete outlet construction. The valleys in which the dams are located are glacial drift overlying rock. Below the surface this drift is gravel and sand which have been worked

over by the waters of the melting glaciers. On the surface there is an inundation deposit from later streams of glacial fill or fine rock particles, interspersed with clay. Generally speaking these materials properly selected and treated provide excellent aggregates for concrete, and when combined properly are equally, excellent materials for hydraulic fill dam embankment. Some irregularity of the glacial deposits in the distribution of coarse and fine materials makes it necessary at times to go to separate sources to obtain the desired combinations but invariably those sources are all reasonably convenient to the sites of the dams.

Construction of hydraulic fill, aside from administration, involved, then, the following principal problems: (1) stream control; (2) borrow-pit development and materials transportation; (3) pump construction and operation; (4) discharge pipe construction and (5) embankment building. Determination of some of the technical questions, such as hydraulic and mechanical design of pumps and the principles of core control and settlement, must await the completion of the records and their analyses, but the broad developments of practice which are of service to the contractor are capable of expression. They comprehend, as has been noted, a number of improvements of importance.

Stream Control.—The normal flood season of the Miami River valley is March and April. During the remainder of the year construction is usually unhindered by high water except when, by chance, a summer cloudburst causes a temporary freshet on the more flashy streams. This low-water period is during the winter season, when cold weather curtails progress.

Since the earth fill for each dam requires two or more construction seasons stream control and sequence of fill have to be planned with care that: (1) flood danger to downstream centers of population shall not be intensified by the dam construction operations and (2) when final closure by the fill of the original channel is undertaken it can be completed during the low-water season beyond danger of being overtopped by the succeeding spring floods. This danger point is set at a level which is safe in case of a flood as great as that of 1913.

While the problem of stream control at each of the dams is largely determined by the local conditions, among which is the type of outlet, it submits to a general principle of solution for all dams. This principle is construction of the fill in sections longitudinally of the dam as indicated by the series of diagrams making up Fig. 1. Inspection of these diagrams discloses: (1) that until the final closure is undertaken the natural clear-way for flood flow is not constricted and (2) that when final closure is undertaken it is completed in one season.

In a measure the complexity of planning stream control and sequence of fill is determined by the type of outlet structure. At three of the dams—Taylorsville, Huffman and Lockington—the outlets are concrete notches through the embankment. By leaving out the wier, which crosses this notch, a flume, whose capacity is flexible up to very large volumes, is obtained to pass floods during embankment construction. At the Englewood and Germantown dams the embankments are continuous across the valleys and the outlets are covered twin conduits penetrating the bottom of the fill. By building the twin conduits temporarily to about twice their final capacity considerable leeway is provided for

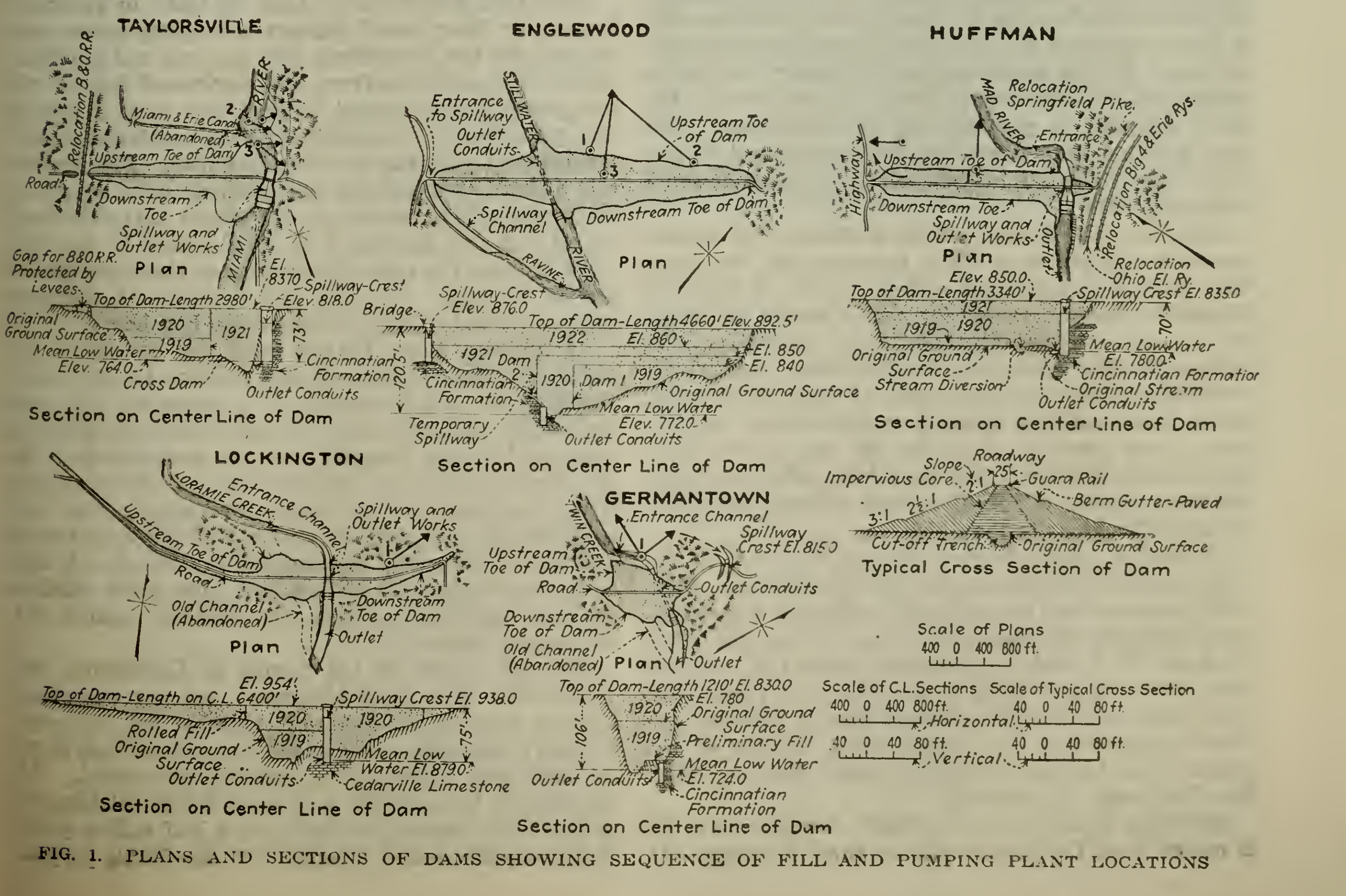

FIG. 1. PLANS AND SECTIONS OF DAMS SHOWING SEQUENCE OF FILL AND PUMPING PLANT LOCATIONS

FIG. 2. START OF HYDRAULIC EXCAVATION AT TAYLORSVILLE BORROW PIT

the excess volume of flood flow, but not enough to make it safe to close all other outlets until the closure can be completed to a safe height during a working season.

At Germantown the limitations of the conduit outlet as a flood channel caused little trouble because the volume of fill required to effect closure to a safe height was not greater than could be completed in one low water season, as is indicated by the diagram of Fig. 1. At Englewood the conditions are different. Here the volume of the embankment is so great that a third season's work is required to complete it to a safe height. During the first season, as the diagram indicates, the fill leaves free both the old river channel and the outlet conduits. In the second season the river channel is closed, but a temporary spillway, in addition to the outlet conduits, is provided for the flood flow. The third season's work completes the embankment to elevation 860, which is a height safe for high water equal to that of 1913.

Aside from the diagrams little explanation of stream control and sequence of fill is necessary for the three dams having open channel outlets. Since at Huffman the outlet structure came very nearly within the original channel stream diversion was necessary. At Taylorsville the excavation for the outlet channel involved about half a million yards of earth overburden, and to dispose of this material so that channel excavation in rock could go ahead the fill west of the river was begun in 1919 and then shut down, when the ledge had been cleared off, until certain railway relocation permitted progress to the finish.

Altogether, stream control plays a vital role in determining the embankment construction processes. Only at Germantown was the condition realized of a straightaway hydraulic fill from end to end. At all the other dams the fill is made in irregular sections of embankment, with the maximum of complexity at Englewood. More numerous pipe line changes than is ordinary are therefore necessary, and considerable volumes of the embankment have to be built as cross dams by other than hydraulic fill methods.

Materials Transportation.—Earth for hydraulic fill is moved from the borrow pits by three methods: (1) train haulage from pit to sump and then pumping into the embankment; (2) sluicing from pit to sump and then pumping into embankment; (3) sluicing from the pit directly into the embankment. The first method is employed exclusively at Englewood and the second method exclusively at Lockington and at Taylorsville. At Germantown both the first and the second methods are employed and at Huffman all three methods.

Except at the Taylorsville and the Lockington operations the locations of favorable materials for hydraulic fill are in the bottoms of the valleys upstream from the dams. From these locations to the dams the average distances are about 2,000 ft. and when excavating from the far ends of the pits the maximum distances are about 4,000 ft. With the friction heads, 8 to 12 ft. in 100 ft., developed by the heavy glacial gravel, pumping in several relays would be required to move the material from the pit to the fill. It was estimated, therefore, that the cost would be less to excavate by dragline machines and haul by trains to pump sumps located adjacent to the dam sites at such elevations as permitted reasonable railway grades from the pits and as made it practicable to pump the material into embankment at any required location with a main pump and one booster pump on any pipe line. In appraising the wisdom of this decision a study of the friction heads developed in pumping the Miami glacial drift is of supreme importance. These friction heads are analyzed in a succeeding article.

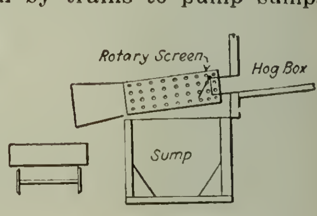

FIG. 3. DIAGRAM OF ROTARY GRIZZLY ARRANGEMENT

Upon this determination haul by train to receiving hoppers or "hog boxes" delivering to pump sumps was adopted for the Englewood, Germantown and Huffman dams. The material from the Englewood borrow pit has proved nearly perfect in gradation from coarse to fine particles for hydraulic fill dam construction and the original plan has not been modified. The borrow pits at both Germantown and Huffman have developed a scarcity of fine material. To supply this deficiency gravel and clay deposits have been opened in the hillsides flanking the ends of the dams at elevations which permit sluicing. The side hill material at Germantown is sluiced into the sump at the hog box.

At Huffman about 150,000 cu.yd. can be sluiced directly into the embankment and perhaps an additional 50,000 cu.yd. will be sluiced to a pump sump at the foot of the hill and across the valley from the hog-box sump and thence pumped into the embankment. In the direct sluicing at Huffman the pit sluice ditches lead to an inlet on the hillside overtopping the dam and from the inlet a 15-in. dredge pipe line on a trestle and thence along the beaches delivers the flow to the dam embankment. A 2½-per cent pipe grade handles the clay readily but a 4-per cent grade is required for the coarser gravel.

Material supply to the pumps at Lockington and Taylorsville is a straightforward sluicing operation. Hillside deposits of materials suitable for hydraulic fill dam construction exist at the east ends of both dams at elevations which make sluicing economical. At Taylorsville this deposit is in the hillside, cut through by the outlet channel, so that over a half million yards of the deposit sluiced accomplishes the double purpose

of removing the overburden of the rock cut for the outlet and of creating hydraulic fill embankment.

Monitor and Sluicing Practice.—To break down the streaky glacial drift for sluicing, monitor and nozzle sizes and pressures are varied. For the denser clay portions a 2½- to 3½-in. nozzle operating at 110- to 135-lb. pressure meets the conditions where the clay strata can be broken down by undercutting. It is better to shake up and fissure the deep layers by blasting. From 90- to 100-lb. pressure with a 4-in. nozzle meets best the average conditions of mixed gravel and clay. For the straight gravel containing a considerable proportion of stone too large for sluicing a stream of large volume, say 5 in. at low pressure, say 60 to 80 lb., gives the best results. Such a stream has the volume of flow required to pull away the usable materials from the oversize stone whereas a small stream at high pressure merely beats this larger stone down into a blanket which covers and protects the usable sizes from erosion. The practice is to use a No. 2 monitor for nozzles up to 2½ in. and a No. 3 or a No. 4 monitor for nozzles from 2½ to 5 in.

Different clays exhibit quite different behaviors under the action of the monitor streams. Generally the yellow and the red clays melt down completely. On the other hand, the blue clays resist dissolution. In the solid bank they stand firmly against direct attack of the stream. Where the layers are thin enough to be broken down by undercutting or when they have been fissured and crumbled by blasting the sluicing is fairly rapid. A considerable portion of the clay, however, does not melt down, but is carried by the water in lumps which, by rolling along the sluices and pipe line, are rounded into balls from the size of a marble to that of a grapefruit. These balls, of course, drop on the beaches of the fill and do not go into the cores.

Except at Huffman, where, generally speaking, only fine material is sluiced, the monitor discharge does not provide sufficient water for sluicing. The additional water is pumped to the crest of the pit face and then, led by sluices, drops over the face and flows across the pit bottom to the sump. At Lockington pumping is supplemented by gravity flow from the old Miami & Erie Canal, but broadly speaking, sluicing water at all of the conservancy dams has to be pumped. The sluices are earth ditches and 4 per cent sluice grades are found ample.

Pit development and sluice location are determined by the demand for coarse or fine materials and the locations of these materials in the pit. At Lockington, where conditions made possible the greatest regularity, perhaps, of pit development, the excavation is worked out in the shape of a fan with the pump sump at the apex. The monitor pipe line is laid on the pit bottom parallel to the face arc, with monitor connections at intervals so that any section of the face, depending upon the character of the material wanted, may be sluiced. The sluice ditches are radial. By crowding the ditches in one side with baffle boards considerable material has been added to the output by the erosion of pit tailings, and the height of working face has been increased.

Ground water at the Lockington sump stood so high that too much water was fed to the dredge pumps and the amount of solids pumped was therefore reduced. By lowering the ground water by means of a separate sump and water pump the output of the dredge pumps in per cent of solids handled was immediately increased. Overflow from the dredge pump sump is also carried over to the ground water sump. The discharge from the water pump is taken up to the sluice ditch on the hill above the pit face and added to the sluicing water.

Hauling and Hog-Box Practice.—Much of the excavation in the valley bottom borrow pits is below water level. At places the digging must also go to considerable depths to obtain the required materials. These conditions and the fact that dragline excavators were considered to satisfy best the requirements of the other excavating operations in connection with the dam construction led to the adoption of this type of machine to excavate the embankment material and to load it into cars. Ordinarily each excavator is served by two trains each consisting of five 12-cu.yd. cars hauled by a 40-ton locomotive. At periods of the work the train length has been increased by one or two cars, but normally two

FIG. 4. HOW STREAM FROM NOZZLE IS CONTROLLED

5-car trains have been plenty to handle the output of one excavator. Broadly speaking the dragline output has limited the dredge pump output. A 15-in. dredge pump has been capable of handling more material under the conditions than a dragline having 85-ft. to 100-ft. tailings, and the height of working face has been increased.

At Englewood, where the greatest volumes of materials are being handled, a steam and an electric dragline are working in the same borrow area. Both are 115-ton machines with 85-ft. booms and 4½-cu.yd. buckets. With an average pit face of 15 ft. these machines each handle comfortably from 150 to 180 cu.yd. an hour. Comparison of the two machines indicates that with current costing under 1.6c. per kilowatt-hour and with coal at $6.50 per ton on wagons at the machine the steam machine is somewhat more expensive. It is faster in operation than the electric machine, but the cost of coaling runs the unit cost higher.

At the pumps, the trainloads of material are dumped from side trestles into concrete hog-boxes. These are rectangular boxes the floors of which slope from the

trestle side and also from the ends toward a discharge outlet at the center of the opposite side. Monitors at each end sluice the material as it lies in the hog boxes to the outlets, using generally a 3-in. stream at 60-lb. pressure. Wear of the floors is about the only maintenance cost of hog-box structures. At Germantown a well built 4-in. floor of rich concrete had a life of 425,000 cu.yd. of materials sluiced. It was then practically worn out.

Screen Practice.—Material from the hog-boxes passes to the pump sumps through rotary screens which remove the oversize. These screens are the development of several experiments. At first flat or sloping grates of several types, with square openings, were tried. They had a tendency to clog under a rush of material and two or three men, working under sloppy and disagreeable conditions, were required to keep them clear. In the original installation at Germantown a traveling flat grate was found to be much better but it did not fully meet the requirements. A rotary screen with round holes was the final solution.

A typical rotary screen arrangement is indicated by Fig. 3. The screen is a sheet steel cylinder with a screening section 4 ft. in diameter and 9 ft. long. The holes are 7 in. in diameter. It is operated at about nine revolutions per minute by a 7½-hp. motor. All oversize material is rejected without hand labor except where use of the stones for construction necessitates that they be sorted out from the clay balls and any useless material contained in the screen waste. It is found that these screens also tend to rectify irregular feed from the hog-box and to deliver the solids to the pump suctions in a uniform flow. This has proved to be a very useful function, since with all reasonable care in using the sluicing monitors there will be moments when the solids will pass the hog-box outlet in masses which temporarily overload the pumps. As the discharge from the hog-box at times enters the screen end at a velocity which would shoot the solids past the screening area of the cylinder an important operating feature of each screen is a hanging flap gate which breaks the force of the outlet discharge but swings back readily to pass the water and earth.

[*Part II, in next week's issue, will present the developments in sump and pump layout and pump construction. All work is being performed by the construction department of the Miami Conservancy District, Arthur E. Morgan, chief engineer, Charles H. Paul, assistant chief engineer, and C. H. Locher, construction manager. Much credit for the success of the hydraulicking operations is due to the division engineers at the dams. All of them have given careful thought and study to the problems encountered and have made valuable suggestions for improvements in design. They are: Arthur L. Pauls, Germantown; H. S. R. McCurdy, Englewood; Barton M. Jones, Lockington; O. N. Floyd, Taylorsville; and C. C. Chambers, Huffman. G. L. Albert, hydraulic engineer, has given special attention to the hydraulic fill installations and operations at all of the dams and S. M. Woodward, consulting engineer, has offered valuable advice and suggestions.*]

Window Display Advertises Engineering

Working paraphernalia of the engineer are displayed in the windows of the principal store of Butte, Mont., for the purpose of stimulating the interest of citizens in engineering affairs. The A. A. E. chapter arranged the display.

Activated-Sludge Experiments at Mount Vernon, N. Y.

By R. H. Eagles
Chief, Industrial Section, Sanitary Engineering Department, the Dorr Co., New York City

SIX months' operation of an experimental activated-sludge plant at Mt. Vernon, N. Y., by the Dorr Co., Engineers, of New York City, has developed a modification known at "The Dorr-Peck Process." The system differs chiefly from former methods, in the application of different mechanical principles to the introduction of the air and circulation of the sludge, resulting in lower air consumption, and higher nitrogen recoveries in the sludge.

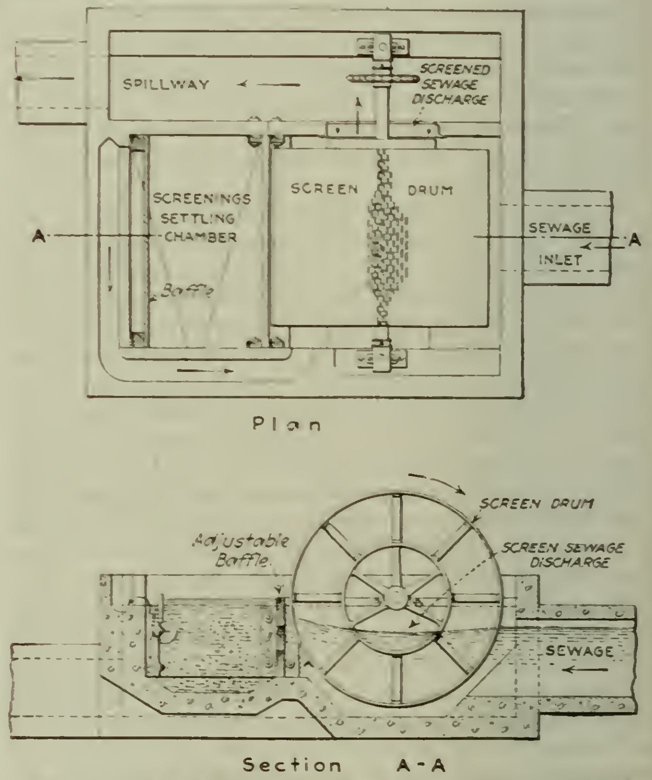

FIG. 1. PLAN AND ELEVATION OF DORRCO SCREEN

The sewage treated was fresh domestic sewage of the following average composition in parts per million: total solids, 596; suspended solids, 245; soluble solids, 351; alkalinity, 265; oxygen consuming power, 154. Detailed results for the month of November, 1919, are shown by the accompanying table. Conclusions reached are as follows:

(a) Purification is effected by 0.6 cu.ft. of air per gallon of sewage treated, with a detention period ranging from 8 to 10 hours.

(b) A clear colorless effluent is produced, containing less than 20 p.p.m. of suspended solids, up to 1 p.p.m. of nitrate and nitrite nitrogen, and is stable at least four days by the methylene blue reaction.

(c) A 90 per cent removal of bacteria is effected.

(d) The "oxygen consumed" value is reduced by 79.6 per cent.

(e) The dry sludge has a nitrogen content of 7 to 9 per cent expressed as ammonia.

(f) Sludge disposal was only slightly investigated without definite results.

The work was conducted under the supervision of C. Lee Peck, director of Research and Development of the

TEST RESULTS OBTAINED WITH ACTIVATED-SLUDGE PLANT AT MT. VERNON, N. Y., NOVEMBER, 1925

Date Nov. 1925	Flow: City Plant G.P.D.	Flow: Test Plant G.P.D.	Total Solids: Raw Sew. P.P.M.	Total Solids: Eff. P.P.M.	Total Solids: Remov. %	Suspended Solids: Raw Sew. P.P.M.	Removed by Bar Screen P.P.M.	Bar Screen %	Dorrco Screen P.P.M.	Dorrco Screen %	Activating Tank P.P.M.	Activating Tank %	Final Effluent P.P.M.	Final Effluent %	Total Removed P.P.M.	Total Removed %
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Date Nov. 1925	Dissolved Solids: Raw Sew. P.P.M.	Dissolved Solids: Eff. P.P.M.	Dissolved Solids: Re-mov. %	Oxygen Consumed: Raw Sew. P.P.M.	Screened Influent P.P.M.	Screened Influent %	Eff. P.P.M.	Re-mov. %	Relative Putrescibility: Raw Sew. Days	Scr. Inf. Days	Eff. Days	Air: Per 24 Hr. Cu.Ft.	Air: Cu.Ft. per Gal.	Alkalinity (CaCO₃): Raw Sew. P.P.M.	Alkalinity: Eff. P.P.M.	Weather
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Rain
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Rain
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Rain
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
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16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Rain
27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fair
29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Rain
30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Fine
Av.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

[1] Feed off 2 hr. to ... No. 5 with raw sewage for experiment.
[2] Shut down 4 hr. running tests for ... consumption.
[3] Shut down 4 hr. repairing belt on screen and repairing pulley slipping on shaft.
[4] 5-hr. down—replacing belts.
[5] Down total of 1 hr. for fuse trouble.
[6] Shut down for power 2 hr.
[7] Shut down for power 1 hr.
[8] Shut down 3 hr. ... cleaning bar screens and tests on compressor.
[9] Shut down 2 hr. repairs to air meter.
[10] Air meter not recording.

Sanitary Engineering Department of The Dorr Co., assisted by F. H. Rhodes and S. L. Neave, chemists. Analytical results and biologic effects were checked up by Prof. D. D. Jackson and Robert Brown of Columbia University.

The experimental plant was established at the sewage-works of Mt. Vernon, N. Y., by permission of the Board of Aldermen of that city. The feed to the experimental plant was cut from the main sewage flow after passing through a bar screen with ½-in. intervals. The average flow treated was 45,000 gal. per day of rather strong domestic sewage, and the treatment units consisted of fine screening by the Dorrco screen, followed by two combination aeration-sedimentation tanks in series, each 12 ft. in diameter by 11 ft. deep, with a total capacity of 13,600 gallons.

The first unit in the system is the Dorrco screen (Fig. 1), which is a self-cleaning revolving drum screen. It removes the tough and non-digestible solids, while the soft and easily digested solids are passed through to the activating units. Low nitrogen solids are thus excluded with a corresponding increase in the grade of activated sludge.

The two deep tanks (Fig. 2) are constructed to effect aeration, sludge circulation, and sedimentation in each individual unit. Each tank is divided into two com-

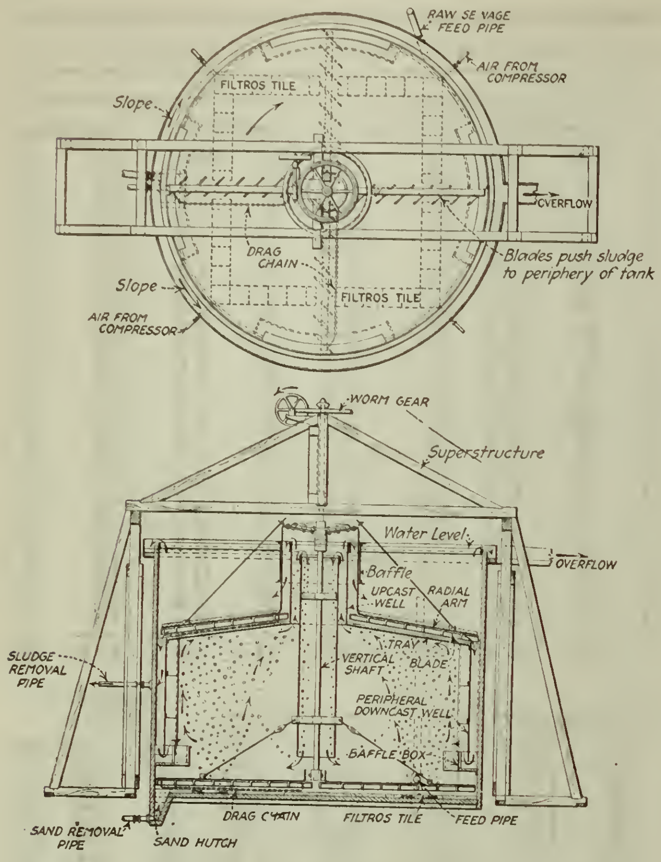


FIG. 2. AERATION—SEDIMENTATION UNIT OF DORR-PECK ACTIVATED-SLUDGE PROCESS

partments by a horizontal tray. Aeration occurs in the lower compartment, sedimentation in the upper. The depth of liquor in the aeration chamber is 6½ ft. The diffusion medium is filtros tile laid in the bottom of each tank. A central vertical shaft is suspended in each tank, to the bottom of which are attached two radial arms with squeegees which engage and keep clean the exposed surface of the filtros tile, and at the same time move the settled sludge to the periphery. Half way up on the shaft and engaging the upper surface of the horizontal tray or diaphragm (which is the floor of the sedimentation chamber), are attached similar radial arms with plows which move the settled sludge out to the periphery and allow it to drop back through peripheral downcast wells into the aerating chamber. Thus a circulation of the sludge is effected and a concentration of fresh sludge is kept in the aerating chamber. Provision is made for drawing off sludge from the final sedimentation chamber to prevent its building up and escaping with the overflow. A clear overflow is continuously removed by a peripheral launder around the top of the tank.

Approximately 75 per cent of the air is introduced into the first unit and 25 per cent into the second.

An important feature of the mechanical design is that it utilizes the natural lifting effect of the air, by constructing its exit, in such a manner that a rapid continuous circulation of the activated sludge and incoming sewage feed is effected. This gives intimate and prolonged contact between the air, biologic flocs, and sewage, with the resulting air economy.

The air was supplied by a Nash hydro-turbine compressor, delivering the air at an average pressure of 4¾ lb. per square inch and was measured by the Rotary Meter Co.'s compensating meter, which is so constructed as to compensate for any pressure passing through it, registering the actual amount of free air passed. The sewage flow was recorded over a 90 deg. V-notch weir by a Foxboro recording depth gage. Both meters were carefully checked up. The power requirement of the two aerating unit mechanisms amounted to one-half horsepower.

Snow and Water Relations in Nevada

WATER storage represented by the snow on the Sierra Nevada in April, 1920, was below normal, averaging 77.5 per cent of normal in the Yuba Basin, 76 in the Tahoe basin, 80 in the Carson basin and 84.8 per cent in the Walker basin. The probable run-off from these basins during the 1920 season, was estimated provisionally in April at corresponding percentages of the normal annual run-off, but this estimate was reduced to 10 to 25 per cent in May for precautionary reasons. Observations in the Humbolt basin have not been established long enough to determine normal conditions, but although the amount of snow on the ground averaged only 76 per cent of that in 1919 the run-off for 1920 was expected to approach that of 1919 owing to probable improvement in spring and summer precipitation. These results of a study of snow surveys are given by J. E. Church, Jr., in charge of the Nevada co-operative snow surveys at Mount Rose Observatory, Reno.

The run-off from two basins in 1919 is shown in the accompanying table. The high figures for April and May and the practical exhaustion of the snow cover by June, as shown by this table, was due to the relatively high temperature of April and May. For 1920, a temperature deficiency in April and moderate temperature in May were expected to reverse the former conditions and to assure at least a moderate run-off in June and July. Further, although the snow cover this year was less deep than in 1919, the precipitation in April, 1920, assured a run-off nearly equal to that of the previous year.

A fairly definite forecast of the late summer run-off for the Tahoe and Truckee basins is made practicable because the run-off of Lake Tahoe is controlled artificially. From the records of lake level and draft for irrigation it is estimated that the available supply above the outlet level will be exhausted early in September, or late in September with a reduced draft for irrigation. This impending shortage is accentuated somewhat by a rise in the bar at the outlet of the lake. Normally, the lake level should be raised by rains in October to December, but for several years the level has continued to fall during October and November. The chances are about even for a rise in the lake in December, 1920, but only unusual rains can improve the situation before that time. Navigation has been interferred with, some boat stops having been discontinued owing to shallowness of the water.

This shortage of water at Lake Tahoe is due largely to lack of normal rains in spring and summer. In the spring of 1918, 1919 and 1920 the snow cover in the Tahoe basin was 95, 103 and 76.2 per cent of normal. Heavy rains in early April, this year, were offset partially by excessive evaporation and the relatively greater drain upon a shallow snow cover to prime the soil. These summer losses have reduced the

run-off efficiency of the years mentioned to 53.6, 60.9 and 46.2 per cent respectively. On the theory of probabilities the forecast is for a wet spring and summer rather than a heavy winter in the coming season of 1920-21.

RUN-OFF FROM SNOW FIELDS OF THE SIERRA NEVADA IN 1919 (PER CENT OF NORMAL)

	Tahoe Basin, per Cent	Carson Basin, per Cent
Snow cover, April	103.0	96.8
Run-off April	100.0	86.4
Run-off May	121.5	115.2
Run-off June	7.7	27.6
Run-off July	0.0	4.0
Run-off April-July	72.9	66.6

This snow survey and water forecast system, which originated in Nevada, was described in *Engineering News-Record*, Oct. 23, 1919, p. 766. It is now being operated jointly by Nevada and California under the direction of Prof. J. E. Church, Jr., of the University of Nevada, and Major Paul M. Norboe, chief assistant state engineer of California, as noted in *Engineering News-Record*, Jan. 1, 1920, p. 60.

Portable Elevator Cleans Sand Catcher at San Francisco

A PORTABLE elevator which has been built by the city of San Francisco for the purpose of removing material from the sand catcher of the Treat Avenue sewer does the work with less labor, in less time and at lower cost than was found possible by the old method of bucket and windlass.

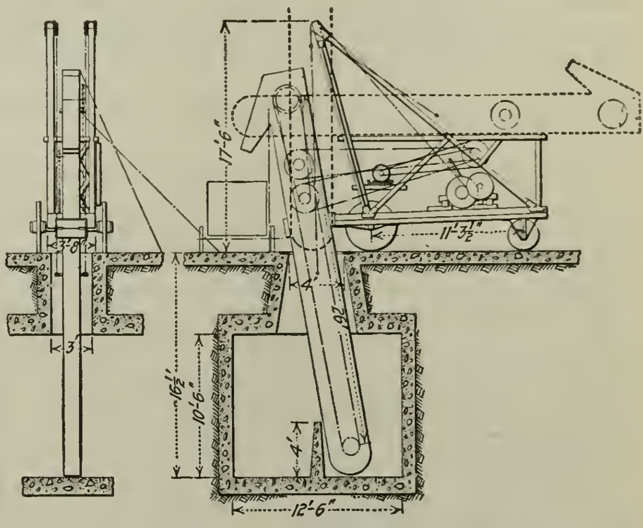
The detritus chamber for which the elevator was primarily designed is a part of a main trunk combined sewer. The chamber is 10½ x 12½ ft. in section and about 1400 ft. long. It has a center partition 4 ft. high for its full length and during storm periods the deposit accumulates throughout the entire length of the chamber to about the height of the center partition.

After the seasonal storms are over the flow is diverted to one side of the sedimentation chamber by means of a dam at the inlet. Through a manhole the elevator is then lowered so as to excavate from the other side of the center partition and men with wheelbarrows are sent down to move the material into a pile where the elevator can handle it. Designs for a longitudinal conveyor to replace the wheelbarrow men are now under consideration and with this improvement it is expected that the daily capacity of the elevator will be doubled.

PORTABLE BUCKET ELEVATOR FOR SEWER CLEANING

Under the old system of elevating the material with bucket and hand windlass, an average of about 4 cu.yd. per day was the best that could be done. With the elevator and five or six wheelbarrow men working in the sewer the quantity handled is at least 28 cu.yd. per day. The elevator is designed to handle 6 cu.yd. per hour when worked continuously at full capacity.

As shown in the drawing, the elevator proper is designed to be supported by cables attached at the center of gravity so that when raised to the top of its support by means of a hand winch its bottom swings clear of the street and it can be easily tipped over in a horizontal position and placed on top of the truck for moving. In order to steady the elevator in position while in operation it is attached to the front end of the truck by means of wooden blocks and steel bolts and swinging or vibration at the top is reduced by means of a pair of braces resembling pike poles.



DETAILS OF PORTABLE BUCKET ELEVATOR FOR CLEANING SEWER SAND CATCHER AT SAN FRANCISCO

Power is supplied by a 5-hp. motor, current for which is taken from special wires strung on the poles of a convenient power line. The upper part of the elevator proper is housed in a sheet metal casing so as to prevent the spilling of any material on the street where the work is in operation. The buckets are made of malleable iron and are mounted on chain belts. The outfit, as shown, exclusive of the bucket elevator proper, was built after the design prepared by the city at a cost of about $2300.

Fuller's Earth Output

About 106,000 short tons of fuller's earth, valued at $2,000,000, or $18.87 a ton, was produced in the United States in 1919, as shown by preliminary returns made by the producers to the U. S. Geological Survey, Department of the Interior. These figures are the highest yet recorded by the Geological Survey, and show an increase of 217 per cent in quantity, and of 563 per cent in value, in 10 years. The increase in quantity in 1919 compared with 1918 was 25 per cent and the increase in value was 74 per cent. The average price per ton increased from $13.57 in 1918 to $18.87 in 1917. Florida, which has long been the leading producer, made nearly nine-tenths of the output in 1919.

Doubly Eccentric Load Pressure on Rectangular Footings

By Marshall G. Findley
Assistant Designing Engineer, Board of Commissioners of the Port of New Orleans, New Orleans, La.

Computation of the varying pressure on a rectangular base due to the reaction of a homogenous elastic foundation material to load eccentric in one direction only is fairly simple. In general, the formula $p = \frac{P}{A}(1 \pm 6e)$ is correct for the extremes of unit pressure, in which e is the eccentricity expressed as a decimal portion of the length P, the total vertical load, and A the cross section of the base. If, however,

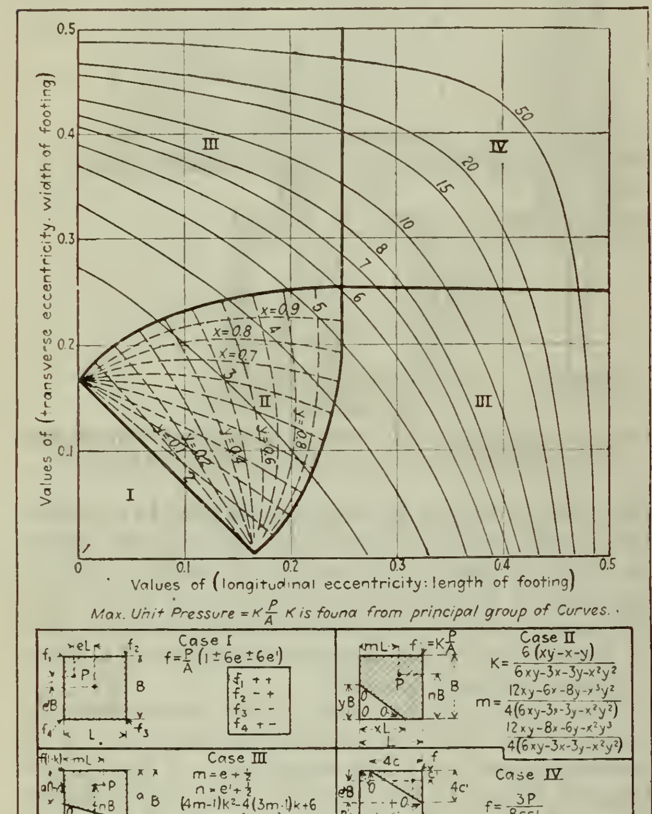


FIG. 1. DIAGRAM FOR COMPUTING PRESSURES ON DOUBLY ECCENTRIC FOOTINGS

the eccentricity is rather large and the material cannot take tension, one should use instead the formula $p = \frac{P}{A}\frac{4}{3(1-2e)}$. In using this formula, p applies only to the maximum unit pressure along the edge nearest the load, and the value of e must be greater than $\frac{1}{6}$ and less than $\frac{1}{2}$.

When there is double eccentricity, such as for instance that caused by traction to the north and wind blowing to the east, the case becomes much more difficult. Checking a number of methods in current use disclosed the fact that not only did they give results inconsistent with each other, but also that their results could be proved in many cases far from correct. A study of the case, which reduces at once to a problem in pure mathematics, disclosed the fact that there are four cases, each having an entirely different set of formulas. Two of these sets are simple, one more complex, and a fourth capable of direct solution only by determinants, and the solution awkward to handle. To meet the difficulty, the accompanying diagram was developed.

As a rule, in designing the only foundation figure

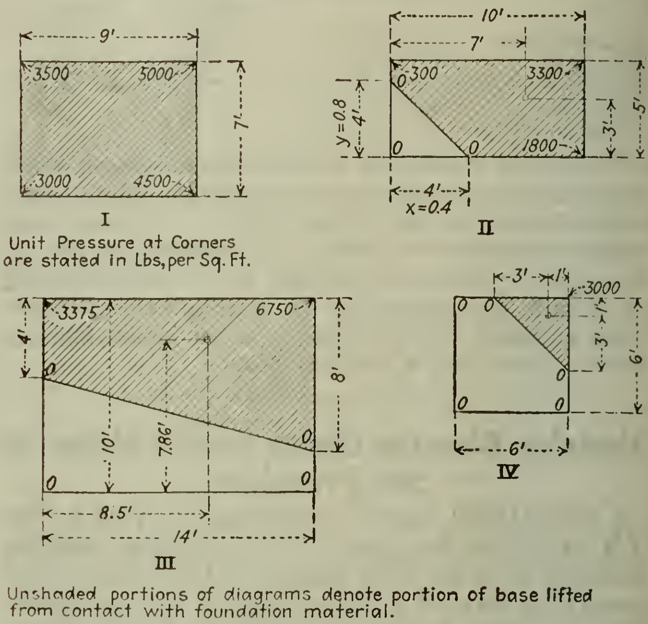


FIG. 2. TYPICAL EXAMPLES OF FOUR CASES OF DOUBLE ECCENTRIC LOADING

desired is the maximum unit pressure. To find this from the diagrams, (1) compute the value of $\frac{P}{A}$, the average unit pressure; (2) compute the values of e, the longitudinal ratio of eccentricity, and e', the transverse ratio of eccentricity from the given side pressures and loads; (3) plot on the diagram, which represents one quarter of the base, an abscissa e and an ordinate e'; (4) read from the principal curves the value of K; (5) multiply $\frac{P}{A}$ by K, which gives the maximum unit pressure on the one.

For figuring moments in a cantilever footing, this full value of the maximum corner unit reaction is too high to use as uniformly distributed, and the exact distribution of load makes rather complex figures; a value of $\frac{1-3K}{4} \times \frac{P}{A}$ distributed uniformly is convenient and conservative.

In the rare event that more exact information is required, the formulas given below the curves afford a solution for Cases I, III and IV. To solve Case II, for which the formulas are awkward, values of the ratios x and y are plotted on the diagram, and from these any other desired information may be obtained, by application of the elementary principles of solid geometry. The other two cases are fairly simple mathematics.

It should be noted that the assumptions are: (1) that the foundation material cannot take tension; (2) that it follows Hooke's law in compression, and (3) that e and e' are less than 0.5. In case either e or e' is greater than 0.5 it becomes necessary to provide for tension.

	Data Given					Computed			From Diagram	Computed Max. Pres.
Case	P (Lb.)	M Ft.-Lb.	M′Ft.-Lb.	L (Ft.)	B (Ft)	e	e′	P/A	K	(lb. per sq.ft.)
I	252,000	70,875	18,375	9	7	0.031	0.010	4,000	1.25	5,000
II	55,000	110,000	27,500	10	5	0.2	0.1	1,100	3.0	3,300
III	220,500	330,750	630,630	14	10	0.107	0.286	1,575	4.29	6,750
IV	8,000	16,000	16,000	6	6	0.333	0.333	222	13.5	3,000

To illustrate typical solutions the accompanying tabulation of four cases is given, the maximum unit pressure being worked out in each case from the simple formula. In Fig. 2 the more precise analysis of each case is shown as worked out by the formulas at the bottom of Fig. 1. It should be noted that the values of K as worked out in the formulas in Fig. 1 are not necessarily the same as the K for the same case as worked out by the diagram.

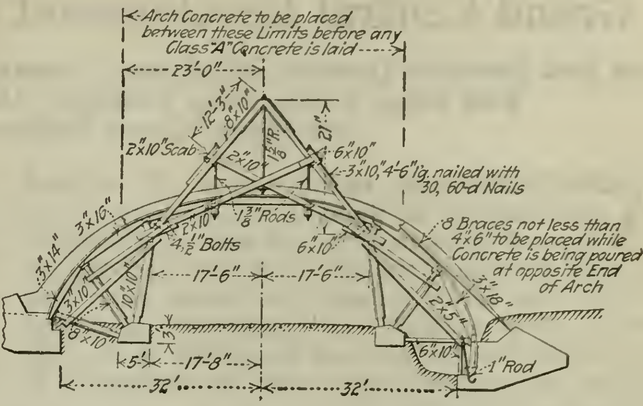
Overhead Truss Supports Falsework for Concrete Arch

Need for Clearance for Street Railway Leads to Use of Timber Framework Penetrating Solid Arch Rib

By R. W. Stewart
Chief Deputy City Engineer, Los Angeles, Cal.

On account of the wide clearance required for an interurban electric railway under the new Arlington Heights bridge at Los Angeles, Cal., it was decided to support the falsework for the arch ribs on a series of so-called scissors trusses extending up from the ground near the springing line through the arch rib proper. Openings were left where the truss timbers pass through the rib and were filled after the main arch was poured and the falsework removed.

The arch has a clear span of 64 ft., but it was permissible to erect verticals at a distance of about 18 ft. from the center line and leave room for the car line. Small concrete pedestals, therefore, were placed here and the main posts of the triangular trusses erected on them. There were four trusses spaced about 6 ft.

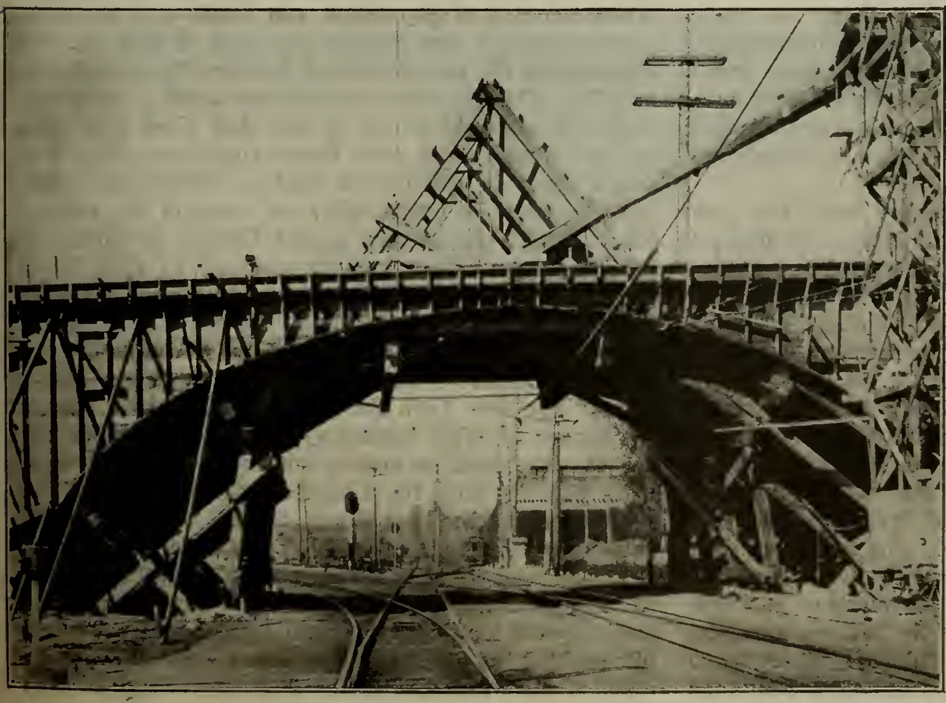


ELEVATION OF SPECIAL TRUSS TO SUPPORT CONCRETE ARCH BRIDGE

apart carrying transverse beams on which the segments for the lagging were placed.

It will be noted that the falsework would not resist the longitudinal stress along the arch if one haunch was poured while the remainder of the falsework was without load. It was, therefore, decided to pour the crown section first, as indicated on the drawing, and after it had set the concrete so poured was braced at one end by struts to hold it while the haunch at the other end was poured. After the first haunch was poured and had set the anchorage of the reinforcing rods which pass through crown and haunch and into the abutments formed a tie which permitted the removal of the struts.

In pouring the crown section settlement due to deflection of the trusses and other causes amounted to 1¼ in. and the crown drifted about 1 in. toward one abutment, the joists at the first panel from the center toward the abutment rising off the cap. The gap between these joists and their supports was filled with thin boards and that haunch filled, causing the crown to drift back to its original position. The last operation was pouring the opposite haunch. When both haunches were poured the central part of the arch settled an additional ⅜ in. The allowance for anticipated settlement varied from ½ to 2 in., so that the arch after completion was close to its correct position. The bottom chords of the trusses carry 40,000-lb. tension. They are built up of five pieces of 2 x 10-in. plank, three of which pass through the center joint on one leg and two through on the other leg, the other pieces being cut on each side of the joint. This 40,000-lb. tension was transmitted entirely by nails driven through the layers of plank which projected above the center joint. The correct number of nails was determined by reference to the tables by H. C. Dewell published in *Engineering News-Record*, Dec. 27, 1917, p. 1,211.



OVERHEAD TRUSS CENTERING PERMITS CLEAR PASSAGEWAY

Grand Central Development Seen As Great Civic Center

New York Passenger Terminal and Adjacent Property Surpassing Expectations as Unit Including Depot, Post Office, Hotels, Office Buildings, Apartments, Clubs and Stores — Use of "Air Rights" Above Tracks — Service and Power Units

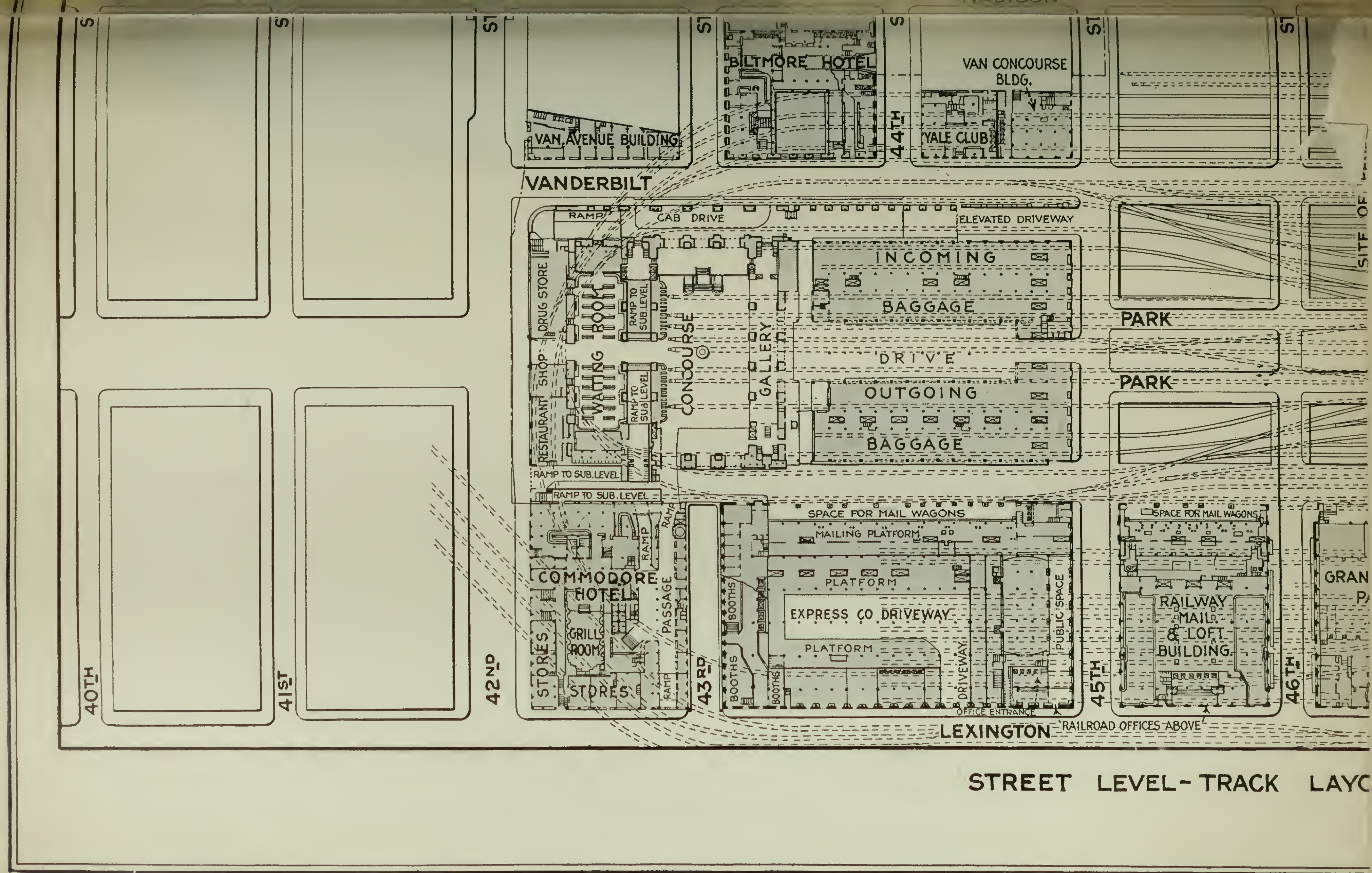
Since the opening of the great passenger station in New York City in 1913, the development of the Grand Central property has in many respects far surpassed original expectations. With its hotels, office buildings, apartments and underground streets, it not only is a wonderful railroad terminal but also a great civic center. Recent announcements of projected development for utilization of the "air rights" over the yard tracks, on a scale for which there is no precedent, may well serve as the occasion for retelling at least a part of an old story and recording more recent developments together with facts which appear to be little known. This account was prepared in the thought that it would be of more than passing interest to engineers as illustrating an unexampled civic development resulting from a great engineering undertaking.—Editor.

ANNOUNCEMENTS recently made of projected development of the Grand Central property in New York City call attention to the fact that the building of the great passenger terminal of the New York Central and the New Haven railroads has already led to the creation of a remarkable civic center far surpassing the original plans in size and importance to the city, and to the railroads that enter the terminal. In addition to the building of the depot, post office, hotels, office buildings, apartments, clubs, stores and the opening of important city thoroughfares, which has already been accomplished through the foresight of engineers and other railroad officers in the development of the "air rights" over the terminal trackage following the electrification, construction has now commenced on additional apartment houses and a large extension of the railroad offices, and there is actively projected the building of a thirty-one story office building, with over 1,000,000 sq.ft. of office space, at a rental of $4,700,000, all over the depressed tracks on sites on which it was not thought that building height would exceed six stories. While the New York passenger terminal of the Pennsylvania Railroad is unique in being the only project of its kind which involves river tunnelling, in which seemingly insurmountable obstacles were overcome, the Grand Central now stands out not only as a great railroad terminal but as a great civic development with an earning power more than enough to justify the very large expenditure.

While the primary purpose was to build the best terminal possible, with a capacity of 250,000 passengers per day, the foresight of those in charge of the undertaking has led to the opening of more than two miles of city streets and the reclamation of about 40 acres for building purposes—all over the two levels of the thirty-two miles of electrified terminal tracks—forming an impressive and beautiful civic development where there existed before a steam- and smoke-filled railroad yard crossed only by foot bridges. Groups of buildings to which access may be had from the station concourse itself without going above ground are remarkable for their diversity of service and use. The main building, with the express and suburban levels connected by long ramps instead of stairways, is a labyrinth of passageways—"inside streets" on which there are shops and stores—connecting with three subway routes, two hotels with more than 3,000 rooms, office buildings housing some 6,000 workers, a post office, restaurants and two university clubs. Even to those who constantly use the terminal but little is known of the hidden network of power and service facilities, the machinery and power plants—one of them excavated out of solid rock 90 ft. below the level of the street—that make possible the operation and the maintenance of the whole group. To any one not well acquainted with New York City it would be difficult indeed to convey an impression of what the building of the Grand Central has involved without a sketch of the historical approach that led to these vast plans being initiated by the New York Central Railroad in 1903, with the actual opening of the new station in 1913.

What was probably the first real railroad passenger terminal in New York City was leased in 1839 by the New York & Harlem Railroad, now a leased line of the New York Central, at the corner of Centre St. and Tryon Row, on the site of the southern portion of the present Municipal Building, some three miles further down town than the present Grand Central. About eleven years later the old building was taken down and a five story depot and office building was erected. When the tide of population and traffic had begun to move up-town a new station was built at 26th St. and 4th Ave., on the present site of Madison Square Garden, in 1856. This station was then considered a fine structure and was used jointly by the New York & Harlem and the New York & New Haven roads, being the first union depot in the United States. Incidentally, this building could be comfortably set down in the express concourse of the present Grand Central Station. In 1857, the use of steam locomotives south of 42nd Street was discontinued; so freight cars and passenger coaches were drawn by horses both to the old Centre Street Station and to the Twenty-Sixth Street Terminal.

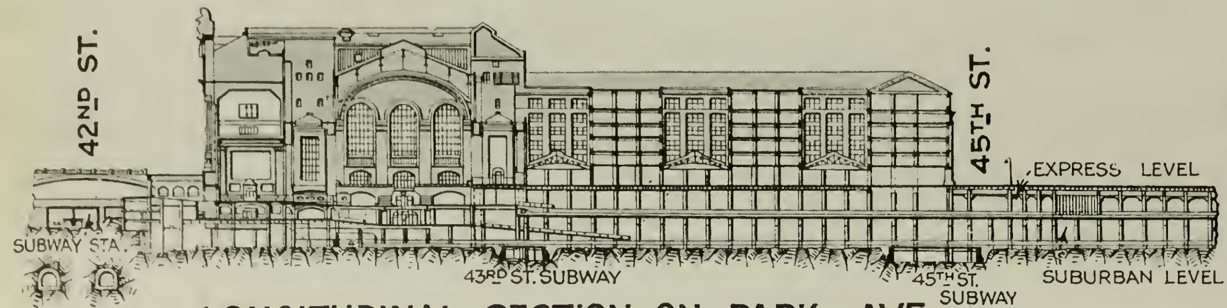
The terminus of the Hudson River Railroad, now a part of the New York Central System, in 1851 was on the corner of West Broadway and Chambers St., and horses were used as motive power up to a station at 30th St. In 1868 the Chambers Street Station was abandoned and the 30th Street Station was used as the passenger terminal until the opening of the Grand Central Depot in 1871. Traffic soon outgrew the 26th St. and 30th St. Stations, and after great discussion over the site for the new terminal, Commodore Vanderbilt decided the question by selecting a piece of ground on 42nd St., which he called the Grand Central, because



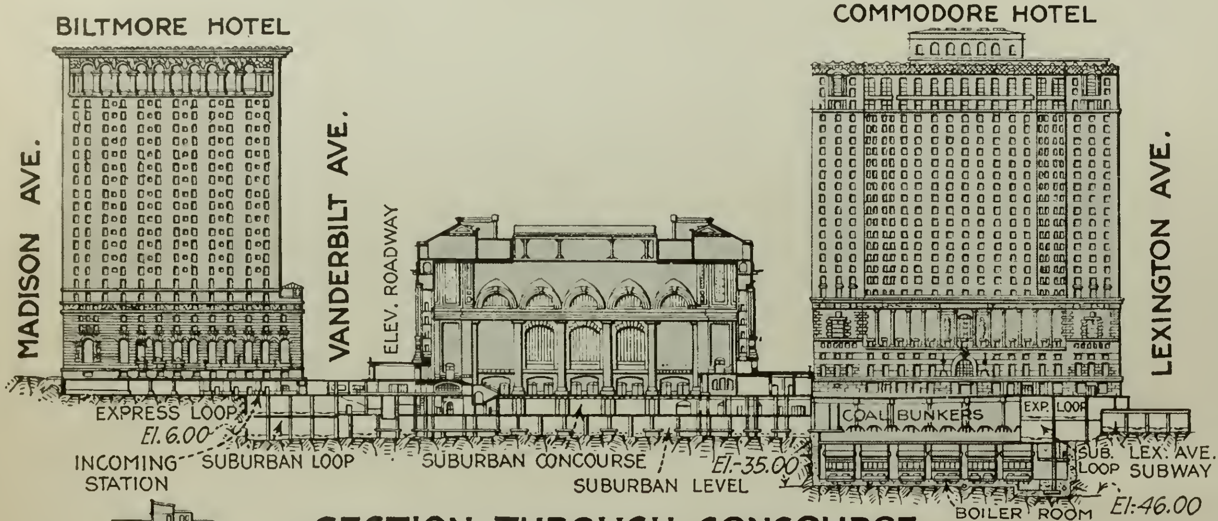
STREET LEVEL-TRACK LAYC

Grand Central Passenger Terminal an

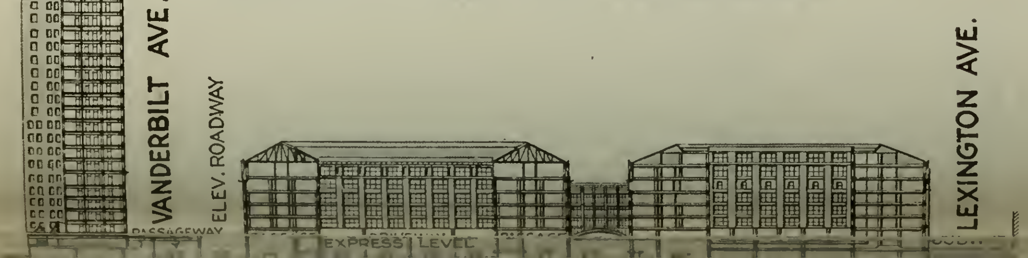
Four Levels Reproduced from Most Recent "Lay

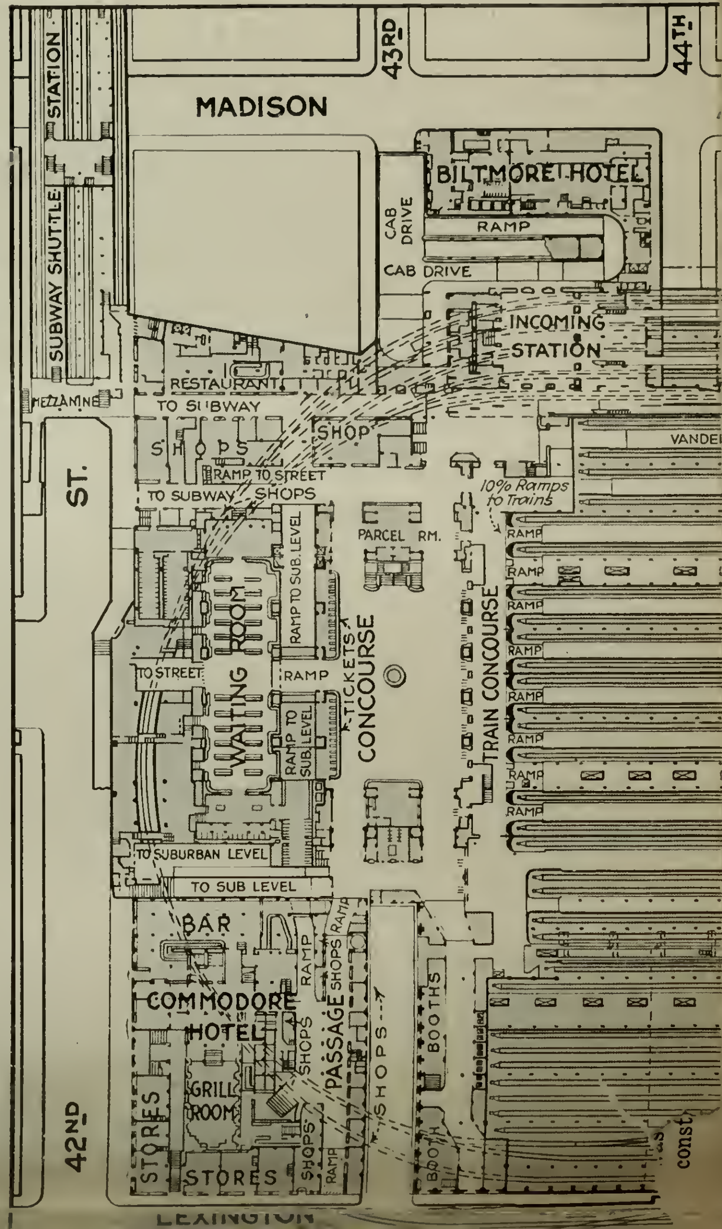


LONGITUDINAL SECTION ON PARK AVE.



SECTION THROUGH CONCOURSE





PRESENT DEVELOPMENT FROM TOP OF BUILDING AT 41ST STREET LOOKING NORTH UP PARK AVENUE

Hotel Belmont in left foreground beyond which are Biltmore Hotel (surmounting incoming station), Yale and Princeton clubs, Vanderbilt Concourse offices, with Paterno Apartments in background. Commodore Hotel at right, with railroad and post office building, Grand Central Palace and 50th St. power plant beyond. There are direct underground connections between main building and Biltmore Hotel, Yale and Princeton clubs, Vanderbilt Concourse offices and Commodore Hotel.

of its accessibility. Used by the three railroads, the Grand Central Depot was enlarged by the construction of an annex between 1884 and 1886, and in 1900 the station was again enlarged, this time to accommodate about 60,000 passengers daily. The number of tracks was increased and three stories were added to the main building.

Particularly with the tremendous growth in suburban traffic it soon became evident that the facilities of the old Grand Central Depot could not be expanded to meet future traffic demands without building an entirely new terminal on a much larger scale. Sentiment was developing for the electrification of the roads using this station and in January, 1902, the case was crystallized by a serious accident which occurred in the Park Ave. tunnel between 96th St. and 56th St., connecting with the elevated structure northward where the road crosses the Harlem River from Manhattan Island. As a result the New York Legislature passed an act requiring the railroads, after a certain date to operate their trains by electricity through Park Ave. and attention was given to the plan of reconstructing the terminal. In 1903 plans were begun for the present development.

With the requirement to electrify and with the necessity of providing tremendously larger facilities to handle the traffic of future years came the idea of the present development: a two-level yard and the reclamation of all the space over the tracks. Actual construction was begun in the Autumn of 1903 with the widening of the yard entrance at 50th St., before excavation was begun to establish a lower level. To carry out the construction under traffic and change the entire plant so that not a vestige of the old remained, to keep 800 trains (including work trains) running per day, with a traffic of from 75,000 to 100,000 passengers, required the closest co-ordination between operating and engineering departments in the division of space for construction and operation. For this purpose and to provide for the larger terminal facilities the first thing required was more room, and large purchases of land were made adjoining Lexington, Park and Madison Aves., increasing the terminal area from 23 acres to 79 acres, including both levels of tracks. Articles on the original construction appeared in *Engineering Record* of February 8, 1913, page 144, and in *Engineering News* of May 1, 1913, page 883. The story already has been told how this construction, involving the excavation of 3,250,000 cu.yd. of material (about 2,000,000 cu.yd. of which was solid rock), over 50,000 tons of structural steel and about 1,000,000 barrels of cement, was carried out without interruption to service rendered the thousands of passengers who used the terminal daily while the old structure was being taken down and replaced with the new terminal.

With the opening of the new station in 1913, there already had been built over the yard tracks Grand Central Palace, and the Post Office and office building. In 1914 the Biltmore Hotel and the incoming station, which it surmounts, were completed. The main power plant at 50th St., including heating and electric substation units, to serve all of the buildings of the group, had been completed and put into operation previous to the opening of the main building. Between 1916 and 1918 the apartment buildings over the tracks between 47th and 48th Sts. and 50th and 53rd Sts., were com-

PRESENT GRAND CENTRAL CIVIC CENTER ON UPPER PARK AVENUE SHOWS DEVELOPMENT OF "AIR RIGHTS"

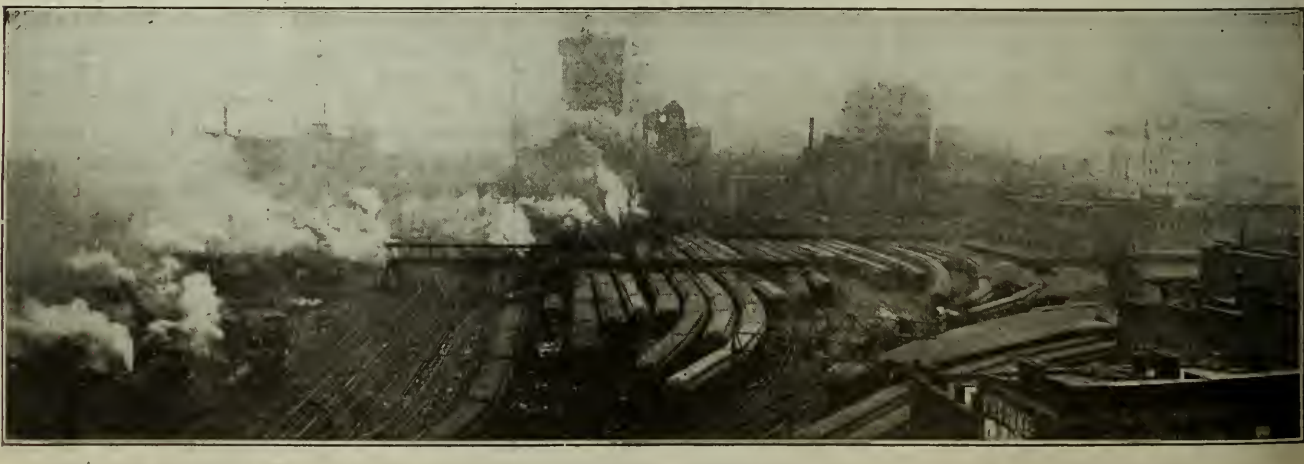
Looking down Park Avenue from 48th Street: Paterno Apartments in right foreground, Grand Central Palace at left. Commodore Hotel between Palace and Head building, beyond which is Hotel Belmont and Biltmore Hotel, partly hidden by apartment buildings.

pleted, following the building of the superstructure carrying the city streets across the yards. The Commodore Hotel, connecting directly with the main station building, was opened in 1919. To provide the additional heating capacity necessary a power plant 90 ft. below the street level at 43rd St. had been built. During this year the viaduct connection between Park Ave. and the south approach around the main building was also completed. In the meantime the Yale Club, the Vanderbilt Concourse Offices, and the Hotel Chatham had been erected.

Although the terminal—in its larger sense—is even now incomplete, with the vacant rectangles still existing over the yards, it has already passed expectations in some respects. Most striking is the height and diversity of the buildings which have been erected and are planned, as indicated by the project to build the Park-Madison Building, 31 tories in height, on the two rectangles bounded by Madison and Park Aves., 46th and 47th Sts., and a 25-story building on the two plots immediately southward. The uses to which these structures are put seem to represent almost every form of business and activity to be found in a great city. The development as a whole has already become so large that the tax revenues accruing to the City of New York from the Grand Central property have increased from about $700,000 to almost $3,000,000. While the utilization of "air rights" over the terminal yards appears to be the most important phase of the present work to those in charge of the property, the traveller is more particularly struck by the many services rendered him and the places and buildings that can be directly reached from the main building.

It is not exactly accurate to refer to the main building with its two levels and many passages as a labyrinth, since the station was so carefully laid out that the movement of the traveller is a progressive one in which different levels are reached by ramps of easy grade with the ready guidance of legends—which were placed after a most careful study—whether the passenger enters from the street, the subways or the connecting hotels or offices. On entering the main concourse one is instantly impressed with the great size of the room and even the sophisticated commuter must sometimes marvel at the pains expended in working out the architectural detail. The walls and columns, finished in Botticine marble and Caen stone, with arched windows 75 ft. high at each end of the room, support an arch roof, the ceiling of which is blue-tinted and laid out to represent the Constellations of the Heavens, in their true relativity of direction. At night the ceiling is illuminated so that the individual stars which are represented correspond in intensity exactly with the corresponding stars in the Heavens.

The floor level of the main concourse was established as identical with the level of the mezzanine floor of the Interborough Subway Station, since investigation had developed that about 80 per cent of the passengers



GRAND CENTRAL YARD, NOVEMBER, 1906, FROM SAME SPOT AS VIEW ABOVE

Before electrification and new construction took place, cross streets from 42nd Street to 50th Street were entirely closed except for foot bridges over the terminal yards. Except for trackage purposes the property was useless and surrounding district was largely undeveloped. Hotel Belmont is the only building common to both views.

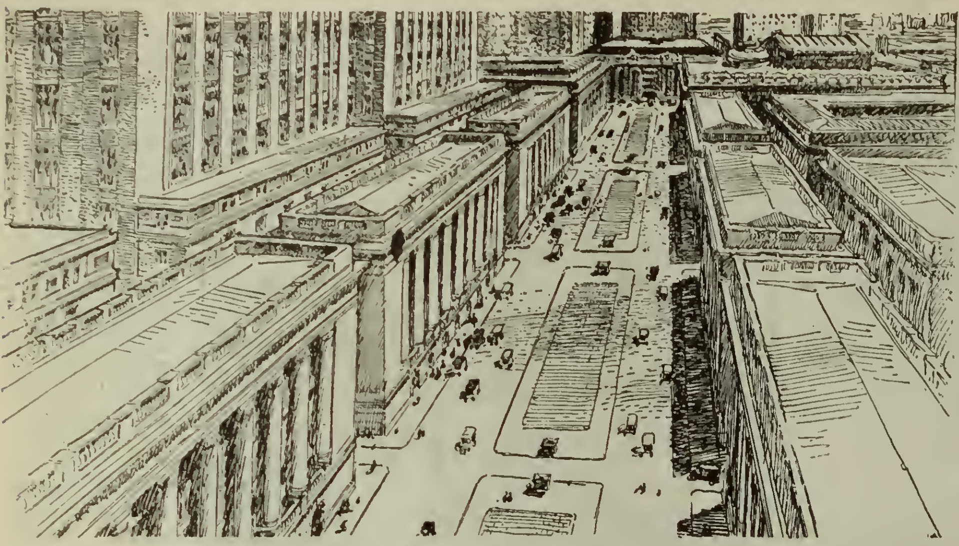
MAIN CONCOURSE IS ONE HUNDRED AND TWENTY-FIVE FEET HIGH

With length of 275 ft. and width of 120 ft., room could accommodate thirty thousand people. Ceiling laid out to represent "constellations of the heavens" in true relatively of direction and illumination. Main entrance at the left and train gates at the right.

entering and leaving the terminal use the subways. From the concourse may be reached almost directly the incoming station, the Commodore and Biltmore Hotels, the Yale and Princeton Clubs, the Vanderbilt Concourse Offices, the offices of the two railroad companies, as well as the subways and various shops and numerous other facilities located in the main building for the convenience of travellers. These connections are indicated clearly in the accompanying insert showing sections of the upper and lower concourse levels and the street level.

The incoming station, located beneath the Biltmore Hotel, to the west of the main concourse and separated from it by a passageway beneath Vanderbilt Ave. on a level with the main concourse, has separate passageways leading to the subways, the street and the cab driveway (also located under the hotel) so that passengers arriving in the terminal will not interfere with the flow of people on the way to trains. A stairway from the incoming station leads directly up into the Biltmore Hotel, the use of which was originally intended for travellers but which has become a popular "society" hotel. Soon the need became apparent for an additional hotel connected directly with the main building to serve the convenience of travellers, and the project was launched to build the Commodore Hotel on the corner of 42d St. and Lexington Ave., with 2,000 rooms in addition to the 1,000 rooms in the Biltmore. This elaborately appointed hostelry, with its great lobby giving the impression of Babylonian hanging gardens, is reached directly from the main building passageway to the east of the concourse. The railroad offices in the head building, connected by overhead bridges with the railroad office building surmounting the Post Office, are reached directly by two sets of elevators on each side of the train gates directly off the main concourse. A private underground entrance to the Yale and Princeton Clubs connects with the Vanderbilt Ave. passageway to 45th St., which also gives direct access to the Vanderbilt Concourse Offices adjacent to the building occupied by the two university clubs. All of these passageways, on a level with the main concourse, connecting it with the street, subway and building entrances, are brought into their fullest use by virtually making them "inside streets" on which may be found shops and stores dealing in almost every conceivable want that would occur to any one using a passenger terminal—or for that matter to almost any shopper. Here are found small places of business which deal not only in the usual commodities on sale in any passenger terminals but also in musical supplies—even pianos—haberdashery and clothing,

SHOPS ON THE "INSIDE STREETS" OF THE MAIN BUILDING.



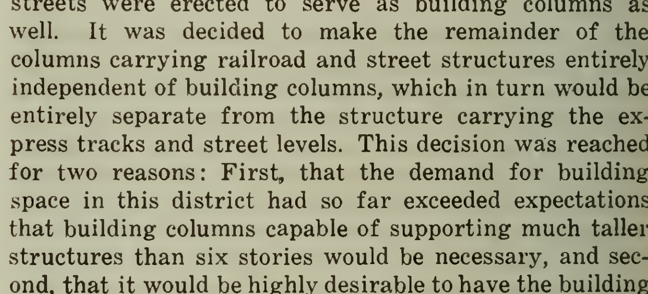
ORIGINAL PLAN FOR PARK AVENUE DEVELOPMENT

Only nine years ago it was not thought that building over yard tracks at this point would exceed six stories in height. Already a thirteen story apartment building has been erected and a thirty-one story office building is projected.

ladies wear, electrical appliances—including electric washing machines—luggage and trunks, stationery and printing, dried fruits and nuts, and French pastry. Here may also be found a shoe repair shop, a shop which deals exclusively in safety razors and shaving accessories, a milk and dairy stand, a delicatessen store, elaborate candy shops, a circulating library, drug stores, lunch counters and restaurants, and a sub postal station. At first the development of the business of these shops was slow, but in the past few years it has increased by leaps and bounds. Last year the company operating the haberdashery and clothing shops in the terminal building did a business amounting to very nearly one-half million dollars, and the indications are this year that gross receipts will total somewhere near three-quarters of a million.

Far more important than these concessions inside the main building, from the viewpoint of revenue-production, is the development of the "air rights" over the yards to the north, and the opening of Park Ave. With Park Ave. opened throughout its entire length by building the cantilever viaduct over 42d St., and by carrying the elevated roadway around the west side of the station, and thence northward on its normal course over the terminal yards, a great plaza is opened north of the head building. Outstanding among buildings located almost entirely over the terminal tracks to the north of the head building is the Mansions Apartment House (more popularly known as the Paterno Apartments) consisting of two sections of thirteen stories each, located on the rectangle bounded by Park and Madison Aves., and 47th and 48th Sts. This building, which was completed in 1918, contains 104 apartments, 23 stores, 10 doctor's offices, and 65 extra servant's rooms. and brings in a total annual rental of $1,100,000. Upon entering its courtyard consisting of an elaborate formal garden it seems almost inconceivable that it is built over the yards of a railroad terminal. Similarly appointed apartment houses, but of smaller size, are located over the two plots on the west side of Park Ave., between 50th and 52d Sts. Another apartment house which will bring in a total annual rental of $900,000 is now being constructed by Fred T. Ley & Co., Inc., on the plot bounded by Park Ave., the extension of Vanderbilt Ave. and 48th and 49th Sts. The building has been financed on the co-operative ownership and management plan without the aid of a mortgage and is the first application of the co-operative plan to an apartment dwelling of such large size. Still another apartment building, which will also bring in a rental of $900,000 per year, is being built between Park Ave., the extension of Vanderbilt Ave. and 49th and 50th Sts. Louis Sherry's restaurant will be one of the features and will occupy the entire ground floor of this building. The number of occupants in these two apartment houses will be from 500 to 600 each and the number in the Paterno Apartments is approximately 1,000.

It was the original plan of the Park Ave. development that the buildings at this point would not exceed over six stories in height, but even the apartment houses mentioned above exceed this limit. During the first part of the new Grand Central construction work, the steel columns carrying the express tracks and overhead streets were erected to serve as building columns as well. It was decided to make the remainder of the columns carrying railroad and street structures entirely independent of building columns, which in turn would be entirely separate from the structure carrying the express tracks and street levels. This decision was reached for two reasons: First, that the demand for building space in this district had so far exceeded expectations that building columns capable of supporting much taller structures than six stories would be necessary, and second, that it would be highly desirable to have the building columns entirely independent of the rest of the structure so that they could be thoroughly insulated against vibration and sound from the moving trains beneath. A plan for accomplishing this purpose was evolved after extensive tests made by the engineering department. In these tests the effect of vibration from trains was measured in three planes by seismographic instruments. The protection evolved for all building columns supporting "high grade" structures is indicated in the accompanying drawing, which shows the details of the vibration mat consisting of alternate layers of lead and asbestos which support the column at



BUILDING COLUMNS PROTECTED FROM VIBRATION

Surrounded by air space and supported by mat of alternate layers of lead and asbestos to insulate buildings against sound and vibration of moving trains.

POSSIBILITIES OF FUTURE DEVELOPMENT OVER YARDS SUGGESTED BY DIVERSITY OF PRESENT BUILDINGS
Left: Group includes railroad offices, hotel, university clubs and business offices, all built over yard tracks. Right: Modern apartment house over tracks, which brings in total rental of $1,100,000 yearly. Vacant rectangle is site for thirty-one story office building.

its base, and the air space which separates it from the railroad structure. By far the greater portion of the steel now in place supporting the railroad and street structures is designed for that purpose only and not to aid in carrying building loads, but the track layout was, of course, made to permit the erection of building columns without interfering with clearances.

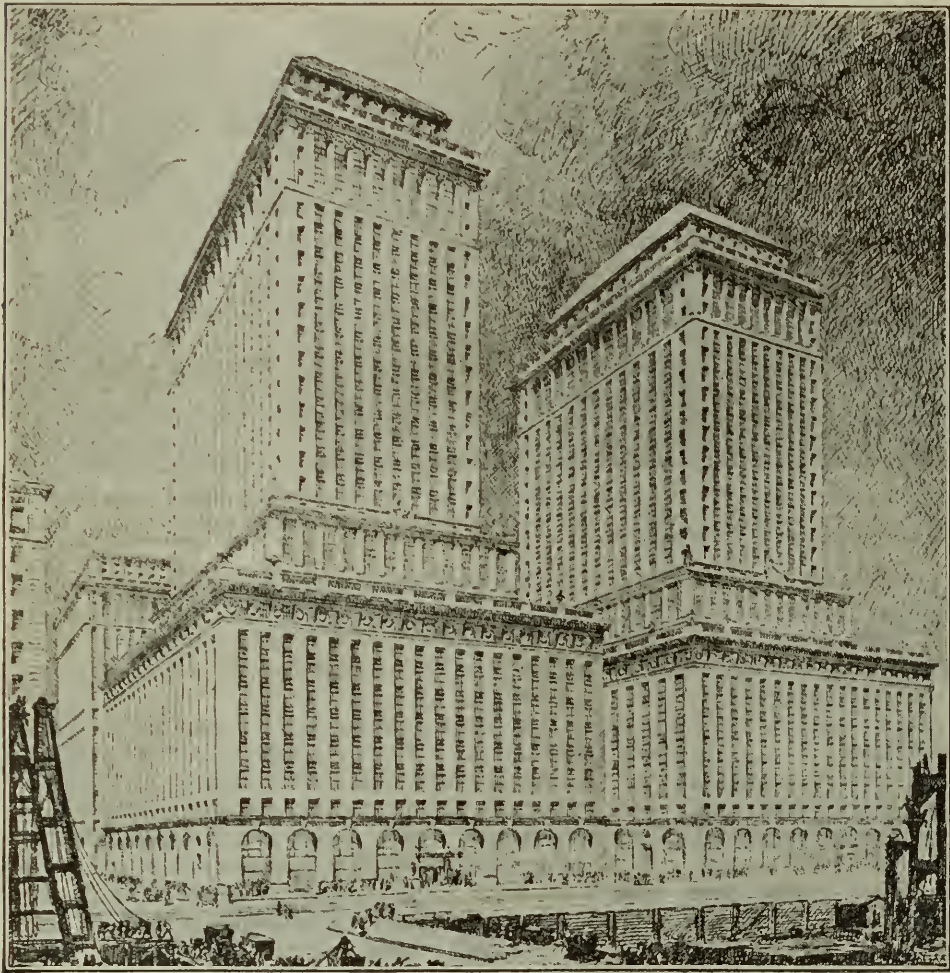
Great interest now attaches to the project to build a twin office building 31 stories high over the area bounded by Madison and Park Aves., and 46th and 47th Sts. This building, which will provide 1,100,000 sq.ft. of office space, will, as planned, be almost entirely over the terminal tracks. It is being projected on the co-operative plan by the Weaver-Crawford Corporation, with Douglas L. Elliman & Co., Inc., managing agents. The total annual rental of the building will amount to about $4,154,000 and of this amount $1,454,000 will be derived in rentals from non-owners who will lease their space from year to year and the remaining $2,700,000 will be derived from the sale outright of office space to subscribers or co-operative owners. This project will involve nearly $35,000,000, consisting of an estimated construction cost of $18,900,000 and a twenty-one year lease for about $15,000,000 with two renewals. Already a considerable proportion of the stock in the new corporation has been subscribed and it is intended to begin construction within a few months. The structure will be 31 stories high on the Madison Ave. end and 18 stories high on the Park Ave. end, these sections being connected by a wing seven stories high over Vanderbilt Ave. It is also contemplated to erect a 25-story office building over the area bounded by Madison and Park Aves., 45th and 46th Sts.

The Grand Central Palace, between Lexington Ave., 46th and 47th Sts. and Depew Place, was built during the original construction. It was intended and is now used largely as an office and exhibit building for manufacturers and their associations. On the rectangle immediately to the south of the Grand Central Palace is the mail service and office building now consisting of 4 stories in which are the executive offices of the New York Central Railroad. To the present building is now being added 13 stories which will afford space for all the New York Central offices and those of the New Haven road which are in New York City. This will release all of the office space now occupied by New York Central offices in the Post Office and office building. At present most of the office space occupied by the New York Central is in the head building, in which a small part of the space is now leased to private concerns. Recently the demand for office space here has become so great that it was decided to build the addition to the mail service building.

While the casual sightseer looking out over the yards and the Park Ave. Plaza from the head building sees only the visible development, the interest of the engineer will attach also to the vast network of tracks, signaling systems, power, heating and communicating lines, subways and ventilating systems that are necessary to serve the group of buildings as a whole and operate the Grand Central as a railroad terminal as well. Since no basement room is available in the buildings surmounting the area of trackage it was necessary to provide central power and heating plants, with an elaborate system of distribution under the lower level. This may be said to be one of the distinctive features of the plan. The fire signal system that has been installed is comparable to that of a small modern city.

The distinctive feature of the track layout of both levels is the system of loops shown in the accompanying insert. Although connections of the upper level loop and the outside loop of the lower level are not yet complete on the east side of the layout north of 45th St., it is the ultimate plan of operation to have the incoming trains enter on the west side and run out around the loop tracks so as to avoid cross-over movements at the throat of the yards above 50th St. This will greatly increase the traffic capacity of the terminal as the demand is increased above the 600 trains a day which now enter and depart. Since practically all of the suburban traffic is handled on the lower level, provision was made for an inner loop, having much sharper curves, around which can be operated only multiple unit electrically driven cars on account of the short radius. This loop is now in use. Of course, it is not necessary to pull all of the empty trains out to the Mott Haven Yards, on the other side of the Harlem River, for cleaning since the terminal layout includes a large area of storage tracks in addition to the network of running tracks and the platform tracks.

To operate the complicated network of trackage it was necessary to devise a signaling system for each level that could be operated by a director who could not possibly see the train movements. The main signal tower—a tower below the street level at 49th St.—is a 4 story building that houses the interlocking ma-



THIRTY-ONE STORY TWIN OFFICE BUILDING OVER RAILROAD YARDS
Building of which is now being projected as co-operative corporation, formed by owner-tenants, holding option on "Air Rights" above tracks.

chines that operate the switches and signals. Each level is controlled by a director who has before him a facsimile diagram of the track layout on which movement of trains between switches and fouling points is indicated by small electric lights. The signal machine for the suburban level is the largest ever constructed and has 400 levers, each of which operates a switch or signal, and on the floor above, the machine for the upper level has 362 levers. To each 40 levers a man is assigned who works under the instruction of a train director. An incoming train is announced to the director by telegraph from the interlocking station at Mott Haven Junction stating the kind of train and what time it is being sent. When the train has passed down Park Ave. as far as 72d St. an electric light located on the director's desk informs him that the train has passed that point, so that the director may decide upon what track to receive the train and then call his orders to the levermen accordingly. The moment the incoming track is determined upon this information is transmitted from the signal tower by a telautograph to similar instruments located in other parts of the terminal. One of these informs the attendant at the incoming bulletin board of train movements for the convenience of people meeting friends. Other recording instruments at various points notify the 200 station porters of the approach of all through trains.

The signal system, which is as nearly automatic as is possible to make it, may be termed the nerve center of the railroad terminal proper, for without it there could be no movement of trains over this vast area in which movements can hardly be seen from one track to another at some points. The signal and switches interlock both mechanically and electrically. Alternating current track circuits are used in lieu of detector bars and there is a complete spare set of these connections to insure continuous service. The track circuits are used to prevent the operation of switches while trains are moving over them and to indicate the presence of trains within the limits of fouling or danger zones These circuits are also used to operate electric locks which automatically hold the levers in position. The lock is released only when there are no trains on the track between the fouling limits. Alternating current track circuits are necessary on account of the 660 volt direct current circuit made through the track and third rail for electric motive power.

The extent of the power and heating plant facilities serving the terminal layout is indicated by the fact that on the coldest days the coal consumption reaches 500 tons, and the average boiler load per day during a cold month is about 5,000,000 lbs. of steam, equivalent evaporation from 212 degrees. The average coal consumption in the winter months is 390 tons per day. Both steam and hot water heating systems are used and the hot water mains alone have a total length of over four miles, with pipes from 14 to 18 in. in diameter. A complete refrigerating plant is also included in the power units. The 50th St. power plant is the main heating unit for the terminal. It is equipped with fourteen 600 hp. boilers, steam from which passes through the surface heaters of the hot water system. Although lighting current for the entire terminal is derived from a complete electrical substation in the 50th St. plant, consisting of four rotaries for lighting and power purposes besides six rotaries for railroad purposes, steam from the boilers is first used to operate turbines driving direct-current generators, and exhaust steam from the turbines is passed through the hot water heaters in order to increase the efficiency of the unit. From the 50th St. plant hot water for heating purposes is driven a mile in its circuit to most of the buildings in the group including the main station building the incoming station, the terminal offices, the Post Office, general office building, the Vanderbilt Concourse Offices, Grand Central Palace, the Yale Club, the Biltmore Hotel, the Express Building and the Y. M. C. A., the last being in the same block as the 50th St. power plant. Three

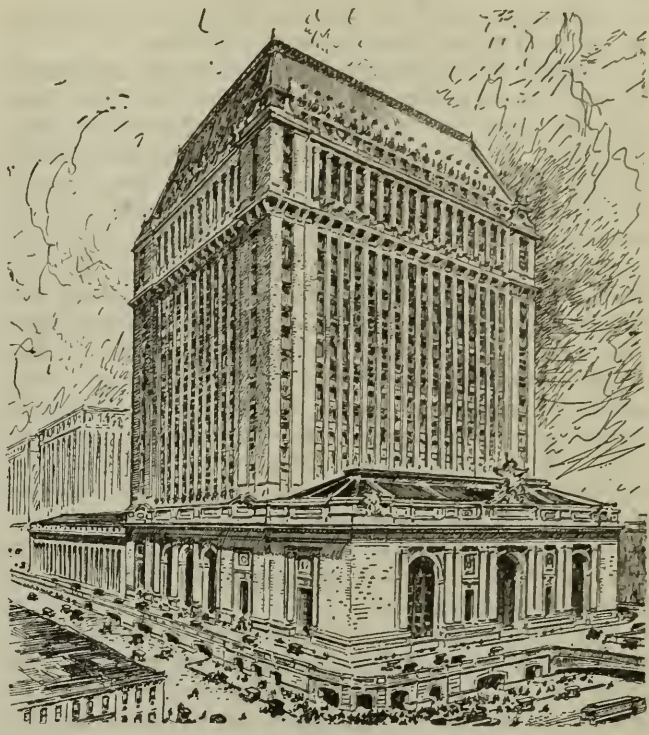
stages of pressure are necessary to provide for the great height to which hot water is raised in connection with heating the Biltmore Hotel.

Subsequent to 1916, the desire of tenants in new buildings to be erected to use steam for heating purposes led the management to erect an additional boiler plant under 43rd St., from Lexington Ave. to Depew Place. This plant, which has space for six boilers of more than 1,400 hp. each, is located 90 ft. below the street level. The excavation for it involved the removal of 36,790 cu.yd. of solid rock. The two boilers now installed, while having a direct emergency connection with the 50th St. power plant, are used for generating steam heat for the Commodore Hotel and may also be used to heat the Hotel Chatham and the Paterno Apartments. During the winter, the average steam consumption per month of the Commodore Hotel alone is 36,000,000 lb. equivalent evaporation. It is interesting to note that the smoke stack for this power plant is virtually included in the Hotel Commodore itself, being located in a corner of the west wing, leaving two vertical rows of windows blank on each side. The stack is carefully insulated from the adjoining structure, so as not to overheat hotel rooms. The coal and ash handling systems of the 43rd St. Power Plant are entirely mechanical. Coal is dumped by motor truck through the street manholes into the bunkers, which have a capacity of 2500 tons, from which it is delivered by gravity to the automatic chain grates. Ashes are delivered mechanically to an overhead conveyor which loads into cars on one of the loop tracks above. The lowest point in the whole terminal is the sump in the floor of this plant, at an elevation of 57 ft. below mean low water, or 100 ft. below street level.

Anyone who is shown the power plant facilities of the Grand Central cannot but be impressed with the extent to which engineers have gone in furnishing spare units. One of the boilers in the 43rd St. Power Plant itself is a spare and the plant as a unit, in case of emergency, might be used as a spare for a portion of the 50th St. plant by direct steam connection. This phase of planning for continuous and uninterrupted service is also carried out in the electrical equipment. Just above and adjacent to the 43rd St. plant is located a 2,000 kw. rotary converter, which may be used as a spare at this point in addition to those installed in the 50th St. plant. Thus continuous service is rendered the power and lighting load which in January, 1920, amounted to 2,115,000 kw.-hr.

The complete refrigerating plant is located adjacent to the suburban loops and on the same level near the southeast corner of the main building, as indicated in the accompanying insert. It provides refrigeration for the cold-water system extending throughout the terminal office buildings, furnishing water at 45 deg. F. The plant also serves various soda fountains and ice cream stands and other minor facilities throughout the terminal. It is equipped with three compressors with a total capacity of 60 tons of ice per 24 hours. Two auxiliary compressors with a capacity of 20 tons are also provided.

The express waiting room, the suburban concourse and the incoming station are ventilated and heated with tempered air delivered by twelve blowers with a total capacity of 648,000 cu.ft. per minute. The blowers and air tempering units are located on the suburban track level in various spaces between the



OFFICES ULTIMATELY TO BE BUILT OVER CONCOURSES
Present structure designed and built to carry seventeen story building. Columns weigh approximately one ton per linneal foot

main and loop tracks below the suburban concourse. They are all electrically driven. No air is delivered from the blowers to the main concourse direct, since circulation in this room is accomplished through the large openings above ramps leading to the lower level.

When the terminal was built it was necessary to construct a separate sewer under 46th St. about 40 ft. below the street level to drain the suburban track level. In addition to this sewer there are three sewage ejectors located in sumps just below the suburban track level near the southeast corner of the main building from which sewage is received and raised to sufficient height to be carried off. There are also four sumps for receiving drainage water which is pumped up to the water system.

Subways for the handling of baggage, mail and express below the lower level are at the lowest elevation of any of the terminal passageways, being between 50 and 60 ft. below the level of the street. The location of these passages is shown in the accompanying insert. Here all of the baggage, mail and express received and sent out of the terminal is transferred to and from the individual tracks of the upper and lower levels by means of elevators connecting with the subways, so that there is a minimum of baggage trucking on the train platforms. Also on this sub level are found fire proof oil rooms and lamp rooms used by the trainmen. Throughout all of the levels of the terminal are fire stations—96 in number, divided into four districts—each indicated by a blue light marking a signal box and all connected to a main switchboard in the terminal office building and through it to the city fire alarm system. An alarm turned in is sounded in all parts of the terminal indicating its exact location. Frequent fire drills are held to maintain the efficiency of the great force of terminal employees as emergency fire fighters. With this protection it seems

inconceivable that a fire should ever gain any headway in any part of the great fireproof structure.

Primarily a great center of transportation and transfer with direct connection between the New York Central and New Haven railroads, the Lexington Ave. and Times Square routes of the Interborough Subway, and the Belmont Tube to Queensboro and Long Island, the Grand Central stands today as a remarkable civic development for which there is no precedent. Although its traffic capacity has by no means been reached and the development of the whole is still incomplete, the terminal is used daily by 50,000 to 100,000 people besides 111,040 arriving and leaving on trains. One of the surprises to the management is the result of actual counts of people who do not use trains but still pass in and out of the terminal. Of the daily train passenger traffic about 65,480 are suburbanites, and this portion of the traffic is steadily increasing. The number of passengers in and out of the station on trains in 1903, at the beginning of reconstruction, was 16,135,667 —or 44,200 per day—as compared to 32,338,053 in 1919—or 88,500 per day.

Additional building already planned for the Grand Central property indicates the increasing value of land connected with the greatest transportation center in the United States. While there are no definite plans yet developed for building over some of the vacant rectangles, the growing demand for Grand Central property points to the building up of the whole area, many projects for which are under consideration.

Sales of Garbage By-Products at Chicago

Disposal of the byproducts of the Chicago municipal garbage plant by private sale without advertising for bids has led to an investigation by the Chicago *Tribune*, which arrives at the conclusion that the city is a loser by this method of handling the business as the material is sold below current market prices. It appears that in 1918, under war conditions, the finance committee reported that the market value of the byproducts fluctuated so greatly that the city's revenue was smaller from contracts made after advertising for bids than it would be from direct sales made according to market conditions. On this recommendation the city council authorized the commissioner of public works to sell the byproducts according to market conditions by agreement with parties "who will pay the highest price, upon competitive bids obtained without advertising."

In March, 1920, the finance committee recommended a change tc the original practice and the council passed an ordinance providing that bids for the sale of the byproducts should be advertised for and submitted to the finance committee. This ordinance was vetoed by the mayor on recommendation of Mr. Francis, commissioner of public works, the reason given being that advertising "prevents rapid disposal at current market prices and opens the door to contract relations with discredited and irresponsible combinations of dealers."

The present purchaser, who was formerly connected with a reduction company whose plant was purchased by the city, is reported as stating that the reason for the relatively low price paid to the city is that its garbage byproducts are inferior in quality to those of other cities. He buys it as it comes, without making analysis, and sells it on the buyer's analysis.

Proposed Water and Sewer Districts in Cuyahoga County, Ohio

By R. F. MacDowell

Division Engineer, Morris Knowles, Incorporated, Cleveland, Ohio

To PROVIDE badly needed water and sewerage improvements for a large unincorporated area just outside of the city of Cleveland the County Commissioners of Cuyahoga County recently created two large county sewer districts and retained MacDowell & Garvin, Sanitary Engineers of Cleveland, to make a preliminary investigation and report.

The State Law under which these sewer districts were created was enacted for the purpose of providing water and sewer improvements for built-up territories outside of cities and hence not under the jurisdiction of the municipalities. The law gives the County Commissioners authority to define the limits of the district, to design the improvements, and to raise funds for their construction by special assessment upon the property benefited.

County Sewer Districts 1 and 2 in Cuyahoga County cover about 27,000 acres to the southwest of the city and were laid out along topographic rather than political boundary lines in order to simplify the problem of sewerage design.

The report, which was submitted on June 1 by MacDowell & Garvin, Cleveland, Ohio, recommends a general plan of trunk and intercepting sewers for each of the districts, all of the sewage in each district being conveyed by means of these sewers to a single point for treatment. The sewage-treatment plant for District 1, the westerly district, would be constructed, under the plan recommended, just inside the corporate limits of the city of Cleveland in the valley of Big Creek. This plant can be made to serve not only this sewer district but an area of about 1,250 acres within the city limits, as well as a large portion of the village of West Park. It is estimated that the plant at this site, comprising sedimentation tanks and contact filters, would be satisfactory for a period of ten to fifteen years in the future, at the end of which time the plant could be enlarged and the tank effluent conveyed either to the Cuyahoga River or to Lake Erie.

It is recommended that the sewage from District 2 be treated by means of a plant comprising sedimentation tanks and sprinkling filters, located in the valley of the Cuyahoga River, and constructed by the county. This plant would also serve for a period of ten to fifteen years, at the end of which time the sewage could be conveyed by means of a siphon across the Cuyahoga River to the site of the proposed southerly sewage treatment plant of the city of Cleveland.

It is estimated that the trunk sewers and sewage treatment plants for these two districts will cost in the neighborhood of $2,500,000.

The report recommends that the water supply for the two districts be secured from the city of Cleveland. However, on account of the high elevation of a large portion of the districts above Lake Erie it would be necessary to construct booster stations and reservoirs within the district to supplement the city water-works system. It is estimated that the water-works facilities, including the main water lines, pumping stations and reservoirs to serve the district until 1960, would cost some $1,100,000.

Although the improvements as recommended would be built by the county they would be designed with a view to their operation and maintenance by the City of Cleveland in the event of annexation of the area by the city at some time in the future.

Building Highways to Meet Demands of the Subgrade

By F. A. Churchill
Dunn Wire-Cut Lug Brick Co., Conneaut, Ohio

A BUILDING is no better than its foundation. A highway is no better than its subgrade. A great deal is being said, pro and con, about building highways to bear the load. On the other hand, legislative steps are being taken to limit all loads to the capacity of inferior roads. At present the first proposition seems to involve construction so heavy as to be prohibitive in cost. The alternative imposes a handicap on the development of transportation and retards progress. The primary purpose of all traffic lines, whether rail, water or highway, is to meet the transportation needs of the country. Restrictions of transportation are contrary to public policy.

Nevertheless a temporary compromise must be adopted. Roads built for pre-war traffic cannot sustain the 15-ton truck loads of the present. Unless a safe limit be put on unit loads a vast mileage of hard-surface roads built in years past will soon be ruined. Some form of traffic regulation must be adopted in order to save such roads. But the alternative for new road construction is not necessarily massive construction.

Must Consider Soil in Subgrade

The solution of the problem does not seem to be more material but more knowledge—not heavier designs of surfacing but accommodation of beams to soil conditions. This involves flexibility in designs. The practice of designing uniform construction for all parts of a road, regardless of differences in soils, is the source of many failures in roads. Engineers who have studied the subject intelligently agree that most of the failures of brick highways have been due to defective subgrades. Experiments have demonstrated that an 8-in. slab—4 in. of vitrified brick and 4 in. of concrete foundation united in a monolithic beam—if properly built will sustain almost any traffic load if the supporting subgrade be stable and uniform.

Drainage is highly important. Too much stress cannot be laid on that point. But draining alone, as it is now done by almost uniform specifications, will not suffice. It is difficult in any case to prevent moisture from entering a subgrade, either from capillary action or by seepage; but different soils require different treatment. It is of the utmost importance to know your soil and to know how it acts under the influence of different degrees of moisture content.

Very few highways have uniform soil conditions. There may be gravel that drains readily, and sand that compacts easily, and sand that refuses to compact, and clay that retains moisture persistently, and quicksand that when saturated is as unstable as quicksilver.

Very frequently all these conditions are found on a single road. It is therefore manifestly absurd to design a uniform slab for such a road. On some portions of the road a 7-in. beam would suffice for any traffic. On other sections of the road a 12-in. beam might be required, while on the worst sections heavy reinforcement might be necessary. Nor would the question of drainage be less complex. Instead of emphasizing building roads for the traffic, better results will be obtained by building roads for the soil. If we do that, the traffic problem will solve itself. This, of course, presupposes the building of a high-class type of road that in itself has strength and wearing qualities. If there is on a road only one spot of poor soil, however short, the design should be changed to meet the conditions, and changes should be made wherever poor spots occur.

Proof of the folly of building uniform surfacing for various kinds of soil is furnished by one of the most important Federal-aid projects in Ohio. Main Market road No. 1, traversing the northern tier of counties from the Indiana State line to the Pennsylvania State line, was paved 12 mi. from Ashtabula to Conneaut in 1919. Construction was monolithic, 5 in. of concrete foundation and 4 in. of wire-cut lug brick. The road was completed in the fall of 1919. During the winter of 1919-1920 heavy snows covered the road from mid-November until late in the spring. Snow came before hard freezing, so that there was hardly any frost in the ground, not deeper than 1 in. when the snow went off.

An inspection in May, 1920, showed the road to be in perfect condition, even in low-lying places, with the exception of three sections where wide longitudinal cracks appeared. The cracks were in the highest part of the crown, and in one instance extended for ¼ mi. in length.

A careful examination of the road and diligent inquiry into natural conditions developed the facts that although the defective sections were at least 4 ft. above the bottom of the side ditch and were underdrained with tile the sub-grade contained quicksand. No evidence of frost heaval was discoverable, but the north half of the pavement had settled appreciably and caused the slab to break, by its own weight and the weight of heavy trucks, along the median line. The pavement was laid during hot, dry weather, when the quicksand was firm; but moisture created by melting snows had evidently given the quicksand almost a fluidic consistency, leaving the slab practically unsupported by the subgrade.

If the road had been built with an intelligent understanding of existing soil conditions the weak sections could have been strengthened either by increasing the depth of beam or by reinforcing the foundation.

Instance of Faulty Design

A similar instance is that of the Cleveland-Akron brick road built of a uniform thickness on firm soil and over marshy ground. Where the subgrade was firm the pavement sustained enormous traffic without damage, although the road was constructed during the period of only moderately heavy truck traffic; but the sections built over yielding soil broke down so completely that reconstruction was necessary.

Doubtless other cases at point could be cited, but these examples should teach engineers: (1) To study the soil of the subgrade; (2) to design the pavement to suit the varying conditions of subgrade; (3) to adapt the drainage system to the nature of the soil, as well as the lay of the land. It is obvious that comparatively light construction will serve where the sub-

grade is dry, firm and unyielding, but that heavy construction is advisable when the nature of the subgrade makes it necessary for the beam itself to supply a large part of the load-bearing strength.

Study of soil has been neglected in the past. In fact soil as an integral factor in pavement construction never received serious consideration until the war brought heavy trucking over highways into the problem, and it is only very recently that soil study in relation to road building has been taken up in the spirit of scientific inquiry.

The U. S. Bureau of Public Roads, the Federal Highway Council, state highway departments and other bodies have at last undertaken research work with a view to acquiring accurate data regarding soils, as a basis for scientific road building. The Bureau of Public Roads has done some field investigating, making borings where high-class road surfacings have broken down, and conducting laboratory analyses of soil specimens so obtained.

So much attention has been given in years past to improvement of road surfacing methods that engineers and others in interest have overlooked the fact that the only really permanent part of a road is that which supports the metal. Surfacings wear out in time but the grade ought to be so constructed as to remain indefinitely, serviceable for resurfacing several times. Improving a highway is a structural problem akin in principle to the erection of a lofty building. In either case the stability of the superstructure depends on the rigidity of the foundation and its natural support. Architects and builders do not figure on the same style and weight of foundation for all kinds of subsoil. Roadbuilders should be equally discriminating in the matter of foundations.

Maintenance on English Roads

DURING the year ending in March, 1920, maintenance upon the Essex, England, county main roads, aggregating 672 mi., cost the county authorities, according to the annual report of the county surveyor and recently reported in the *Surveyor*, a total of £162,065, or an average of $1,170 per mile. Essex County main roads total 788½ mi., though 116½ mi. are under urban authority, making the length under the direct control of the county council, 672 mi.

Some difficulty was experienced in the maintenance of the Essex roads owing to the lack of railway transportation for the conveyance of granite and the small quantity possible of delivery as compared with requirements. The railway strike of September, 1919, imposed an additional strain upon the roads at a time when they were least able to stand it. Several of the Essex roads suffered to such an extent that complete reconstruction will be necessary, one of such roads being the one from London to Ipswich running through the center of the county. To restore this road alone, which is but 33 mi. in length, an expenditure of £132,000 will be necessary, it is estimated, exclusive of the cost of repair to damaged bridges.

As an indication of the traffic carried by some of these roads during the railway strike, statistics taken in November, 1919, show that on one occasion, about 2 a.m., a fleet of 39 loaded trucks, representing 585 tons, passed an observation post on the Chelmsford-Colchester road at intervals of 45 seconds.

Flood Check Dams Formed by Fill Behind Wire Frame

New Type of California Dam Automatically Fills With Flood Debris Which Causes Barrier

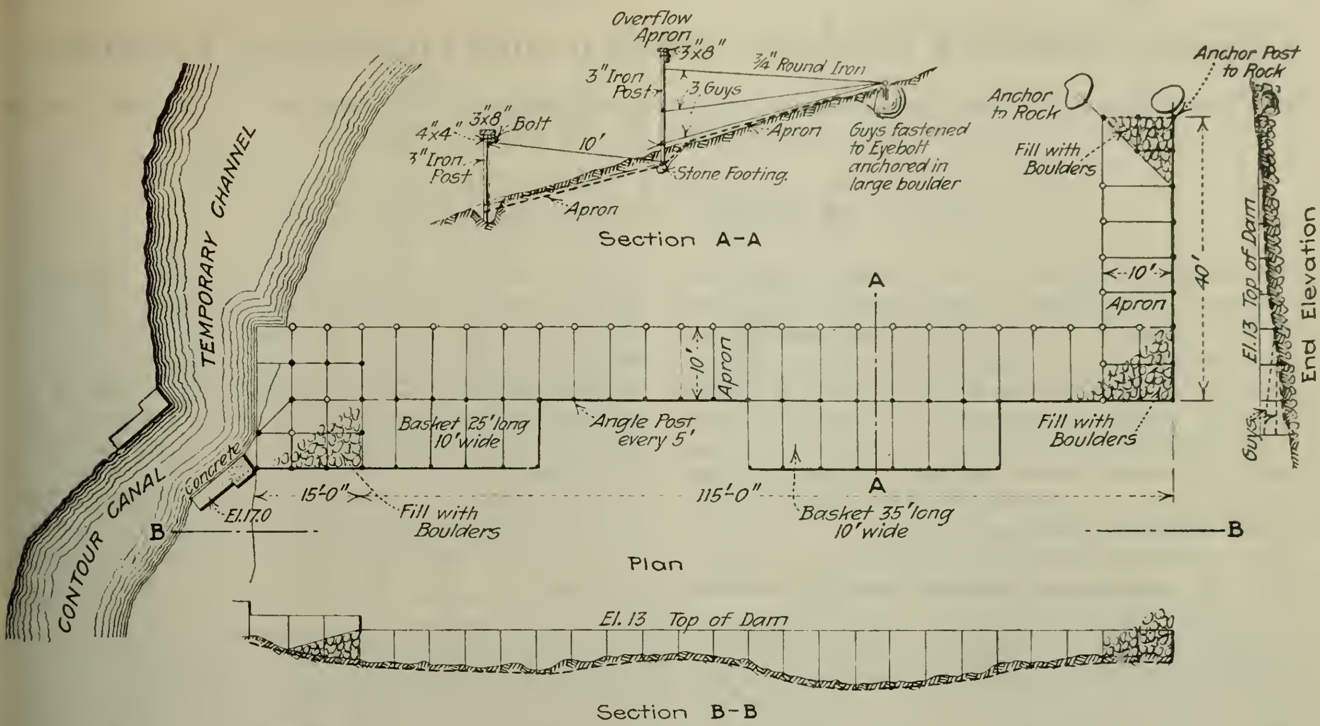
TO CHECK the velocity of streams in flood times and to store the surplus water which flows down the sandy and porous California river beds there have been built lately some special dams known as "Pratt Porous Dams," after their designer and builder, A. A. Pratt, of Los Angeles, Cal. They consist of a gaged

DAM FRAME COMPLETED. NOTE NATURE OF THE RIVER BOTTOM

wire frame stretched across the dry bed of the stream behind which frame there builds up during a flood a mattress of debris which constitutes an effective barrier to the water.

The views and drawing herewith are of such a dam built for the Water Conservation Association of River-

PASSING A FLOOD OF 1 FT. ABOVE DAM



DETAILS OF PRATT POROUS DAM FOR SANTA ANA RIVER, CALIFORNIA

side, Cal., on the Santa Ana River. Here there is a narrow contour canal with a wide adjoining flood water channel which for the most of the year is dry with a bed of heavy boulders, gravel and sand. It was desired not only to check the occasional floods which overflow the channel, but to store these surplus waters which would then sink into the gravel of the debris cone to replenish the San Bernardino artesian basin below.

The dam extends 130 ft. across the channel with a wing 40 ft. long and has a main barrier for its whole length with two supplemental front barriers for a part of the length as shown.

The dam is constructed of iron posts or angle irons set into the bed of the stream and standing about 6½ ft. above the bed and about 3 ft. deep. These posts are guyed upstream by heavy wires to anchors set in boulders in the bed of the stream. The lower line of posts for the supplemental sections are set on the bed of the stream but not below the surface. They are guyed upstream as in the main dam. Upon these posts transverse angle irons are bolted forming a frame on which wire mesh is stretched. The mesh in this case was made of ¼-in. wire with 6-in. mesh The wire mesh is carried upstream above the river bed for about 16 ft. and boulders laid upon the apron so formed.

The dam itself is built on a gravelly river channel which had no water in it at the time the dam was constructed. There is no bedrock anywhere near the dam, either below it or at either end. During times of heavy rain boulders, sand and gravel are carried downstream in large quantities. During periods of high water this stream runs from 4 to 8 ft. deep and ranges from 1 to 500 ft. wide, with a gradient of approximately 200 ft. to the mile.

After the water reached this dam it took about half a day for it to fill to the top of the dam and on Feb. 22, 1920, the water reached a height of 4 ft. over the top of the upper dam. When the picture of the flood was taken, Feb. 23, the water had receded to about 1 ft. over the top. An inspection made of the dam after the water had subsided shows that it suffered no damage.

In explanation of the action of the dam, Mr. Pratt says:

"The difference between the porous type and the solid type is this: Water impounded behind a solid dam becomes a reservoir. Over the surface of this resevoir all floating debris is carried until dropped over the crest of the dam. All matter in traction is deposited at the place of contact between the active stream and the quieter waters impounded by the dam. No deposits is made at the back of the solid dam, except pervious silts.

"Behind a porous dam no water is impounded, at first. But as the water passes freely through the structure the floating debris is caught and deposited in a mattress extending from 1 to 20 ft. upstream. As the mattress builds it is joined and cemented by the matter in traction, thus creating a solid impervious mattress commencing at the bottom and building up to the top of the dam. After this mattress is completed the overflow then acts exactly as it would in the case of the solid dam, with the difference that the back-cutting can only proceed to where it encounters the mattress previously built by the stream itself, when the menace ceases. With a solid dam, when the back-cutting reaches this same point it connects with the water percolating from the reservoir and a channel is apt to be opened under the structure which automatically enlarges until the solid dam falls."

Value of 1919 Clay Products

The value of the clay products marketed in the United States in 1919 is estimated by Jefferson Middleton, of the U. S. Geological Survey, Department of the Interior, at $260,790,000, the highest yet recorded. This is an increase of $40,216,000 compared with 1918 and of $28,277,000 compared with 1917, and is nearly $100,000,000 greater than the value ten years ago. The value of brick and tile products constituted 71 per cent and that of pottery products 29 per cent of the total.

Chicago Bascule Bridge—Design and Operating Features

Four-Truss Duplex Construction of Double-Deck Bridge—Emergency Grip Brakes—Interlocked Control of Gates, Locks, Safety Devices and Machinery

By Hugh E. Young
Engineer of the Chicago Plan Commission, recently Engineer of Bridge Design for the City of Chicago

TO MEET severe service requirements many new features of construction were incorporated in the new double-deck double-leaf fixed-counterweight trunnion bascule highway bridge of 256-ft. span over the Chicago River at Michigan Ave., which was opened in May, 1920. They have proved wholly successful, except for the division of the bridge into two separable structures set side by side and coupled together, which arrangement has not yet been put to the test of uncoupling and separate service.

Even apart from its novel design the bridge is noteworthy for its size and the exceptionally heavy traffic which it carries. It is believed to be the only double-deck bridge ever built having highways on both levels in order to provide for a separation of fast and slow traffic. Other double-deck bridges combine railway and highway traffic. A view of the bridge is given in Fig. 1.

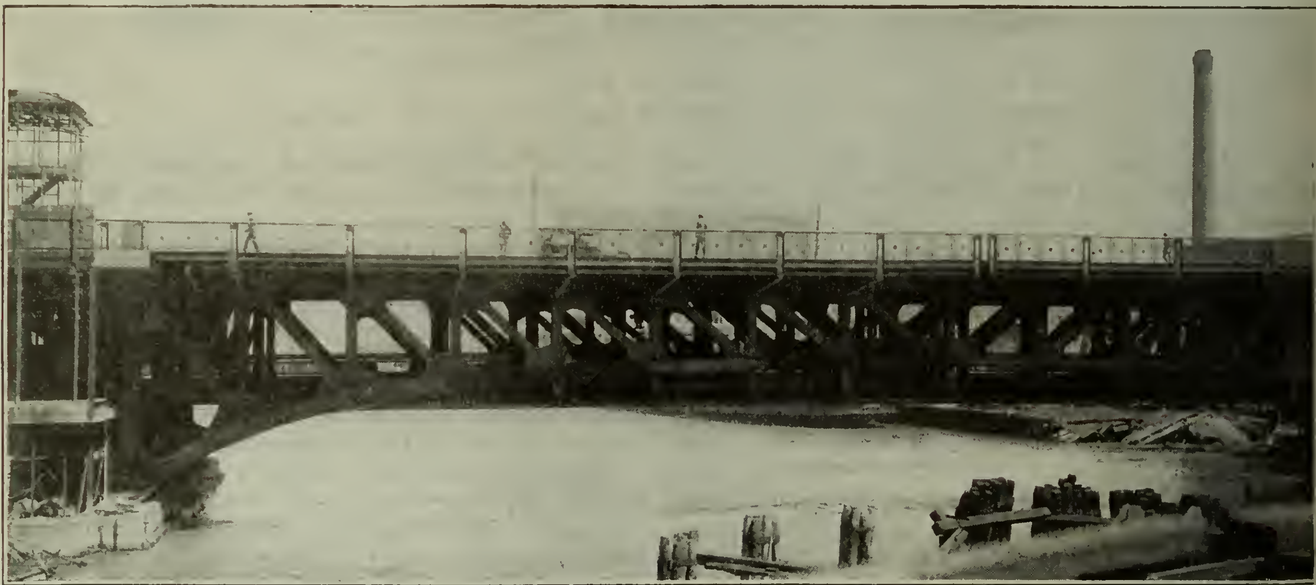


FIG. 1. DOUBLE-DECK HIGHWAY BASCULE BRIDGE OVER CHICAGO RIVER AT MICHIGAN AVE.

This bridge is the most important part of the widening and extension of Michigan Ave. between Randolph St. and Chicago Ave. to afford a wide and direct thoroughfare connecting the business district with the north-side section of the city, an improvement which eliminates the former circuitous and congested route crossing the old Rush St. swingbridge. Viaduct approaches connect the street level of the avenue with the upper roadway of the bridge, the lower roadway being for the slow and heavy traffic between various industries, terminals and steamship docks in the vicinity of the river. At the ends of the bridge the approaches are widened to form broad and ornamental plazas.

With a span of 256 ft. c. to c. of trunnions, the structure provides a clear channel width of 220 ft. Its navigation headroom was required by the War Department to be 16½ ft. from water line (city datum) for 80 per cent of the channel width with the bridge closed, and 120 ft. for the entire width of channel with the bridge open. The lower deck has a traffic clearance height of 13½ ft., while the upper deck is free of overhead obstruction. Both floors are paved with creosoted yellow-pine block paving on transverse planking bolted to the I-beam stringers. Back of the trunnions, however, the lower deck has sandstone block paving on concrete on a buckle-plate floor, in order to add weight to the tail and to give a better footing for teams on the 3 per cent grade from the street. Provision is made for the future construction of two street-car tracks on the lower deck.

Four trusses were used for each leaf, for reasons noted below. The two inner trusses are spaced 6 ft. c. to c., and the outer trusses 27 ft. On the upper deck there are two 27-ft. roadways between trusses and two 15-ft. sidewalks on cantilever floor beams. On the lower deck are two 18-ft. roadways and two 6 ft. sidewalks, all inside of the trusses. The width over all on the upper deck is 91 ft. 9 in.

Reasons for Four-Truss Construction—Two principal reasons determined the adoption of four-truss in preference to three-truss construction: (1) advantages in design and construction, and (2) the possibility of separating the bridge into two parallel parts in case of emergency. With three trusses the load on the center truss would have been approximately double that on each outside truss, which would have meant double work in designing, detailing and fabricating the trusses. The anchor arm for the center truss would have been so heavy that the shop details would of necessity have differed considerably from those of the outside trusses,

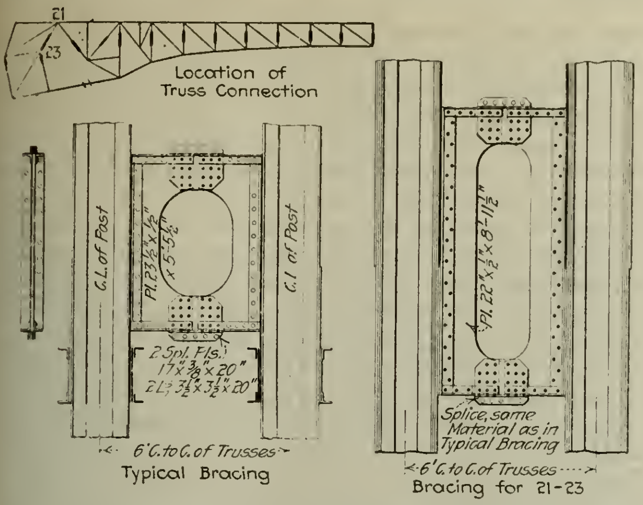


FIG. 2. SEPARABLE DIAPHRAGMS CONNECT INNER TRUSSES OF FOUR-TRUSS BRIDGE

grips of rivets would have been increased and difficulties of detail encountered. The increased weight of the two center trusses over one center truss is slight, being due only to additional structural detail, as the main section of the chord and web members requires the same amount of material in both cases. The increased weight due to truss details and to diaphragms connecting the two parts is offset by cost advantages secured through the shorter floor beams and fewer stringers in the roadways. Erection would have been more difficult with a heavy center truss and light outer trusses.

Again, the trunnions for the four-truss span are all of approximately the same diameter, while the much larger trunnions of a center truss would have involved difficulties and extra cost. Further, there would have been difficulty in arranging the anchor-arm floor members to clear the journal boxes of the larger inner trunnions. The cross-girder supporting the trunnions would have required wider flanges in order to seat the bearings and this, in turn, would have made it difficult to obtain clearance between the lower flanges of the cross-girder and the truss members of the anchor arm.

The Duplex Arrangement—By using four trusses each leaf could be built in two parallel parts so constructed that each part can be operated independently. Bridges over the Chicago River frequently are struck by vessels and damaged to an extent that necessitates raising them to the open position for repairs, interrupting street traffic until these are completed. Experience has shown that in such cases the principal damage done is to the sidewalk construction and to the trusses ahead of the trunnions, and as the parts back of the trunnions are not affected it has been possible to raise the damaged leaves into the open position. If one side of the Michigan Ave. bridge should be struck by a vessel there is no doubt that the shock would be absorbed by one half of the leaf, and that the damage would not prevent the raising of this part of the leaf, leaving the remaining half available for traffic. To provide for such contingencies, therefore, the two halves of the leaves were made independent but connected at the panel joints by diaphragms split at the center and spliced to take shear loads only. These diaphragms (Fig. 2) would buckle under impact before distorting the heavy truss members to which they are connected.

It is estimated that the diaphragms at the 26 panel points could be disconnected in eight hours by a force of twenty men, including the time required to remove bolts from shaft couplings and to place bolts in the differential gears for the purpose of causing this device to act as a unit. The removal of the diaphragm plates is also included in the time given above. If it should become expedient to cut the diaphragm connections by burning it is estimated that eight men with four torches coud accomplish this in four or five hours.

This separable four-truss arrangement was applied years ago in the four-track rolling-lift bascule bridge of the Metropolitan Elevated Ry. at Van Buren St., Chicago. It has never been necessary to disconnect the two parallel parts of that bridge; as it carries only an elevated railway it is considerably higher than the street bridges, and therefore less exposed to damage by vessels. Street bridges are not only lower but also very close together, so that when there is delay in opening a bridge it is difficult to handle a ship so as to avoid striking it. Advantage will be taken of the duplex arrangement, however, in replacing the old Van Buren St. bridge by a new structure: traffic will be maintained over one half of the old bridge during the removal of the other half and the erection of the corresponding half of the new bridge. The Charles River single-leaf bridge of the Boston Elevated Ry. also has the duplex or four-truss arrangement, so as to permit of maintaining traffic on one side if it should become necessary to raise the other part for repairs.

Emergency Brakes of New Type—Electro-pneumatic emergency brakes on the heels of the trusses, which act by gripping rails fastened to concrete supports in the

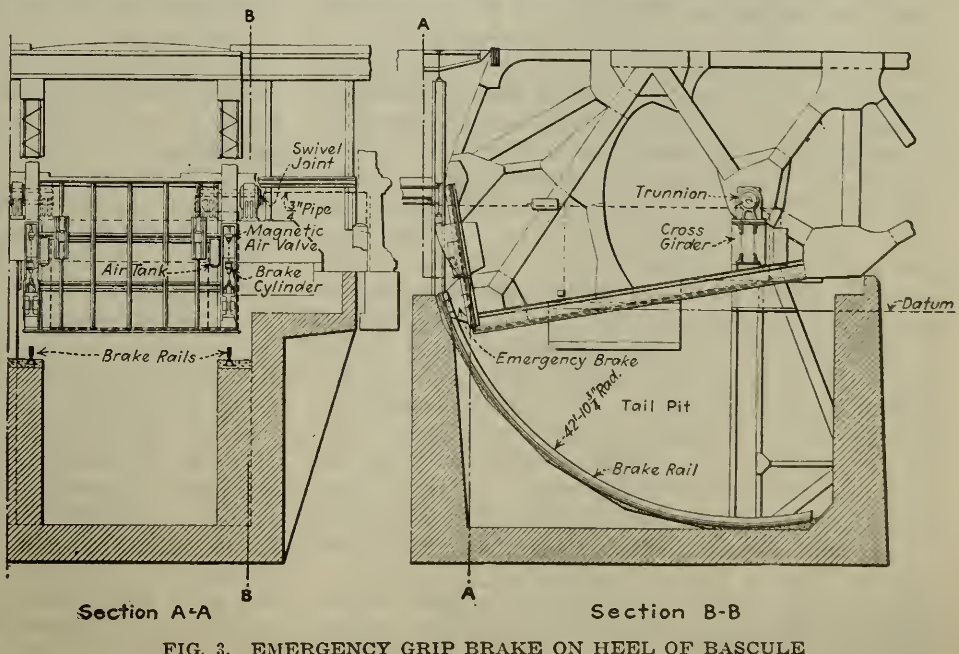


FIG. 3. EMERGENCY GRIP BRAKE ON HEEL OF BASCULE

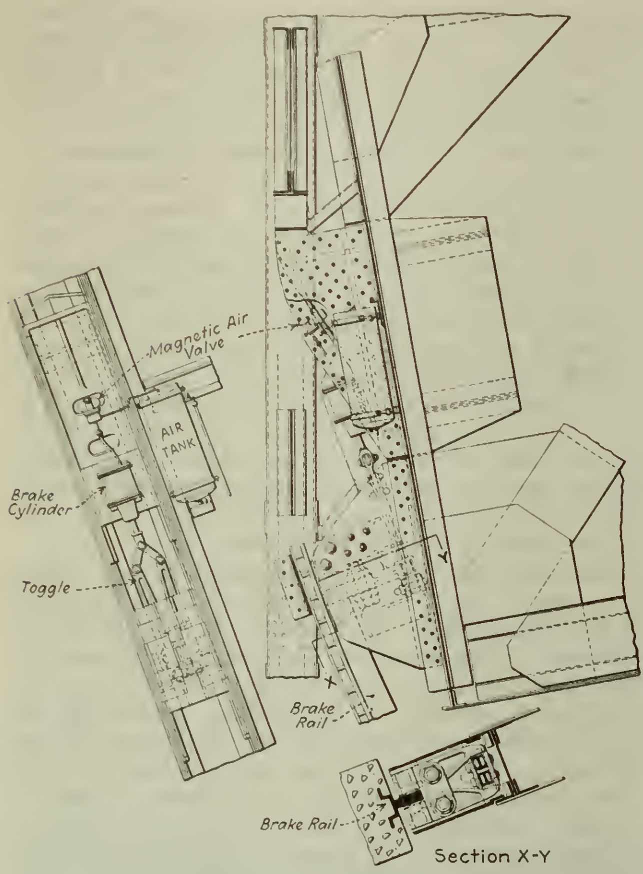


FIG. 4. DETAIL OF EMERGENCY BRAKE

tail pit, have been introduced to supplement the pneumatic and hand brakes which operate through the gear train. This is an innovation in bridge design at Chicago and is for the purpose of holding the bridge in case of accident to the machinery. The construction is shown in Figs. 3 and 4. The four brake rails are curved to the path traveled by the ends of the trusses and each is gripped by shoes operated by toggles through levers from a pneumatic cylinder 10 x 10 in., the air supply to which is regulated by a magnetic air valve controlled from the operator's house.

The grip brakes are designed to hold the leaf in any position against a wind pressure of 20 lb. on the vertical projection of the raised leaf. Under these conditions a gripping force of 95,000 lb. is exerted on each brake rail, corresponding to 6,000 lb. at the cylinder. A friction coefficient of 0.30 was used in the design.

On several bascule bridges of Chicago where the leaves are subject to unbalanced loads, and the brake arms are long, there has been a tendency for the brakes to slip, and it has been found necessary to have at least two shaft-operated brakes on every bridge. The possibility of one brake failing or being out of commission on account of repairs also argues for a second brake. Shaft brakes are operated generally by cables or rods, and failure of any one of these or an element of the gear trains suffices to put the brake out of service. There have been many instances when the braking stress in the shafts has exceeded the driving stresses, and in some instances the shafts have been badly bent due to improper application of brakes.

For ordinary spans it is considered proper to brake through the machinery, but the Michigan Ave. bridge is of such magnitude that it was considered necessary to take the extra precaution of having an emergency brake entirely independent of the shaft brakes. This consideration led to the design of the rail-gripping brakes.

Trunnion and Support Problems—Loads of 1,540,000 lb. on each inside trunnion and 1,800,000 lb. on each outside trunnion required trunnions of 24½ and 26 in. diameter respectively, as shown in Fig. 5. A unit load of 1,800 lb. per sq.in. was used for the bearings, and the allowable stress in the trunnions was taken at 16,000 lb. per square inch. A cross-girder spanning the cantilever weight pit supports the trunnion bearings, as shown by the article on the substructure of this bridge in *Engineering News-Record* of July 31, 1919, p. 210. This girder is supported on the side walls of the pit instead of upon longitudinal girders outside of the trusses, the usual arrangement in Chicago bridges; the new arrangement (Fig. 6) was used for the first time in the Michigan Ave. bridge.

Elimination of the longitudinal girders gives a more efficient way of carrying the loads to the foundations and has proved very satisfactory, but with the trunnion loads carried directly on the side walls of the pits it is necessary to place concrete piers under the walls in addition to those required for the support of the pit proper. Another type of support is to have each trunnion carried by a pair of longitudinal trusses so arranged that they clear the counterweight boxes. Several bridges having the trunnion truss type of support have been built in Chicago, and their operation has been very satisfactory.

Operating Machinery—Each leaf of the bridge is operated by two 100-hp. motors, with two additional motors in reserve. These motors are located in the machinery room under the lower street level just back of the anchor pier, and are arranged both electrically and mechanically so that any two motors can be used for operation. The machinery layout is shown in Fig. 7. In the plane of the chord of each outer truss is a cast-steel internal rack of 19 ft. 9 in. pitch radius, having teeth 22½ in. wide and 7½ in. pitch, as indicated in Fig. 8. This operating scheme requires a gear train at each corner of the bridge, located just outside the outer truss and resting on grillage beams in the walls of the pit. The racks are engaged by pinions having machine-cut teeth with a pitch diameter of 33.4 inches.

The counterweight for each leaf is so distributed laterally that the correct amount required to balance the loads on each truss has its center of gravity approximately in the plane of the truss. This distribution tends to eliminate a deflection of the trusses laterally and an unequal deflection of the trusses in a vertical plane. Since the operating gears lift on the outside trusses only there is a torsional moment developed between the trusses, which is resisted by the girders of the counterweight box back of the trunnions and by transverse trusses framed between the vertical and inclined truss members ahead of the trunnions.

The diaphragms connecting the inner trusses are figured to take the entire load of one pinion in case it should be desirable to operate the entire leaf with one gear train. Normally, however, the shear in the diaphragm is neutralized, due to the action of the differential gearing. The effect of applying the operating load on the outer trusses will, of course, be the same with respect to setting the inner trusses in motion for both the leaves with diaphragms in and with diaphragms out. The diaphragms are of value only when it is necessary

to operate the leaf by one gear train, and for stiffening the bridge laterally. Under normal conditions the diaphragms will overcome the tendency of one half of the leaf to lag behind the other half, which might occur from same differences in the alignment of each half of the leaf or imperfections in the workmanship and erection.

Changes are made from the two working motors to the two reserve motors by means of friction clutches. Each pair of motors is placed so that the motor pinions of each pair engage the differential on opposite sides. On the extended hubs of the motor pinions are keyed discs which are gripped by friction clutches operated by levers mounted on the bearing frames of the armature shafts. The pinions of both sets of motors are always in mesh with the differential gears, one pinion running as an idler when the other set is transmitting power to the operating shaft. The clutches are provided to permit easy shifting of the motors, it being considered necessary to alternate the use of the motors from week to week; the particular reason for putting in the clutches was to avoid the necessity of sending to the municipal shops to get the necessary machinist to take out the bolts (in case such mechanical arrangement had been provided), which would cause considerable delay. Bridge operators are not supposed to remove bolts from couplings or any other apparatus.

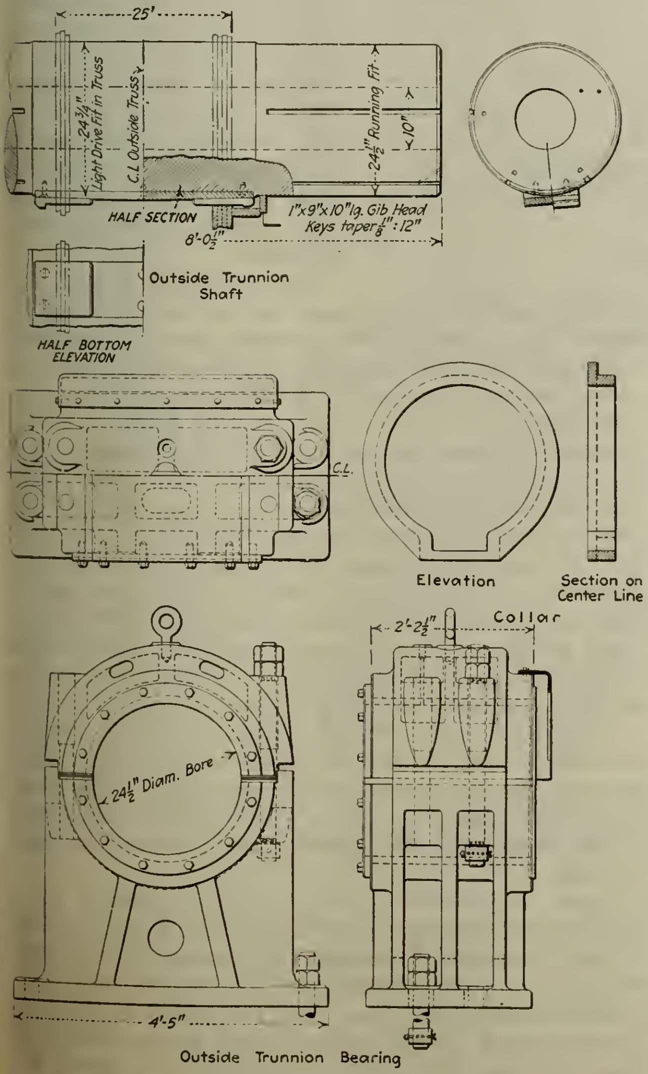


FIG. 5. TRUNNIONS FOR 6,700-TON BASCULE

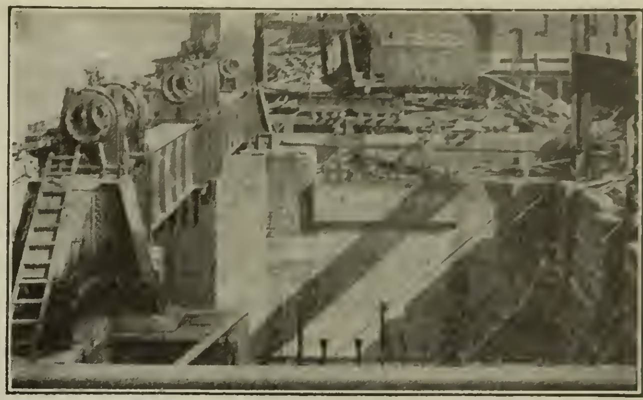


FIG. 6. HEAVY GIRDER CARRIES TRUNNIONS

Heel and End Locks—Heel locks to take the live-load reactions are four in number for each leaf, one lock in the plane of each truss (Fig. 9). These locks are operated through gear trains mounted on the anchor pier and connected with the toggle arm, which engages a casting on the rear girder of the counterweight box. The live load amounts to about 138,000 lb. per lock. What power should be provided for the locks was subject only to arbitrary assumption, but experience has shown that 10-hp. motors are satisfactory. The locks are also required to push the leaf into the final position, which places the heaviest duty on the motors.

Center locks (Fig. 10) are provided to insure that the two leaves of the bridge will deflect equally under live load, to prevent unevenness at the center break in floor. These are bolt locks placed in the bottom chord of each truss and are operated by 5 hp. motors so arranged that the two locks on each side can be operated independently. The machinery for operating the locks is placed below the lower-level floor, and the gearing is connected to rods which operate levers that force the bolts into place.

The locks were designed in accordance with the standard practice of the city of Chicago. They were proportioned for the greatest shear at the end of the arms, which can be definitely determined. The operating mechanism, however, was proportioned for the size of motor which experience has shown to be necessary to operate the bolts against resistances due to small differences in the alignment of the leaves at the guide castings. It has been the experience with Chicago bridges that locks of this type operate satisfactorily when properly adjusted, though there have been instances where these locks have not operated satisfactorily, but this has been chargeable to bad adjustment rather than to deficiency in strength.

Safety Devices—Exceptionally heavy traffic conditions and the large proportion of fast automobile traffic on the Michigan Ave. crossing necessitated special attention to provisions for safety in the operation of the bridge. For this reason a full intercommunicating signal system was installed, in addition to locks and gates, and all these devices were interlocked with each other and with the operating motors, in order to assure protection of traffic. The sequence of operation of signals, gates, flexible barriers (not yet installed), center locks, rear locks and main motors as determined by this interlocking system is as follows:

Assume that the bridge is in the closed position and carrying traffic. The center and rear locks are closed, the roadway and sidewalk gates are raised, the brakes

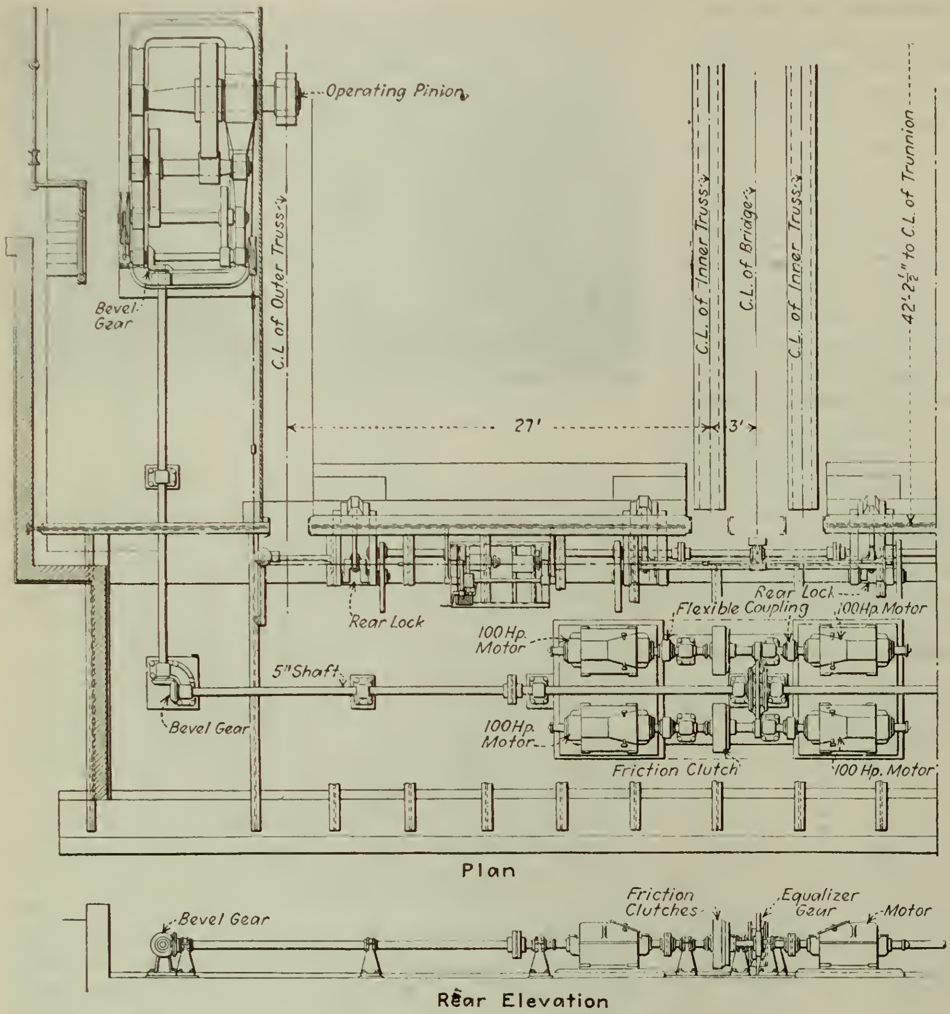


FIG. 7. LAYOUT OF OPERATING MACHINERY

may or may not be set, the magnetic feeder section switch is closed and current is available for the river signals, service and signal lights.

Following the practice as established upon the other city bridges, the operator having the control of the center lock (the north operator in this case) is the one to give the signal for starting the preparation of the bridge for raising, and he also gives the signal for the raising of the leaves. The operators and gatemen exchange signals for the purpose of calling each of the gatemen and the south operator to their posts. This is done by means of vibrating bells in the operator's houses and single stroke bells in the gatemen's and operators' houses. Upon receiving the return signals the north operator again signals as before, and the gatemen and operators each ring the large hand-operated bells and start the warning bells and flasher motors of warning signs by means of a snap switch located near the gate controllers. When these switches are closed current is available for the operation of the gates closing that section of the roadway at which the signals are displayed.

The roadway gates against traffic approaching the bridge are stopped when they reach the fully lowered position, and at the same time they automatically close switches in the gate posts and current is available for the operation of the flexible barrier at that section of the roadway closed by the gates. The barrier is then lowered, a limit switch cutting off the current and applying a brake when it is down. The sidewalk gates are now lowered. When traffic has cleared the bridge the exit gates and barriers are operated in the same sequence. When all the barriers are down the interlocking switches at each barrier are closed automatically and the first section of the interlocking is completed.

The centerlocks may be operated at any time in the opening, the object of this being to permit of the opening of the center locks by the operator while waiting for the traffic to clear. In closing, however, the center locks cannot be closed until the rear locks are closed. The operation of the center locks is controlled by a master controller and the necessary magnet switches for accelerating and reversing; limit switches cut off the current and brakes are automatically applied when the limit of travel is reached in either direction. When the center locks are fully opened an interlocking contact is closed and the rear locks on the north and south sides may be operated independently.

The operation of the rear locks is controlled in the same way as that of the center locks. When they are fully opened current is available for the operation of the main motors on their respective sides, provided, however, that the clutch and throwover switches are in proper relation for the operation of the two motors for which the switches and clutches are presumed to be set. This arrangement is such that should the clutch on the motor shaft be left open and the throwover switch closed, for the operation of any particular pair of motors, or should the clutch be closed and the throwover switches be left open for the same pair of motors, the control circuit would be open and the movement of the main motor master controller handle would not be productive of any results, as the magnet switches could not be closed owing to the lack of control current.

The clutch and switches being in proper relation current is available and the operator pulls the reverse lever on the main motor master controller in the direction the bridge is to move. This unlocks the power drum handle and the operator may proceed to raise the leaf.

Traffic Figures—On the old Rush St. Bridge, which formerly was the link in the Michigan Ave. route, traffic in 1917 amounted to about 17,000 automobiles per day, in addition to about 2,500 teams and 10,000 pedestrians. In the three years since then the traffic undoubtedly has increased 25 per cent. Before the completion of the Michigan Ave bridge 50 per cent of all of the automobile traffic from the north side to the loop took

the Rush St. bridge, the remainder being distributed over the north-south crossings. Much of the latter traffic now goes to the Michigan Ave. bridge, and its total automobile traffic is approximately 30,000 per day. The lower level of the bridge, not yet opened to team traffic, accommodating two lines of trucks in each direction, probably will carry about 6,000 teams per day.

Weights and Stresses—The weight of the Michigan Ave. bridge, both leaves included, is about 13,400,000 lb., there being an average load on each trunnion of 1,675,000 lb. Thus the new bridge is the heaviest in Chicago, and probably it is heavier than any other double-leaf double-deck bridge of its kind in the world. The weight of the new Wells St. bridge, which will be its nearest competitor in Chicago, will be 9,600,000 lb. for both leaves, and this bridge will carry an elevated railway on the upper deck. The single-leaf double-deck bridge of the Canadian Pacific Ry. over the Kaministiquia River at Fort William, Ont., weighs 9,800,000 lb. It has a double-track railway on the lower deck and a 29-ft. roadway on the upper deck.

In determining the stresses for the truss chords of

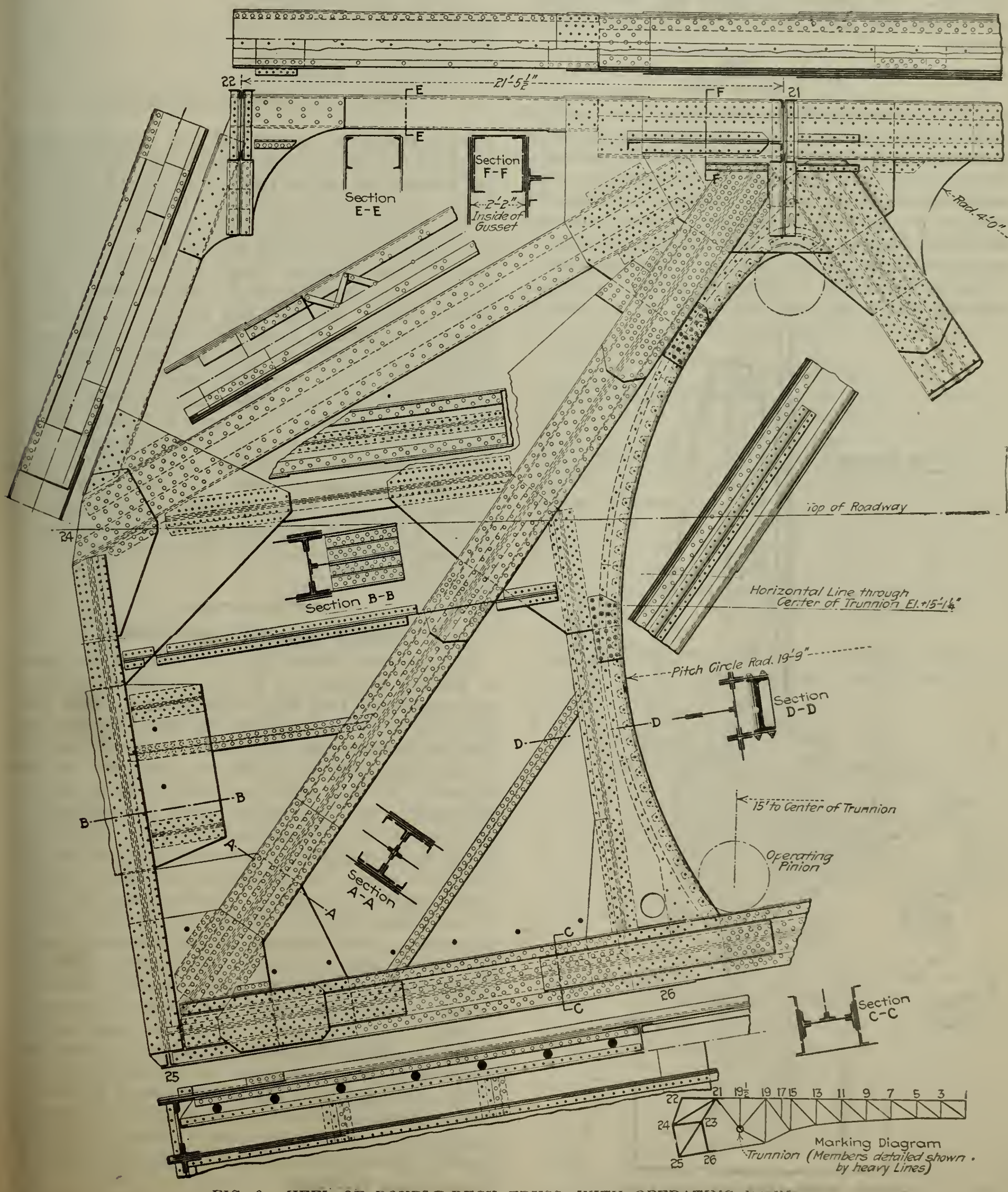


FIG. 8. HEEL OF DOUBLE-DECK TRUSS, WITH OPERATING RACK

the Michigan Ave. bridge the live load assumed was 100 lb. per square foot over roadways and sidewalks for the upper deck, and for the lower deck 2,000 lb. per lineal foot of street-car track distributed over a 10-ft. width, and 100 lb. per square foot over the remaining area, plus the actual dead load of the structure. For the design of the floor beams and stringers of the upper deck, and that part of the lower deck not occupied by street cars, the assumption was a live load of 24,000 lb. on two axles spaced 10 ft., and 100 lb. per square foot over the area not occupied by this load, plus the actual dead load. The street car assumed was a 50-ft. 50-ton car. Impact was added in all cases, determined by the formula

$$I = S \frac{100}{NL + 300}$$

in which S = maximum live load stress, L = length of load producing maximum, N = $\frac{1}{10}$ of the loaded width of roadway and sidewalks. For all cases of reversal of stress in members 50 per cent of the smaller stress was added to either stress to obtain the designing stress. The maximum stress, 2,692,000 lb. tension, occurs in the outside truss members leading from the top chord to the counterweight box, just to the rear of the trunnion.

The counterweight is composed partly of concrete weighing 145 lb. per cu.ft. and partly of a composite concrete formed of concrete and rivet punchings weighing about 300 lbs. per cu.ft. The counterweight for each leaf contains 930 tons of 145-lb. concrete and 665 tons of 300-lb. composite concrete, a total of 1,595 tons per leaf.

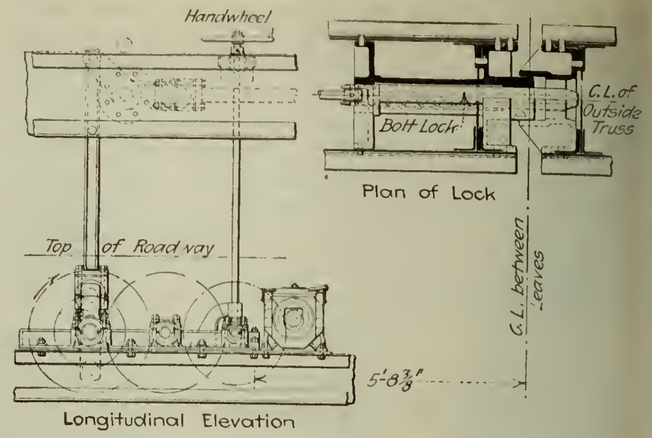


FIG. 10. CENTER LOCK OF BASCULE

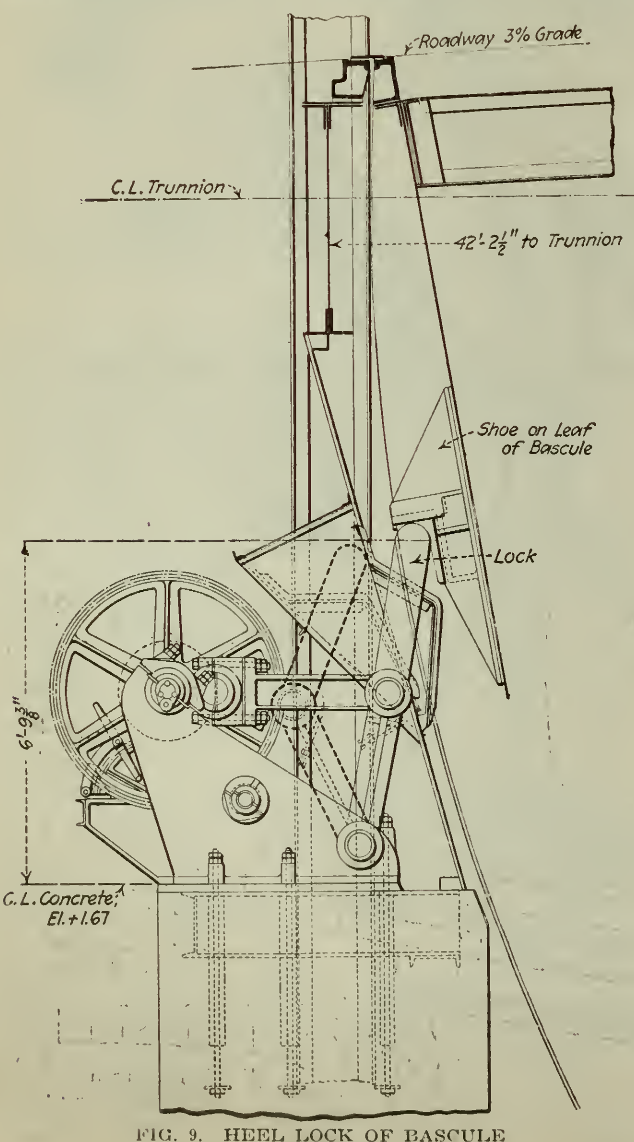


FIG. 9. HEEL LOCK OF BASCULE

The Michigan Ave. improvement, of which this bascule bridge is the principal feature, is one of the main items in the "Chicago Plan," supported actively by the City Plan Commission. The improvement was developed largely through the efforts of Michael J. Faherty, president of the Board of Local Improvements. The plans and specifications for the entire improvement, including the bridge, were prepared in the Bridge Designing Section of the Bureau of Engineering; Hugh E. Young, then engineer in charge of bridge design; Thomas G. Pihlfeldt, then engineer of bridges; P. S. Combs, city engineer; C. D. Hill, engineer of the Board of Local Improvements. William A. Mulcahy was chief engineer in charge of construction. The Great Lakes Dredge & Dock Co. was the general contractor for the work and the structural steel was fabricated by the American Bridge Co.

British Imperial Forest Policy

At the recent British Empire Forestry Conference in London, according to *U. S. Commerce Reports*, it was emphasized that the foundation of a stable forest policy for the Empire must be the collection, co-ordination and dissemination of facts as to the existing state of the forests and the current and prospective demands on them. To this end it was considered of the first importance that a systematic survey be undertaken in each part of the Empire which would serve not only as the basis of the forest policy in that part, but also provide a means for reviewing the forestry position of the Empire as a whole. The destruction of forests in the United Kingdom during the war for military purposes and the dependence upon overseas supplies have led to extensive reafforestation plans and given stimulus to governmental action toward securing a scientific forest policy based on the economic principles of annual cutting of surplus timber as a crop and provision for automatic reproduction, as well as the afforestation of large unused areas. It was urged that each of the governments of the Empire should lay down a definite forest policy to be administered by a properly constituted and adequate forest service. A central Forestry Bureau in London was recommended for study, research and reference.

Notes from Foreign Fields

GENERAL IMPRESSIONS OF EUROPE

By E. J. Mehren

Editor of *Engineering News-Record*

RETURNING to America I have been urged by my associates to write at once a summary of my impressions—such a summary, as they put it, as one would give in a ten-minute talk to a group of friends. Complying with the request, this contribution to "Notes from Foreign Fields" is published in advance of its regular order.

The briefest possible summary of my impressions is expressed in one word—*discouraging*. The situation is discouraging industrially and politically.

In England, France and Germany orders are falling off and an industrial crisis appears to be approaching. In England a serious strike is threatened and labor conditions generally are serious. There is war between Russia and Poland, and between Greece and Turkey; the English have military operations on their hands in the Near East; France and England are not in agreement on the treatment of Germany and have been dangerously near a split on the Russo-Polish question; France is playing politics with Belgium, with Holland's control of the mouth of the Scheldt as one of the factors of the game; England has a mean and serious problem on its hands in Ireland.

All in all, the outlook, at least to an American, is very discouraging. One American manufacturer who knows Europe intimately remarked to me that "Europe is no farther ahead today than it was at the signing of the Armistice." That is probably an exaggeration, but he meant to convey the impression that there was not a satisfactory solution of the great political and economical questions that existed on Nov. 11, 1918.

Industrial Conditions

Industrially, western Europe is slowing up. Many German factories, as recorded in the article which follows are working half time. Buying has dropped off sharply in France and Great Britain, and English business men are looking for a depression. Competent financial students, fellow passengers on the homeward voyage, reported that their conferences with European bankers had checked the views that I had gathered.

In England, labor difficulties are looked for. Just before sailing on Aug. 14 the mutterings began in the coal trade. Since then the situation has crystallized and, as I write, the strike vote is being taken. An appreciation of the power which Labor believes it has can be gathered from the fact that at the height of the Russo-Polish crisis a Committee of Action, representing the labor organizations called upon Lloyd George to serve notice that if England should decide to go to war in support of Poland the workers would refuse to move the munitions.

Political Situation—Politically, the situation in Europe is equally disturbing. The Russo-Polish situation is known to all of us. Unfortunately, it has tended to widen the rift which has been developing between England and France. The latter's unexpected recognition of Wrangel came while I was in England. To say that it caused dismay is putting it mildly. A more excitable people than the English would have indulged in rabid talk. Instead, all English views were focused on reaching an immediate understanding and preventing the breach from widening.

The disagreement between England and France as to Germany has been increasingly emphasized in the various conferences following the conclusion of the Versailles Treaty. Only dire necessity, it seems, is holding them together, and I cannot help feeling that they will not for many years go hand in hand. I do not mean that there will be an open breach, but that England's policy will so favor Germany and be so in contrast with the French that there will be estrangement between them. The view was expressed to me by the keenest man I met in England that, fundamentally, there is more reason for sympathy between England and Germany than between England and France. England and Germany are both industrial nations, with strong commercial instincts, and a tendency to take a similar view of international questions. Temperamentally, also, they are much alike. On the contrary England and France, are entirely unlike each other temperamentally and in their industrial and commercial aptitudes and outlook.

In this connection an interesting story was told me by an Austrian. In 1913 he attended in London a luncheon given by a member of Parliament and sat beside a distinguished English statesman, subsequently Chancellor of the Exchequer. The latter asked the Austrian whether he thought there was danger of war between England and Germany. The Austrian's reply was that he heard no such talk in Berlin, where he then resided, and that he considered a war impossible. The statesman's prophetic reply was that he believed that England and Germany were destined to be fast friends, but before that took place there might have to be a war.

Certain it is at the present time English business men are looking very favorably upon trade relations with Germany and, in fact, are in Germany in large numbers engaging in business negotiations.

France, unfortunately, is being alienated from the strong nations of Europe. I heard enough in England to realize that keenly. Germany's attitude toward France is well known—and natural. I was not in Italy, but men who were there told me that the attitude toward France was not a sympathetic one. In Holland I heard sharp criticism of France, two men making almost identical remarks to the effect that France's victory had intoxicated her.

Bolshevism

Regarding a spread of Bolshevism I found that there is little fear entertained in England or France that their countries will succumb to it. In England the prediction, so often made in the last two years, that there would come a Labor government is still repeated. It is felt, though, that responsibility would cause the labor leaders to modify their radical program. The sound sense of the British people is relied on to save the country from excesses.

France believes that it has had its test with Bolshevism and come off victorious. In fact, its unwill-

ingness to recognize Russia is no longer put on the ground of fear of Bolshevism, but on the ground that it should not recognize a government that will not assume the former Russian debt to France.

In the Central Powers, anything may happen. That is always true when people are cold, hungry, and without hope. American observers whom I met on the trip home had the same feeling that I have with reference to the Central Powers. One of them, a journalist who has represented the New York *Times* in Europe for many years, closed a statement in which he expressed his confidence in the German promise to live up to their obligations with reference to the delivery of coal, with the words, "I am as positive about it as one can be about anything in Europe today." Another American, general manager of an American enterprise having four plants in Europe, said briefly, "No one can tell what is going to happen in Europe." He expects a crisis throughout western and central Europe, accompanied by unemployment and suffering. In the past such crises have passed without revolutionary endeavor. Today, in the Central Powers at least, the danger is that there may be revolution.

The one bright feature of the whole situation is that the principal food-raising countries of Europe have excellent crops this year. That is true of France, Germany, Austria, and Czecho-Slovakia. The food situation should be better this winter than it has been for many years, but, even so, the amount available will not be sufficient in the Central Powers to carry the people over to the next harvest. Means must be found to supply them from the United States and probably Argentina, even with the exchange so badly against them.

The League of Nations

An American is naturally curious to know how the people of Europe feel with reference to our non-participation in the League of Nations. Naturally there is deep disappointment. The League was President Wilson's creation, and the people of Europe believed firmly that he had plenipotentiary powers. In a nice way they accuse us of "welching" on our contract. Apparently, though, they are but little interested in the military feature of the covenant. They are all tired of war. They do believe, however, that if we had sat in on the conferences that have followed the completion of the Treaty the United States would have taken hold of the credit situation and either directly or by government approval and encouragement of consortiums of bankers helped to put the Continent on its feet in a practical way.

As one travels around he cannot help but feel apologetic for the American position, even though he may sympathize to the utmost with the action of those senators who prevented approval of the covenant unchanged, as the President wanted. One American put it well when he said that we had created Poland, that we had helped to put France in a position where she could, single-handed and without reference to any other power, invade the Ruhr, and then had washed our hands of the whole situation. Certainly the political alignment in Europe today is largely of our own and President Wilson's making. Yet, having created the situation, we have shouldered none of its responsibilities. What form our participation should have taken and should still take seems to be a matter of indifference to the European. If we come in and help, we can name our own terms.

While one feels apologetic for our position he cannot escape the thought that we are fortunate to be free of "entangling alliances." We may have moral obligations there for the time being, but no one who sees for a period of three and a half months the interplay of politics in Central and Western Europe will want to put us in a position where our hands are tied or where we will be compelled to act.

England's Hopefulness

Before sailing for home I recrossed the Channel and spent eight days in England, taking occasion to see acquaintances and get the English view of the Continental situation. I had left Holland feeling, as I have here set down, quite discouraged. To my surprise I found the Englishman very calm about the whole situation. He sees the serious side of it, but is confident that much progress has been made and that the present situation, while much confused, is becoming better week by week. That comes, no doubt, not merely from the naturally calm temperament of the Englishman, but from his long interest in and study of international affairs. My admiration for the English was immeasurably heightened by their wonderful attitude. One American said to me that the crux of the whole situation in Europe was the confidence which investors would have in the promise of the German people to make good on the indemnity bonds that may be issued, to meet their obligations. There may be much truth in that, but if I had to name the factor through which the salvation of Europe is most likely to be worked out I would unhesitatingly name the British people. They have the capacity and experience to handle the situation, while their position adjacent to the Continent forces them to take the matter in hand lest a break up result in alignments unfavorable to them.

Coming home after an absence of four months and getting into the swing and the hum of American life, finding that our costs are only double pre-war costs, as against threefold to tenfold increases in Europe; seeing our resources, as represented in our broad fields, sensing the strength of our industrial life I cannot but feel that we fail to appreciate how much better off we are than the people of Europe. One German said to me in Berlin that we had got more than we deserved. He made the remark half in fun, but I cannot help wondering whether there is not some truth in it. We are lavish of our natural resources. We waste to an appalling extent. We regard as trifles the economies that loom up importantly in Europe. Natural resources considered, our development of them is extremely inefficient. We are living in a gold mine, yet we quarrel and are dissatisfied. We live on the fat of a rich land, and earn our daily bread by loafing half the time, or what is the same working at half pace.

Could our people be brought to an appreciation of the difference in conditions between Europe and America, I am sure that the unrest here would disappear and that enthusiasm and loyalty and an effort to solve our problems without strife would replace the present attitude. To get a deep appreciation of what America is, what its possibilities are, a trip to Europe—and a trip right now—to learn by observing the contrast, can be heartily recommended.

New York, Sept. 2.

General Conditions in Germany

The engineering visitor to England, France or Switzerland naturally devotes his time to a study of the problems of his special field. No so in Germany. There the fundamental social conditions so transcend all special problems that one forgets he is a specialist and loses himself in any inquiry into the general situation.

As a whole, the conditions here are discouraging. The people of the cities, generally, are under-nourished, unhappy, and without hope as to the future. They have suffered grievously. What is past they would be glad to forget, but, unfortunately, the memory of what they have endured is always with them because of the continuance of unsatisfactory conditions and the prospect, they believe, of privation for years to come. They have been put in this frame of mind mainly by insufficiency of food—in both quantity and quality. Conditions have improved materially since the last year of the war, and even since 1919, but the foodcard system still persists and the rations supplied against the cards are insufficient in quantity, while the quality is extremely poor. The quantities called for by the food cards, per week, are as follows:—

Bread	1¼ kg.	(2.75 lb.)
Flour	340 g.	(12 oz.)
Sugar	170 g.	(6 oz.)
Butter	60 g.	(1⅝ oz.)
Fat	100 g.	(3½ oz.)
Meat	200 g.	(7 oz.)
1 Egg		

Only children under two and the sick receive milk.

The quality of food and, with the obvious exception of the eggs and sugar, is far below that found in the very poorest quarters of any city I have seen in Europe or America. The bread is made of barley flour with a 25 per cent admixture of rye and some maize. It is heavy, coarse, and unpalatable.

To test the quality of food I ate on several occasions in restaurants of the average class. The prices were higher than can be afforded by people even in the higher clerical positions yet in one restaurant the food was uneatable, the stew made with rancid meat and the fruit desert sour. Only the plain cooked vegetables were acceptable. In the other restaurants the food was tasteless and of poor quality, but eatable.

Green vegetables and dried peas and beans can be purchased in the open market but the prices are roughly ten times or more what they were before the war. It is possible to buy meat of fairly good quality, chickens, eggs, and occasionally butter and fat, from dealers who buy secretly and unlawfully from the farmers. Repeated efforts have been made to stop this traffic and to turn these supplies into the channels of official rationing, but despite repeated convictions and punishment the farmers continued to hide their products and sell them at high profit to secret dealers. In fact, it is only by buying from illegal sources that it is possible to maintain oneself in even fair physical condition, but only those who have profited by the war or whose wages have gone up in proportion to the cost of living can do so. Skilled laborers *who have regular employment* can do so but the great middle class, far worse off than the laborers, cannot. The food conditions show themselves in the appearance of the people. Even in Berlin, which presents a much more hopeful picture than Munich, the poorer and middle-class districts are filled with under-nourished people, and, more's the pity, with under-nourished children. The children have a pallor and leanness that do not go with healthy childhood, while often one finds cases of under-nourished, aged heads on little emaciated bodies—that are heart rending. What is true of the poorer quarters of Berlin regarding under-nourishment is true of *every part* of Munich.

THE CARLSPLATZ, A "BUSY" SQUARE IN MUNICH
Taken at 4 p.m. on July 16, a weekday. Note the absence of traffic.

Yet it is easy to be deceived regarding food conditions. If one confines his observations to Berlin, and in Berlin to the business district and the wealthy Westend, he will, probably, report that food conditions are good. In fact, the very first American I met after a week's stay here remarked, immediately after the exchange of greetings, that he did not find food conditions "so bad." On close questioning he and his wife admitted that they were staying at the Adlon Hotel and had eaten only there. They had had the best of meat, excellent fowl, white bread, delicious butter—everything they wanted. Undoubtedly, they will go back to their small manufacturing town in Pennsylvania and declare that reports regarding food conditions are exaggerated. They probably paid 200 marks a day for their room, if without a bath, and 300 or 350 marks if with a bath, while for the two of them each luncheon and dinner cost not less than 100 marks, which, referred to the purchasing value of the mark before the war, means as much to a German as a $50 meal for two would to an American. I had the similar experience of getting whatsoever I wanted at from 40 to 50 marks per meal, but it is unnecessary to say that no German, except a war profiteer, can pay those prices.

In general, when present-day prices are quoted, an

American can appreciate what they mean to a German if he remembers that before the war a German could buy as much for 2 marks as we could for $1. In other words, if a German pays 50 marks for a meal the impression upon him, compared to pre-war purchasing power, is the same as that on Americans if we paid $25.

My own observations of food conditions, based on inquiries from housewives, excursions in the poorer quarters of Berlin, eating in average restaurants and living in a private family in Munich, are completely borne out by the fact that the American Relief Administration (under Herbert Hoover's direction) is not only continuing its food-supply work in Germany, but is making efforts to bring its work to the attention of all classes of Germans, so that they in turn can appeal to American relatives and friends to help them through the purchase and transmittal of food drafts. The American Quakers are continuing their food stations for undernourished children, while the British branch of the Salvation Army and the British "Save the Children Fund" Committee are continuing to supply milk rations to children. The German delegation at Spa reported a great increase in the death of children under 5, and an 11.4-per cent increase in tuberculosis, comparing 1919 with 1913. One may be tempted to disparage those German statistics, but he cannot brush aside the evidence afforded by the continuance of the relief measures of English and American organizations.

IN A MUNICH STREET

Clothing and Fuel—But food shortage is not all that depresses the Germans. Coal shortage, almost since the beginning of the war, has kept them in a freezing condition the greater part of the winter, while clothing is prohibitive in price. For private families the coal allowance is 100 kg. (220 lb.) per month, summer and winter. In winter only one room is heated. In apartment houses having steam heat, where the cooking is done by gas, conditions are even worse, since the central heating plants are shut down. There are no smoke stacks for the installation of coal-burning stoves, and the gas ration is sufficient for cooking and lighting only.

While food prices are about ten times what they were before the war, clothing and shoes are from twenty to thirty times as expensive. Before the war a good suit of men's clothing could be bought for 70 marks; today a suit of decent quality, not up to pre-war quality, costs 1,600 marks. To a German that means the same as if a $35 suit for us had increased in price to $800. Prices of clothing for women and children has increased in the same proportion.

Appearance of the Cities—Industrially, the country is very quiet. In the north there was an industrial revival after the Armistice, but on account of rising prices both foreign and domestic buying dropped off sharply about three months ago, and the industries now are working only three days a week. South Germany had no industrial revival, and the conditions there are accordingly worse. I saw large plants shut up that had not turned a wheel since the close of the war.

The cities naturally show the effects of these conditions. Munich is a dead city. It has less life than one of our 50,000-population towns. So striking is the lack of vehicular traffic that I took a census for an hour in the *Marienplatz*, the broad street or "square" in front of the *Ratshaus*. The avenue is 150 ft. wide and has four traffic ways, two in either direction, and four street-railway tracks. Yet on this broad street I was able with ease to take a vehicular-traffic census by myself. The count, kept on the back of a visiting card, for the hour between 9:55 and 10:55 a.m. on July 16, was as follows:

Horse-drawn passenger vehicles	4
Horse-drawn commercial vehicles	12
Passenger automobiles	19
Motor trucks*	12
Hand-carts	30
Street cars†	42

* The motor-trucks included five post-office vans.

† Most of the street-cars had two trailers and the remainder one trailer each.

Note—From a taxi-cab stand at this point only two auto taxi-cabs were hired in the hour, and only five horse-drawn taxi-cabs.

It should be noted that before the war the use of hand-carts was almost unknown in Munich, while the horse-drawn taxi-cab had disappeared from the streets.

Unless an engineer is concerned with street or highway design he gives but little attention to traffic figures. Those who wish to get a correct idea of the lack of traffic in Munich would do well to stand on a busy corner in any of our cities of 50,000 or more people and for 10 minutes make a count of the vehicular traffic, and then compare it with one-sixth of the Munich figures. I wager that even in a town of 50,000 they will find the traffic heavier than in the *Marienplatz*, the business center of a city of 600,000 people. Some photographs, which are thoroughly representative, and not taken at an interval more quiet than usual, show the almost complete absence of traffic in the business center.

This lack of traffic agrees with the attitude of pedestrians. They are an unhappy people, downcast, care-worn. One and all, they seem to be carrying a burden. The whole atmosphere is a listless one. The *Hofbrauhaus*, once the gathering place for the happiest and most contented throng in the whole of Europe, is nearly deserted. The little knots of people scattered through its great restaurants and halls are quiet and serious. That is true, also, of the other Munich restaurants, which, before the war, were famous throughout Europe for their good-natured companies.

Berlin presents a more encouraging picture. The vehicular traffic is not much heavier than in Munich, due to the present industrial stagnation, but the people are, on the whole, better nourished. In the business district they go along with some vigor, as if life were worth living.

This difference between the two cities probably has two causes. The Bavarian (Munich is the capital of Bavaria) is an artist, and, therefore, temperamental. The Prussian is practical, and more accustomed to overcoming difficulties. Second, there was no industrial revival in Bavaria, while northern Germany profited by fairly good industrial conditions during the latter part of last year and early this year. Earnings were, therefore, larger in Berlin than in Munich, and the difference is shown in the condition and attitude of the people.

Views As to the Future

The view that a nationalization of all wealth must certainly come in Germany, is quite widespread, those that so believe holding that it is the only means through which the workman will be made contented with his lot and apply himself. If the workers, it is argued, are brought to realize that nothing has value in Germany except labor, class prejudice will disappear and Germany will be able to develop an idealism through which she can get on her feet. These men pointed out that fortunes have now been reduced to the level of labor. A fortune of 300,000 marks was a large one before the war. At 4 per cent, the usual German return, the income is 12,000 marks, which now is the salary or wage of a first-class stenographer, an office worker, or a common laborer regularly employed. In other words, a man or woman with an inheritance of 300,000 marks is in the same position financially as a stenographer or laborer. The advantage of fortune, having been wiped out, the remaining step, it is argued, of putting all industries under the control of the government is not a long one.

Opposed to this view is the opinion of business men that the country is really farther today from general socialization than it was a year ago. Even the political leaders of a solialistic tendency have come to appreciate, so the business men say, that an incentive is necessary in the shape of freedom for initiative and opportunity for personal advancement in order to get the best from both laborer and brain worker. They maintain, too, that the political leaders have profited by the Russian debacle and are fearful of schemes that may further interfere with industrial organization.

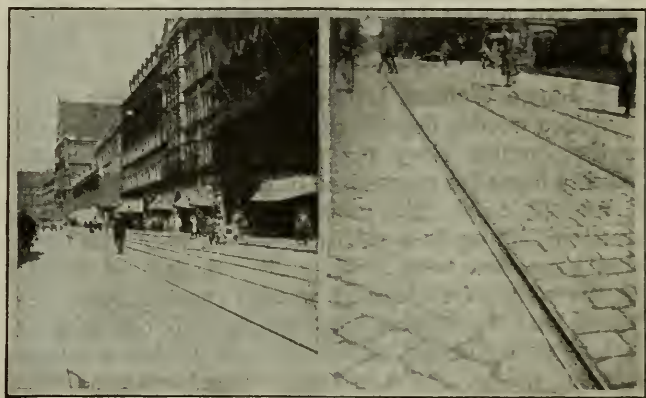
The attitude toward Russia is uniformly quite favorable, though the reasons given for alliance or friendly relations differ with various classes. The agitators hold that alliance with Russia would enable Germany to rebuild her military power, but the middle and educated classes see in friendly relations opportunity for commercial expansion. German brains could help to organize Russia's natural resources, while the growth and development of the country would create a tremendous market for German products. This favorable attitude is shared, apparently, by the present government, for it will be remembered that Dr. Simons, minister of foreign affairs, stated after the Spa conference that if Poland persisted in being a bulwark between Russia and Western Europe she would have a very hard time, but that her lot would be easy if she served as a bridge.

On one imminent question regarding the future, there is entire agreement—that the plebicite in Upper Silesia, where rich coal fields are located, is of vital importance to the future of Germany. Should Upper Silesia remain with Germany the latter will have the coal essential for, at least, industrial production. If Upper Silesia goes to Poland, German industry will be very seriously crippled. One engineer said solemnly, "Without Upper Silesia German industry is dead." For that reason the result of the September plebicite is being awaited with intense interest. Just now there is considerable optimism regarding the probable result, for it is not believed that Upper Silesia, in view of conditions in Poland, will cast her lot with that country.

Attitude Toward Foreigners

During the war there was great bitterness toward England. That feeling his disappeared and Englishmen are now in high favor, for the Germans feel that England is willing to give them an opportunity to get on their feet. Lloyd George's attitude in standing against the severe demands of France is deeply appreciated, while the English people, as individuals and through committees and societies are doing much to relieve the clothing and food distress.

Toward France there is much animosity. The French, so the Germans feel, desire to grind them down to the utmost—even to the extent of making it impossible for



ON THE STREETS OF MUNICH
The left-hand view shows the absence of traffic; the other, granite block laid diagonally between track and footway.

Germany to pay the indemnity. All they ask, they reiterate, is the chance to work and pay their debts. They admit that they did not deliver the coal required by the treaty, but maintain that it was only through the sale of coal, to Switzerland and Holland for example, that they could get food.

Toward Americans, the attitude also is a friendly one, due not only to the extent to which the Hoover food drafts are being sent to Germany and to the work of the American Quakers in feeding German children, but also to the belief that had America signed the peace pact and become a member of the League of Nations, she could be counted upon to support Lloyd George rather than the French in the various conferences following the Versailles treaty.

Whether that view is correct it is not possible to say with certainty. My own feeling is that we in America will take the same position as the English: "The war is over. Let's give Germany a chance to get on her feet, merely taking care that she shall not again become a military menace."

As to the terms of the treaty I have heard little complaint. The word always is, "Give us a chance, give us credits in raw materials, let us keep enough coal, and we shall pay our debts." The paying of her debts is

GUARD RAIL ON KESSELBERG ROAD, A FAMOUS BAVARIAN HIGHWAY SOUTH OF MUNICH

synonymous with industrial rehabilitation, and for her rapid industrial rehabilitation the people of America should hope no less sincerely than the Germans.

Germany unsettled and disturbed will disturb not only the whole of Europe but the whole world.

And now we want peace.

Berlin, July 24.

Large Wooden Latticed Derrick Booms

Latticed wooden derrick booms 135 ft. long were built for the English Navy for war service. Photographs of such a boom are reproduced in *Engineering* (London) of Aug. 13, 1920. The required service was to lift a three-ton load up to a platform 100 ft. high, the boom being connected to a 50-ft. mast. Saving of weight was the reason for choosing wooden construction; it is claimed that the wooden boom weighs only one-third as much as an equivalent steel boom and yet has a higher factor of safety. With end fittings and equipped with a 21-in. hoist sheave it weighs only 6,000 lb.

Like many steel derrick booms, these wooden booms are of balloon-braced shape. In side elevation they taper to both lower and upper ends, but in plan only the upper end has taper, the ribs being kept parallel in the lower part for wide bearing on the hinge pin at the foot of the boom. The main material of the boom comprises four Oregon pine corner members or ribs, $4\frac{1}{2}$ in. square at midlength, $3\frac{1}{2}$ in. square at the top, and $4\frac{1}{2}$ x $3\frac{1}{2}$ in. at the foot of the boom, each glued up of nine boards. The ribs are spread by Oregon pine struts spaced so as to make the bracing panels about square, and are tied by crossed diagonals of stranded piano wire of $\frac{1}{4}$-in. diameter in each panel. The spread of the ribs is about 6 ft. at midlength. The bracing struts are of greater diameter at the middle than at their ends; they are grooved on each of the four faces for the larger part of their length, making them cross-shape in section, presumably for lightness. The bracing diagonals connect to the ribs and struts by attachment to bolts set in "welded steel" connection boxes; the heads of the bolts form ratchets to permit of tightening the diagonals. To facilitate transportation each boom was built in two sections, joined at midlength of the boom by socket splices of steel in each rib held together by four tension bolts engaging lugs projecting from the main parts of the sockets. The end fittings of the boom also are of steel, the ribs being fixed in them by hardwood wedges.

Letters to the Editor

Credit Where Due

Sir—The statement of Mr. H. R. Green of Cedar Rapids that the editorial in the Cedar Rapids *Evening Gazette*, quoted by you on page 366 of your issue of Aug. 19, is "unsolicited publicity," gives the Cedar Rapids *Gazette* a little more credit for discernment of the modern capabilities of engineers than is due.

As a matter of fact, this editorial is copied from one which appeared in the Lexington (Ky.) *Leader* for May 1, 1920, and which was reprinted by the Publicity Service of the American Association of Engineers and mailed to a large number of newspapers throughout the United States. A number of other newspapers have copied the editorial or written new ones with it as a basis.

CEDRIC B. SMITH,
American Association of Engineers.

Effect of Chlorinated Water on Metals

Sir—Referring to the article in *Engineering News-Record*, July 15, 1920, p. 127, regarding the corrosion of metals by chlorinated water at Sacramento: This general subject caused us a little anxiety, as we are using Wallace & Tiernan's liquid chlorine apparatus, the diffuser being located in a well from which our Allis-Chalmers pumping engine takes suction. As we understand it, the method in use in Sacramento was similar to our method here. However, we made an examination of a brass valve immediately joining the suction and did not find any evidence of corrosion. We have been informed that the apparatus in use at Sacramento is not the Wallace & Tiernan type which we use in Terre Haute.

DOW R. GWINN,
President and Manager Terre Haute Water Co.
Terre Haute, Ind.

Twin Reinforced-Concrete Tracks for Highways Suggested

Sir—Full-width, hard-surface roadways for the country generally will be a long way off unless some genius of the near future makes some wonderful discoveries of new materials for construction, or finds more economical methods of handling available road materials. In the meantime the public must be satisfied with the cheaper roads, or submit to and pay for experimentation on substitutes for the fully paved country highway.

At the instance and on the suggestion of P. E. Bellamy of the State cement commission of the State of South Dakota, the writer has prepared the sketches, herewith presented, of a substitute for a paved roadway. Tentatively, this consists of four reinforced concrete track rails spaced at 4 ft. 8 in. on centers, each rail 12 in. wide and 7 in. thick on the sides, and grooved to a hyperbolic section so that the thickness at the center is $6\frac{1}{2}$ in.

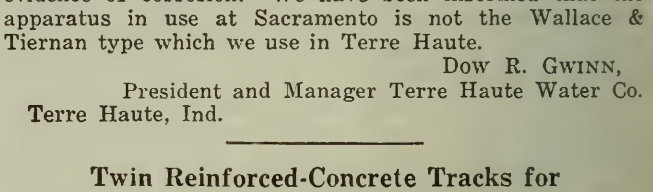


FIG. 1. PROPOSED METHOD OF LAYING TWIN TRACKS

The reinforcing consists of three longitudinal rods of $\frac{1}{2}$-in. rounds, placed as shown. Expansion joints are provided for at intervals of 32 ft., and at these points base pedestals would be necessary. Perhaps plain concrete about 2 ft. square and 6 in. thick would be sufficient. Steel rods or shapes were at first proposed as ties for each pair of

track rails, but the writer has introduced 1-in. galvanized pipe.

In order to reduce the effect of frost action to a minimum the construction would presuppose thorough drainage of the road-bed. The rails would be recessed or imbedded for their full depth of 7 in. in the roadway grade in such a way that the rails would be on a slight crown, say about 3 in.

At section-line and other important crossings the rails would form part of a continuous pavement for about 100 ft., affording a touring car an opportunity to pass a slow-moving truck. An increase of rail width to 18 in. has been suggested to the writer, but it seems that this width would more seriously interfere with horse-drawn traffic. The proposed design is for a gross truck load of 4 tons with a maximum static wheel concentration of 3,000 lb. The material in the proposed section per linear foot of two complete tracks is:

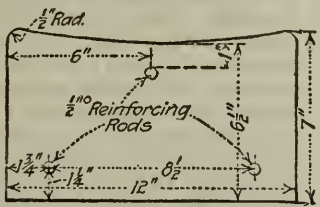


FIG. 2. CROSS SECTION OF CONCRETE RAIL

Concrete	$2\frac{1}{2}$ cu.ft.
Steel	$10\frac{1}{2}$ lb.

The writer would like to have *Engineering News-Record* lend its columns to its readers for discussions on the feasibility of the proposed construction as a substitute for a full reinforced concrete-paved roadway, and hopes information may be brought out on:

(a) Location of tracks, experimental or otherwise, of similar design;

(b) Age of tracks and kind of service;

(c) Composition of tracks and present condition;

(d) Kind of soil, whether loam, gumbo, sand, etc.

(e) Effect of frost action, if any;

(f) Designer or builder, if known, etc.

Suggestions or criticisms along the following lines are invited:

(g) Efficiency of the proposed reinforcement;

(h) Kind and position of rods proposed;

(i) Transverse reinforcement in rails, if any;

(j) Section and frequency of transverse tie rods that might be used with safety and economy;

(k) Cross section of groove, the proposed section being hyperbolic;

(l) Lengths and frequency of cross-overs having full-width pavements;

(m) Suggestions along lines of most likely economical construction;

(n) Suggestions along lines of financing one or more experimental sections in the State of South Dakota, etc., etc.

JOHN BERG,
Pierre, S. D. State Engineer, South Dakota.

What Makes This Vault Sweat?

Sir—Have you any information on how to prevent concrete underground from sweating? The conditions in this particular case are as follows:

A concrete vault 16 x 21 ft. by 7 ft. high inside was built, the top of the slab being even with the surface of the surrounding ground. A sun parlor 8 x 14 ft. rests on part of it. The work was completed July 31, 1920. The floor was poured first, 6 in. thick, with a keyway near the edge. The walls, 10-in. thick, were poured two days after. The top slab is 8-in. thick, reinforced with deformed bars on 7-in. centers. There was 2 ft. of light top soil under which was stiff red clay, fairly dry all the way. The mix was 1 : 2 : 4 with 2 lb. of Mintegne waterproofing being added to each bag of cement. The floor has remained damp since it was poured (July 24) and the walls started to sweat the day after the forms were removed. The roof appears to be dry where the forms have been removed. Two vent holes 3 x 3 in. were left in that part of the roof under the sunparlor. It is proposed to cover the balance of the roof slab with 18 in. of ground. An examination was made after a two days' rain, and while no ground water appeared to be coming in yet the walls were sweating very freely and the steel door was covered with beads of water.

JOHN H. FOWLES,
Milwaukee, Wis. Secretary, Sewerage Commission.

On What Are We Building Our Highways?

Sir—Much money is being expended annually in investigating and testing road surfacing materials. The Federal Government, many states, companies interested in the different materials, and private institutions have established large laboratories for such purpose. Yet we seldom find a laboratory making a study and test of the foundation soils.

Lately the Bureau of Public Roads has taken up this investigation in a small way and appreciates the great value of such an investigation and study, but the appropriation allotted this bureau for such an investigation is so small it will not permit of an extensive research.

Each spring many sections of our roads go to pieces, due to the foundation becoming saturated with moisture, frost action, seepage, capillary action, and other causes. It is useless to expect the road crust to carry all the load unsupported. A firm foundation for our highways is just as essential as it is for every other structure. The little study that has been made of the foundation has been devoted to draining wet places where the sub-base is constantly saturated by seepage water. Such places have been studied and in many cases remedied, but there has been very little, if any, study given to the bearing power of the different types of soils as a foundation. Especially at the period of the year when they are saturated with moisture, or the reverse when they are dry and contracted.

It is safe to say that we know less about the sub-foundation and its ability to sustain the metal surface under the moving load, than any other feature of road construction. There has never been any constructive effort made until recently to find out just what takes place, or to determine the ability of certain types of soils to withstand the impact and weight of a heavy moving load. I know of no element so important in road building that has been studied less, and of which so little is known, as the sub-foundation. The surface materials have been studied and experimented with at a great expense until they can be put togeher and give known results.

It recalls to the writer's mind the biblical phrase, "What doth it profit a man if he gain the whole world and lose his own soul." For what will it profit us if we develop the very highest type of surfacing if we lose it all by a weak and unknown foundation? The question of a stable, firm, and unyielding foundation must have our best thought. The physical and chemical composition of the sub-soils are so complicated that to solve this problem properly will require the very highest type of skill. Problems concerning materials, water, frost action, physical effects of heat, cold and moisture must be solved. The chemical action of acids, alkalies, and the many other different elements found in the soils leading to unknown fields must be found out. Not until this is done, and the bearing power of the sub-foundation can be ascertained by a simple test or brought to a known condition by treatment, will roadbuilding present no uncertain factors.

It is therefore most important that such investigations should be made and a solution found quickly, so that the roads in the future can be constructed to carry the maximum traffic over their entire length without injury.

This applies to the railroads and electric railways the same as it does to the highways, and all should join in a co-operative way in this investigation and find a solution. Congress should be requested to make a sufficient appropriation to the Bureau of Public Roads to establish a large research department so that such investigations can be speedily made and a practical solution found. By all working together a solution will soon be found, and much money annually saved.

H. G. SHIRLEY,
Washington, D. C. Federal Highway Council.

Highway Location and Design

Sir—W. G. Harger's articles in *Engineering News-Record*, July 15, p. 104; July 22, p. 171; and July 29, p. 200, on the economic study of highway location and design, come at a very appropriate time and will be of great assistance in solving a much discussed problem, providing others of equal railroad and highway experience will give us a résumé of their conclusions, either in future articles or in discussions of Mr. Harger's opinions and recommendations.

The rapidly increasing use of motor vehicles for short-haul freight and passenger transportation has outstripped the development of road construction. Maintenance costs of gravel and other similarly surfaced roads, under present conditions, have increased so rapidly that public officials have jumped at "hard surfacing" of the present roadbeds as the only practical solution of the problem.

Apparently there has been a slight reaction to this method and highway engineers are studying the situation from an economical standpoint. The same problems of location and design present themselves that have been studied and solved by railroad engineers for the last 25 years or more. (In passing, I wish to state that I have had none of this particularly valuable kind of experience.) Certain conditions differ, but the main factors and principles are the same.

This discussion refers only to roads requiring a hard surface, which confines us to the heavy traveled highways which are naturally, or are soon to become, parts of certain through routes, for which the name "trunk system" may be applied. Such a trunk system may be within state limits or be a part of the federal highway system.

Present traveled routes usually are improved original trails between local settlers extended to connect communities, often without any regard for grade or alignment as we use these terms today. These trails have been improved step by step as the traffic warranted and as the community developed and money became available.

The question now before the highway departments is: Shall these present traveled roads be hard surfaced or shall extensive relocations be made, and if so, to what extent? It seems logical to conclude that, under the present system and in the course of time, these roads gradually will be re-located as to grade and alignment until ultimately the most economical line is attained. The final result of these changes in location will approach a main line railroad location as a limit. In other words, a trunk highway will eventually be similar to a main line railroad but on a smaller scale.

What is needed to answer this question is the best judgment of the engineering profession as to how far we should go, in the interest of economy, toward the ideal location. The data as to the probable saving in operating costs by decreased distance, decreased rise and fall, certain maximum grades and degrees of curvature, given by Mr. Harger, are most valuable and the conclusions to which these figures bring us are evident.

However, after carefully deducing that radical improvement in location will result in great saving in the cost of operation of vehicles, Mr. Harger upsets the whole argument by reverting to past methods of highway design and attempts to excuse them by saying that he does not deem it advisable to make this saving for the public because the public is wasteful anyway and would not appreciate the saving but would spend it on ice cream and the movies. Is not this the type of economist that the periodicals have been blaming for everything from the H. C. L. to the present labor situation? Is not such an excuse poor logic on the part of a member of what is supposed to be a logical profession? Mr. Harger argues that since a little extra gasoline and a little extra time is of no consequence to a certain percentage of the traveling public, that the necessary expenditure to improve a location is not justified. Here again is evidence of the old highway methods retarding natural development. Why not study, discuss and decide the question and stand by the decision?

Is it true that "the location of a free public road with no direct revenue return can not be analyzed from the same point of view as a trunk line railroad"? It would seem to me that there is a fair comparison, for example: The public pays for the improvement, directly or indirectly, and certainly the public receives the benefit, directly and indirectly from any saving in operating costs which the improvement effects.

Mr. Harger accepts and quotes A. R. Hirst's values of a mile of distance saved—for example: For 100 vehicles per day the saving capitalized at 5 per cent is $73,000. Assuming that this figure is fair, is it economical or just to the public, traveling for business or pleasure, to follow present locations even through thickly settled and valuable land, where distance may be saved and gradients improved by relocation? Such relocation will undoubtely damage certain property, but this is not ordinarily a stumbling block where public service corporations are concerned, and such a capitalized value for this small number of vehicles will pay for all new rights of way required and any reasonable amount of damage which would be allowed after assessing benefits against the damages, together with the cost of the new construction. The relocation does not eliminate the existing road but will remove the through traffic, thereby reducing maintenance costs, and give the public as a whole the most economical route.

I may be in error, but it is my belief and that of many others, that in ten years' time, trunk highway locations, whether they are relocated as a whole or revised piece by piece, will resemble railroad locations closely. All will agree with me that, if this is true, relocation as a whole would be much less expensive. Certainly we should not neglect to study carefully the railroad comparison in order that we may profit by what railroad men have learned from costly experience.

Let us have the opinions of others.

Edward H. Stelle,
Assistant Engineer,
Minnesota State Highway Department.
Grand Marais, Minn.

[A copy of Mr. Stelle's letter was sent Mr. Harger, whose reply follows.—Editor.]

Sir—These articles on highway location were written with the intention of promoting discussion. I am indebted to Mr. Stelle for his courteous appreciation of the detail data given, and I am sure that any difference of opinion that we may have on general policy will add to the interest of the discussion. **I hope that others will express their opinions.**

We all would prefer to have scientifically located highways. A great many engineers believe that the time has come to make extensive relocations. I believe that minor relocations necessary to obtain reasonably good grades and alignment are justified at this time, but that extensive relocations must be gradually worked out except for a few exceptional cases, and that, practically, it will be easier to accomplish and fairer to the general public to do most of this work under reconstruction programs rather than to attempt extensive relocations at this time.

Large bond issues have the habit of disappearing without accomplishing as much as they are expected to accomplish, and any unusual feature of design (either of location or pavement) which raises the average cost per mile must be used with caution. The great need of most localities is a fairly complete road system usable the year round. Until this is accomplished extreme refinements have a doubtful value.

Probably 90 per cent of road traffic does not demand, nor would it be particularly benefited by, extreme refinements of location. On certain commercial hauling roads extensive relocations are probably desirable at once, provided the owners of trucks finance the extra cost of the improvement. But it seems very doubtful if it is good policy for the community at large to spend extremely large sums primarily for the benefit of this class of traffic which pays an entirely inadequate sum for the use of the highway. The so-called return to the community through reducing the hauling rates of a commercial truck haulage concern is not a very convincing argument to the taxpayer putting up the money for construction.

W. G. Harger.
Rochester, N. Y.

Hints for the Contractor

Asphalt Cut by Device Made With Buggy Wheel

By W. F. Reichardt

Consulting Municipal Engineer, Watertown, Wisconsin

ALL contractors who have had occasion to use an asphalt filler on pavements have no doubt experienced much difficulty melting the asphalt, and from experience have learned that the smaller the size of the pieces of asphalt placed in the kettle the more readily does it melt. During cold weather asphalt can be cut with an axe, but as most of our paving is done in warm weather we find that at times when the asphalt is soft it is wellnigh impossible to cut it with an axe or any other sharp instrument.

WIRE AND BUGGY WHEEL MAKE ASPHALT CUTTER

The accompanying cut shows what a contractor did at Bayfield, Wis. By this simple device two men cut more asphalt in an hour than they could have otherwise cut in a day. The machine is constructed of two 4 x 4-in. pieces to which is attached an upright, supporting an ordinary buggy wheel. A heavy wire is fastened to the upright at one end and onto the hub of the wheel at the other. The barrel of asphalt is placed in the loop of the wire and when this wire is wound around the hub of the wheel and the wheel is turned, the wire cuts the asphalt. By this method the asphalt may be cut into any size desired.

Breaking Up Cement Gravel With Dynamite

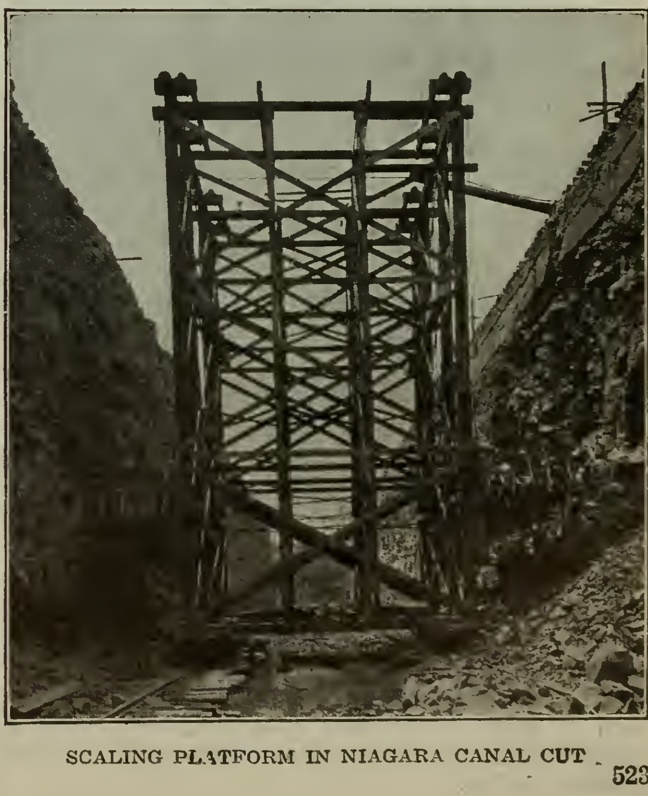
By F. W. Wilson

SUCCESSFUL use of 40 per cent ammonia dynamite in breaking up cement gravel for use in road fills was a feature of a road job recently carried on at Chittenango, Madison County, N. Y. The sand and gravel in the pit being worked were cemented together, making it very difficult to break it up with picks. Holes had been drilled with a well drill and also with a steam drill. These holes had been loaded with dynamite and shot, but the shock of the explosion had been absorbed by the many small air spaces in the cemented gravel and sand and little material had been loosened.

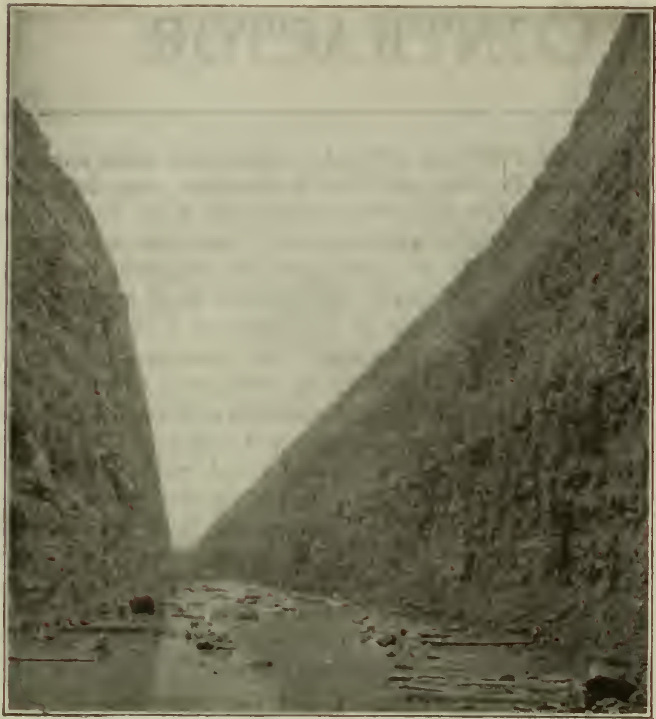
The cemented sand and gravel was successfully broken up by the following method: Horizontal holes approximately 4½ ft. deep and 1 ft. in diameter were drilled in the face of the pit. Two holes about 4 ft. apart were loaded and fired simultaneously. Each hole was loaded with 3 lb. of 40 per cent ammonia dynamite, and the explosive was not pushed all the way back into the end of the bore holes but an air chamber 4 or 5 in. long was left back of each charge. Each charge was entirely surrounded by and packed in stiff mud, affording the necessary resistance, which the sand and gravel, because of the large air spaces through it, did not. The blast loosened the material so that it could be shoveled without picking and the cost, including the price of the explosives was less by considerable than the time it would have taken laborers to pick it loose. The sand and gravel were so thoroughly cemented that when drilling was first done it took three men half a day to put down a 12-ft. hole, using a steam drill.

Movable Platform Used for Scaling Rock

AT THE lower end of the Queenston-Chippawa Canal around Niagara Falls, which is the feed line for the new development now under construction by the Hydro-electric Power Commission of Ontario, the cut is for a distance of about two miles through the Niagara limestone formation. It is here 48 ft. wide and of maximum depth of nearly 60 ft. The upper 10 ft. of the sides was channeled but below that the rock was close-drilled and the spoil removed by the big electrically operated steam-shovels used on all the canal work. The final section will be lined on the bottom and for 30 ft. up the sides with concrete and in preparation for this lining the rough cut sides are now being



SCALING PLATFORM IN NIAGARA CANAL CUT



SCALED SECTION—48 FT. WIDE, 52 FT. DEEP

scaled from a special trestle or platform which moves through the cut on trucks.

One of the views shows the platform in action. It is a simple wood frame with trucks for movement on sectionalized track and with suspended platforms on each side from which the scaling is done by men with picks. These platforms hang by wire cables from sheaves on top of the frame and are counterweighted for easy movement up and down. Plumb-bobs are hung from the top of the trestle on the line of the

SCALING CREW AT WORK ON FACE OF WALL

clean cut and projecting pieces of rock are scaled off.

In order to hand the concrete lining to the rock face, dowels of old steel rods are grouted into the side of the cut at frequent intervals, either in single ⅝-in. rods or double ½-in. rods. The holes are drilled in about 2 ft. and the dowels bent over so as to hold the concrete facing.

Rolling Hitch for Unloading Pipe

FOR unloading 54-in. reinforced-concrete pipe from railway cars for the new conduit of the Denver water-works a portable rolling hitch has been devised. The hitch, an adaptation of a method used for loading and unloading logs in lumber camps, consists of a 4 x 4-in. stick, the ends of which are built up into 6-in. iron-bound cylinders. As shown in the view, the hitch is held by a heavy bow-shaped steel strap with a hook on each end, one to take the cable passing under the pipe and the other a chain secured to the rail to prevent the car from overturning. The railroad is narrow gage and the large pipe would easily tip the cars unless held down.

THREE MEN CAN UNLOAD A 54-IN. PIPE WITH THIS HITCH

The man on the car pinches the pipe over the edge onto the skids when the two men on the ropes lower it slowly to the ground. A small tractor is used to roll the pipe within reach of the boom of the pipe-laying machine. The entire 48,000 ft. of the conduit parallels the railway track.

The hitch was devised by J. C. Mitchell, general manager for the Lock Joint Pipe Co., which has the contract for the new conduit.

Safety Methods in Building Construction

A NOVELTY in making provision for the safety of workmen engaged in building and construction work has been used in the erection of large extensions to the plant of the American Rolling Mill Co., Middletown, Ohio. At 2 p.m. each Tuesday a committee composed of foremen, mechanics and laborers inspects the entire job from sewers to roof with the one purpose of seeing that proper methods are taken to safeguard the employees against accident. This committee makes a detailed report of each inspection to a representative safety committee, which considers and acts upon the recommendations of the inspection committee.

The plan was introduced and is being carried out by Dwight P. Robinson & Co., Inc.

NEWS OF THE WEEK

New York, September 9, 1920

Road Shipments Not Affecting Coal Program, Is Report

Charges having been made that the movement of road materials is interfering with the program of coal distribution, Thomas H. MacDonald, Chief of the Bureau of Public Roads, calls attention to the fact that his policy throughout has been to co-operate in making the Interstate Commerce Commission's orders effective.

It is true that the Bureau of Public Roads is handling applications for special permits to use open-top cars, but applications for these permits are approved only for the movement of materials to important projects, already under way, whose completion is necessary to open main lines of travel. The number of cars which have been used under this permit system has been negligible, Mr. MacDonald says, so far as having any effect on the coal program. In New England, where the problem of distribution has been most difficult, not a single permit has been granted.

Mr. MacDonald believes the best way out of the difficulty is to advance coal distribution as much as possible, with the hope of shortening the time that priority in the use of open-top cars is necessary. Despite a very general desire to secure permits to ship materials for completing street and road projects, Mr. MacDonald is insisting that no permits be granted except in cases where the project is of real importance as a link in transportation.

Engineering Council's Water-Power Committee

An offer to serve the Federal Power Commission in an advisory capacity in technical matters has been made by the Water Conservation Committee of Engineering Council. The committee will meet with Power Commission officials Sept. 10 to discuss the matter. The Water Conservation Committee consists of Calvert Townley, chairman; Charles T. Main, H. Hobart Porter, M. O. Leighton, Allen Hazen, Arthur P. Davis, Arthur E. Morgan and F. W. Scheidenhelm.

Detroit Amendments for Water and Sewer Bonds Carry

At the primary election held Aug. 31 charter amendments of the City of Detroit were carried, including authorization for the issuance of $12,000,000 in public utility bonds and $25,000,000 in public sewer bonds. Of the former, $7,000,000 will be used to extend the pumping system of water-works and $5,000,000 to extend the pumping system and build a nitration plant.

Civil Engineers at New York Condemn Amendments and Proposal to Join Federation

Contend That Amendments Conflict, That Federation Lacks Definite Program and That Both Would Be Costly

Pending amendments to the constitution and the question of joining the Federated American Engineering Societies were discussed at the business meeting of the American Society of Civil Engineers in New York Sept. 1. The meeting was spirited. The discussion, with the exception of one brief statement, was all in opposition to the amendments and to joining the federation.

Objections advanced against the amendments were that they set up expensive machinery for the nomination of officers, that they were in conflict with provisions of the constitution, that the annual conference of representatives of sections would be a heavy expense and would have no important function, and that the amendments regarding the election of officers set up a political machine which can and will be manipulated for the personal benefit of interested factions.

No objections were made to the amendments which relate to dues, honorary membership and candidacy for office of members of the nominating committee.

The proposal to join the federation was condemned on the score that no substantial worth-while program had been put forth, that it created a huge machine which, lacking problems to keep it legitimately employed, would become meddlesome, and that the cost per member, $1.50 per annum, would prove insufficient, necessitating later calls for additional funds.

On account of the straitened character of the society's finances it was argued that the society should not undertake changes or enter movements that would place additional burdens on the treasury.

A motion was carried during the discussion requesting the board of direction through the executive committee to issue the minutes of the meeting, immediately if possible, to the corporate members of the society, in order that they might have the benefit of the discussion in considering the pending vote.

Ninety-nine members were present at the meeting.

Amendments

At the suggestion of the chairman the amendments were taken up first.

Lieut.-Col. W. T. Chevalier, the first speaker, characterized the amendments as having the same purpose and effect as the reputed burning down by the ancient Chinese of their houses when they wanted roast pig. We desire to accomplish certain things—comparable to the Chinese desire to get roast pork—but he contended that we should not tear down the whole fabric of the society in order to effect desired changes.

The fundamental purpose of the proposed amendments was, he stated, to democratize the society, but the means employed was merely the erection of a "vast political machine, that carries with it everything that is connoted by that term, district leadership, log rolling and huge expense, for which," he added, "you and I are going to pay." He maintained that the finances of the society could not stand the financial strain.

But even if the money were available, he contended that the gain was not worth the cost. Ostensibly the local sections were to be exalted. As a matter of fact they had been "stabbed in the back." They were given no definite standing, but would have only such powers as the board gave them. These powers might be revoked and changed by successive boards.

If the amendments were adopted no additional members, he contended, could be elected to the society, since the constitution requires that twenty-five ballots be cast by the board to constitute an election to membership, while the proposed amendments call for a board of only twenty-four.

The proposed annual conference of representatives of sections he characterized as a "lower house," the board of direction being the senate. "The annual conference," he added, "is going to elect the senate; it is going to create the board of direction, and then, in addition, is to instruct the board how to manage the society." The conference is also to consider the welfare of the society and of its members. He believed that his hearers were competent to look after their own welfare. He maintained that the annual conference would be a very expensive undertaking, and contended that, if established, the expenses of a delegate from every section should be paid, no matter if there were sections in London or Hawaii.

He urged that the members reject the pending amendments and await the report of the committee to which certain

amendments were referred by the Portland convention, said amendments to be reported back at the annual meeting in January.

If the progressive members would present their ideas to the committee, there would be reported back in January a well-rounded and comprehensive set of amendments that are going to mean "progress and not factionalism." He concluded by an appeal for the burial of differences and the co-operation of all who have the good of the society at heart.

C. M. Holland, the next speaker, read a circular letter entitled, "An Appeal for a Progressive as Against a Radical Policy," signed by 182 members of the society, of whom over 60 are west of the Mississippi River, which is being sent to all corporate members of the society. The substance of it is given in another column of this issue.

Financial Aspects

Arthur S. Tuttle (treasurer of the society), commenting upon the references that had been made by Colonel Chevalier to the financial status of the society, estimated that the deficit for the year 1920 would be $22,000. Of that deficit a portion would be passed over to the next year through the deferring of the publication of the *Transactions*. If the society joined the federation, the deficit, even if the dues of non-resident members were raised $5, would be, he estimated, about the same next year.

L. D. Rights declared that he favored the incorporation in the constitution of some of the ideas expressed in the amendments, but that he could not favor the pending set because they were not properly co-ordinated with the remainder of the constitution. He pointed out the curtailment in the *Proceedings* and maintained that thereby the discussion will be curtailed. He believed that changes which would involve further expense should be postponed, since even under present financial conditions one of the most valuable parts of the society's work must be sacrificed.

George L. Lucas objected to the second amendment, with reference to assignment of members to local sections, because it would not require that a member shall be identified with a local section in the geographical district in which he resides, nor would it prevent him from belonging to several sections if he so desired.

The amendments take no cognizance of the fact that Article 6, Section 7, of the constitution provides that at least three members of the finance committee and two members of the other standing committees shall be resident within fifty miles of New York. Since the secretary, under the proposed amendments, would no longer be a member of the board and it would be no longer obligatory that one of the vice-presidents be a resident member, the effect of the provision would be that two out of the resident directors would be obliged to serve on both the publication and library committees and all three on the finance committee, unless the treasurer be appointed on the committees, which had not been the usual practice. This would give a few resident members of the board undue preponderance in handling the affairs of the society through committees.

The amendments relating to the number of officers introduced confusion because the nominating committee, which has just functioned, has, provided the amendments be carried, named more candidates than there will be offices to fill. Two directorships would be abolished, but nominees for these offices had already been named.

Replying to a question by the chairman, Mr. Tuttle, the treasurer, said that he had heard an estimate that it might cost $16,000 a year for the expenses of delegates to the annual conference. This was based upon the fact that we have eighty cities in the United States with a population of over 100,000 [there are about 70 such cities—Editor] and that therefore we might have eighty sections. Traveling expenses per delegate were assumed at $200 each. The estimate, he said, was roughly made. It might be increasd by an added number of sections, or decreased if the expense of $200 per delegate was too high. The chairman, Francis Lee Stuart, commenting upon the estimate, believed that the society was not warranted in spending so much "for political purposes."

A. P. Hoover believed that it was a mistake to remove the secretary from the board of direction. No one, he thought, was better qualified to be a member of the board than the secretary.

Question was raised whether the charter of the society allowed a change in the number of directors, but no one could answer it. Dr. Hunt, secretary emeritus, called attention to the exemption of the society from taxation under the laws of the State of New York. In order to secure that exemption it was necessary to sue the City of New York and to prove that the society was purely a scientific organization. He could not say whether Amendment A (expanding the objects of the society) would interfere with that exception or not, but he believed it a mistake to amend the constitution before legal opinion was had on the subject. Since the society is one-fourth owner of the Engineering Societies Building, the taxes would be quite heavy. The chairman replied that legal advice was being sought on the subject.

The Federation

Turning to the proposal to join the Federated American Engineering Societies, Colonel Chevalier again took the floor. He believed we had been regaled with too much rhetoric regarding the federation and not enough "cold-blooded and dispassionate consideration of just what we are going to get for the price we are to pay." It was generally agreed that the professional man should receive greater respect and that the public should get the benefit of the engineering point of view concerning questions of a technical nature.

Granting that the things to be accomplished are what we desire, were they worth the price?

First, there was a material price—$1.50 per year for each member of the society. In his opinion, if the members of the society would get what they thought they were going to get, it was not enough. "If we are going to buy welfare work," he said, "it is my judgment that we will be buying it on margin and that sooner or later we will have to put up or be sold out." The experiences of the A. A. E. have proved that welfare work cannot be done for a small sum per member. If the work was worth having, it was worth paying for, and until we were in a position to pay for "an all-wool article" he did not think "we ought to go flirting with a proposition on a margin."

But there was another price that had to be paid: the American Society of Civil Engineers had to pool its good-will "in this holding company." "The American Society of Civil Engineers," he continued, "has a prestige that comes very nearly being first in the world for a society of this sort. This has been built up over a long period of years by adherence to a policy of rigid selection, of high professional qualifications, by holding men up to these qualifications, and by seeing that the pin which we are proud to wear stands for something." Though the society had been criticised, there were more members coming in than ever. It was his opinion that if the society "delivered the goods" as it had in the past engineers that are worth having will continue to knock at its doors. There are no qualifications as to membership in the federation and other bodies with lower standards would direct the federation. The society would give up the control of its name, for the actions of the federation, he contended, would be the actions of the American Society of Civil Engineers in the eyes of the world. We were asked to put the society in the hands of an organization in whose management we would have an insignificant representation.

For the price that would have to be paid—in money and in prestige—he had been unable to learn what the return would be. The federation's bulletin No. 3 purported to explain the purposes of the organization. There were nine pages in the document, of which seven were devoted to telling the goods things that Engineering Council, which the federation is to displace, had accomplished. The remainder consisted of generalities.

He mistrusted such statements as that the federation was "to use its power for the service of the community, state and nation in public affairs wherever engineering experience and technical knowledge are involved." He feared that that would lead to interference with governmental employees.

Instead of the proposed type of federation, he favored joint committees of

(*Continued on p. 528*)

Good Roads Campaign To Be Started in Argentina

Movement Proposed by S. T. Henry Backed by Argentine, American and British Business Houses

A nation-wide, good-roads educational campaign is to be launched soon in the Argentine Republic. A large number of prominent Argentine, American and British business houses of Buenos Aires have formed a good roads association of the Argentine Republic for this purpose. This organization will demonstrate the value of good roads by methods which have been effective in similar work in the United States.

The primary object of the new association is to bring together every one who is interested in any way in good roads in the Argentine Republic. Information about how good roads are financed, constructed and maintained will be collected in countries where conditions are similar to those in the Argentine. This information will be interpreted in such a way as to make it the most effective for use in that country. It will be put out in various ways. Printed matter of different kinds will be used; plans for a series of moving pictures have been made; in some cases speakers informed on the benefits of good roads will be employed.

The movement was started as a result of a speech made at a luncheon of the American Club of Buenos Aires by S. T. Henry, vice-president of the Allied Machinery Co. of America. Mr. Henry outlined the great effectiveness of the good roads educational work that has been done by the American Automobile Association, the Portland Cement Association, the Federal Highway Council and other American organizations. He urged all American concerns whose business in the Argentine depends in any way on good roads to get together in support of a similar good-roads campaign. He suggested that an organization, formed for this purpose, could co-operate with the Argentine government in the same manner that similar private associations in the United States work with Federal and State highway officials. He stated that several important Argentine, American and British concerns had offered to back such a movement if proper plans were adopted.

Immediately after Mr. Henry's address an organization committee was formed. This committee received help from all of the many lines of business interested in good roads. After several preliminary meetings a tentative form of constitution and bylaws for the association was adopted. A board of directors was elected, but the election of other officers was postponed until later. It is planned to have Argentinos of the highest standing serve as president, vice-president, secretary and treasurer. The directors desire, however, not to ask such men to take these positions until ample funds to carry on the proposed work have been raised.

Temporary Organization Formed

A group of local business men have underwritten a temporary organization. It is thus certain that the movement will go ahead until the plans can be presented to the concerns most interested in supporting it. J. N. Wisnor, who was manager of the United States Chamber of Commerce in the Argentine from the start of that organization until recently, has been employed to manage the association during the organization period.

From the start it was evident that this movement would receive the most cordial moral support of the Argentine people. The board of directors were notified to call upon the Minister of Public Works, who assured them that he would do everything he could to help. Many Argentinos have joined the association, although the directors decided not to make an effort to get individual members until proper financial support was certain. It has been planned to secure then the greatest possible number of individual members in all parts of the country. To this end dues for individual membership will be made very low. Most of the funds will be raised from subscribing members.

Argentine managers and agents of the American concerns will appeal to their home offices for funds with which to help make a success of the movement. It is planned to raise at least $150,000 for the first year's work. Several large subscriptions were promised as soon as the personnel of the directors and the manager was known. Most of these came from managers of American interests, who realize the great impetus which good roads in the Argentine would give their business. Every American manufacturer of automobiles, motor-trucks, accessories and supplies who wants to keep up his present volume of business, or to make greater sales in that country, doubtless will support the new organization financially. Several manufacturers of gasoline, oils, road materials, cement and road machinery have also signified their desire to help.

The board of directors asked Mr. Henry to present the plans of the association to the executives of American manufacturers, who ought to be interested. He will do this soon after his return to the United States this month. In the meantime plans for good-roads educational campaigns in different parts of the Argentine are being worked out. Studies of available road-making materials also are being made. Other preliminary work has been started, so that the movement can be pushed vigorously as soon as sufficient finances are available.

Road-building in many parts of the Argentine has been widely considered to be impracticable. American engineers who have recently studied conditions in the most developed sections of the country report otherwise. They are convinced that the difficulties to be overcome are not nearly so serious as those which have been solved in many places in the United States. The great private wealth of the Argentine is of course ample to carry on a good-roads program relatively as large as anything that has been done in this country. The chief reason why the Argentine has built no roads seems to be a lack of understanding by the average citizen of the great national importance of good roads. It also apparently is not known that good roads can be secured in most places in the Argentine at a very reasonable cost. The association that has been started ought to be able to change this entire situation rapidly.

Make Plans for A. S. M. E. Annual Meeting

According to present plans for the annual meeting of the American Society of Mechanical Engineers in New York, Dec. 7-10, the keynote session will be devoted to the subject of transportation, with addresses by prominent men in that field. This session will include consideration of the railroads, waterways, motor trucks and terminals.

Special sessions will be held by the professional sections on fuels, management, machine shop, power, railroads and textiles. A subcommittee has been appointed on the subject of engineering in woodworking, with Thomas D. Perry, Grand Rapids, Mich., chairman.

It is planned to devote one session of the meeting entirely to the subject of appraisal and valuation.

Notes From the Corps of Engineers

Col. Henry C. Newcomer, Corps of Engineers, U. S. A., who has been department engineer for Hawaii and a commander of the third regiment of engineers, has been ordered to New Orleans to serve as division engineer of the Gulf division. He relieves Col. Herbert Deakyne, who goes to San Francisco to become division engineer of the Pacific division, district engineer of the first San Francisco district and a member of the California Debris Commission. Col. Deakyne will relieve Col. E. Eveleth Winslow, who goes to Governors Island as Corps Area engineer of the Second Corps area. Col. Winslow will relieve Col. William W. Harts, who is to go to Cincinnati as division engineer of the Second division. Col. Harts will be designated as a member of the Mississippi River Commission.

Col. William J. Barden, who is under assignment to become division engineer at Cincinnati, has been ordered instead to Florence, Ala., to take over that district. The post is one of unusual importance at this time, due to the construction of the Wilson dam.

Civil Engineers Condemn Amendments

(*Continued from p. 526*)

local or regional organizations, since most questions that require concerted action are of a local character. Only relatively few become of national scope and it was uneconomical, in his opinion, to build up a big organization merely to have it in wait when these few questions did arise.

He feared that the big organization would have so little work coming to it logically that it would begin to create jobs for itself. The machinery, he thought, should grow out of the need for it. We should build from the bottom up and make each step justify itself, instead of starting from the top and trying to find work to make the top worth while.

He pointed out that in the article in the *Engineering News-Record* recently on the organization of other professions Charles Whiting Baker had indicated that welfare work is handled through local rather than through national organizations.

George W. Fuller believed that the procedure at Portland was a disorderly one when, instead of taking the board's advice of allowing the matter of joining the federation to be referred to the society's counsel, the meeting instructed the board to send out the ballot at once, without waiting for such legal report.

He believed that there was a certain amount of welfare work to be done, but felt with Colonel Chevalier that an organization should be developed from the bottom up. He spoke with commendation about the San Francisco Engineering Council, which later was followed by a State Engineering Council. He believed that this idea might be extended to the establishment of regional engineering councils as well. The regional conferences, in turn, could head up in a national conference. The local bodies would pay the expenses of their delegates to the state and district councils. He did not believe that the proposed federation represented a real need of the engineering profession. He hoped that the proposal to join the federation would be defeated as it was in April of this year.

L. D. Rights also spoke against joining the federation, proposing instead that the society should strengthen its local sections by giving them an adequate amount of money and letting them take care of local and state affairs of a civic nature. He believed that the dues should be made uniform, at $25 per annum, in order to do this. He felt there would be quicker results from such a plan and that the membership would get more for their money than by joining "any diversified federation."

Frederick C. Noble maintained that the present form of the federation is substantially the same as that which was voted on last spring. The representation of the society had been increasesd from about 5½ per cent to 8, but he did not consider that an essential change in the proposal. In the Executive Council the society would have two members out of the thirty.

Lieut.-Col. F. W. Scheidenhelm asked if there were not some one in the room who would speak in favor of the federation. The only response was from W. C. Briggs, who stated that he believed the society should join the federation because it was the only concrete proposal that had been made to meet "a desire that is latent in a very large body of the membership." He was sympathetic to the discussion of the evening, but if we could not get something better than the federation he thought that the society should join it.

Colonel Scheidenhelm then asked a number of questions: (1) Whether it would be possible to get the co-operation of other engineering societies in some alternative scheme; (2) whether it was felt that the American Society of Civil Engineers had a higher set of ideals than other societies, so high that it barred it from getting into an organization with other bodies; (3) whether the society, if it should refuse to go into the federation, would face the same position as it did some years ago when it decided to come into the Engineering Societies Building after having once refused to participate.

Colonel Chevalier believed, answering Colonel Scheidenhelm, that co-operation of other societies could be secured for an alternative plan. He did not maintain that the members of the American Society of Civil Engineers were of "superior clay," but that the society had certain standards which it was its duty to maintain without making comparisons with the standards of other organizations. He considered that these standards would be endangered by joining the federation.

No attempt was made to answer the third question, but Dr. Hunt pointed out that after refusing to come into the society building in the first instance applications for membership quadrupled inside of a month. Dr. Hunt also stated that if, when the proposal came up the second time, the society had not entered the building, it would now have money enough to join the federation and to spare.

Lieut.-Col. J. P. Hogan, replying to Mr. Briggs, maintained that the mere fact that no other concrete proposition was before the society was not a valid argument for voting favorably. It was the duty of the members to inquire as to the workability and probable success of the scheme. He believed the federation to be incapable of practical action and felt that it would be "entirely a political organization," and that it would have possibilities of becoming a public nuisance. In joining a federation we should seek to join with those with whom we can get along or who are "the same sort of crowd that we are ourselves." The federation, however, was to be composed of at least seventy-five "diversified societies of varying purposes and varying standards from all over the country."

Appeal for Am. Soc. C. E. Negative Vote

Defeat Urged by 182 Members So That "Sound" Amendments Can be Considered at Annual Meeting

One hundred and eighty-two members of the American Society of Civil Engineers have joined in an appeal for a defeat of the pending amendments, except those relating to dues, honorary members and candidacy for office of members of the nominating committee. The circular, which is entitled "An Appeal for a Progressive as Against a Radical Policy," has been mailed to all corporate members of the society. Those signing the appeal class themselves as "progressives," and infer that they favor reorganization. They hold that the pending amendments are "disjointed and unco-ordinated." Their defeat is urged, so that the society can at the annual meeting consider the report of the committee to which certain amendments were referred, it being the expectation of the signers that the committee will present "a thoroughly worked-out and comprehensive plan for the amendment of the constitution along sound and progressive lines."

No reference is made in the circular to the referendum regarding membership in the Federated American Engineering Societies.

The reasons advanced against the amendments are as follows:

(*a*) They do not represent the mature views of any representative body of the society. They were conceived by a faction, were worked over and modified at Portland, Ore., and were railroaded through a convention in that city made up of less than 2 per cent of the membership of the society. These amendments are not those formulated by the committee of the board of direction appointed for that purpose. They are almost entirely the product of the radical faction of the society.

(*b*) They are so vague and unco-ordinated that, if adopted, they will give rise in all probability to protracted strife and perhaps litigation that may keep the society in a turmoil for an indefinite time. This resulted from the lack of legal advice and from the tinkering to which they were subjected up to the moment they were voted on, in an attempt to reconcile inconsistencies that continued to come to light even at the eleventh hour.

(*c*) In the endeavor to democratize the society, these amendments tend toward the establishment of a political machine in which the average society member will probably take little interest. Its manipulation will soon fall into the hands of those who will be enabled by it to exploit the society for personal and political advantage.

(*d*) By the introduction of an elaborate system of political machinery the society is committed to an absolutely unknown and unestimated drain upon its treasury, already laboring under a material deficit. Until this financial problem has been attacked and solved, we must not write into our constitution provisions that may involve the society in serious financial embarrassment.

(*e*) The manner in which the Local Sections have been handled in these amendments leaves them without any standing or place in the society. To them are assigned important administrative functions, but no plan is laid down for their support. Their very rights, powers and existence are subject to the whim of each successive board of direction. We believe that the local section should be incorporated in the organization of the society and that it should be established on a solid basis in the constitution. The treatment of the local section illustrates the loose-jointed manner in which the entire question of society reorganization has been handled throughout these amendments.

E. S. Alderman, J. N. Ambler.

W. E. Baldry, W. Baldwin, S. Barfoed, O. Bates, R. N. Begien, W. L. Benham, L. E. Bishop, E. B. Black, R. D. Black, W. L. Breckinridge, H. E. Breed, G. D. Brooke, W. G. Brown, D. J. Brumley, W. W. Brush, W. V. Buck, R. D. Budd, C. B. Burdick, L. Bush.

F. W. Cappelen, E. I. Clawiter, W. T. Chevalier, V. H. Cochrane, M. C. Couchot, A. S. Crane, M. L. Cunningham, C. H. Currie.

A. L. Dabney, P. A. Dallis, J. V. Davies, G. S. Davison, C. Derleth, Jr., H. D. Dewell, G. C. Diehl, G. L. Dillman, A. S. Downey, B. S. Drane.

T. Earle, J. R. Elliott, F. W. Epps, A. C. Everham.

F. H. Fay, C. F. W. Felt, R. Fletcher, S. J. Fortin, G. W. Fuller.

J. D. Galloway, W. B. Gester, L. S. Gillette, C. R. Gow, E M. Graham, R. C. Gray, H. R. Green, B. F. Groat, F. M. Gunby.

J. L. Harrington, F. D. Hartford, R. T. Hartman, E. M. Hastings, J. H. Haylow, A. Hazen, S. H. Hedges, A. S. Hirzel, J. P. Hogan, C. A. Holden, C. M. Holland, H. C. Holmes, R. Hortenstine, E. E. Howard, E. T. Howson, C. R. Hulsart, E. B. Hussey, E. C. Hutchinson.

R. H. Jacobs, J. H. Johnston, F. G. Jonah, W. N. Jones, J. D. Justin.

F. M. Kerr, V. H. Kriegshaber, K. B. Kumpe.

H. A. Lane, G. H. Leland, E. E. Lochridge, C. F. Loweth, G. L. Lucas, J. L. Ludlow.

D. W. McNaugher, E. R. Mack, H. L. Maier, A. Maitland, Jr., C. T. Main, R. R. Marsden, J. B. Marsh, D. H. Maury, J. S. Means, C. A. Mees, R. A. Meeker, W. Meredith, R. Messer, A. F. Meyer, C. A. Mead, A. N. Miller, R. E. Miller, L. V. Morris, B. S. Morrow, F. R. Muhs, E. T. D. Myers, Jr.

W. R. Neel, A. M. Nelson, A. W. Newton, C. S. Nichols.

M. M. O'Shaughnessy, A. E. Owen.

R. S. Parsons, W. B. Parsons, I. W. Patterson, J. N. Pease, C. L. Pillsbury, J. H. Polhemus.

R. I. Randolph, F. M. Randlett, A. R. Raymer, C. H. Reeves, A. F. Reichmann, E. H. Reidpath, C. J. Rhodin, A. O. Ridgway, J. Rosenwald, James G. Ross, H. B. Rust.

H. R. Safford, N. H. Sayford, H. L. Shaner, W. C. Shaw, Jr., W. J. Schlick, W. F. Schulz, F. C. Shenehon, L. K. Sherman, F. B. Smith, J. W. Smith, L. B. Smith, G. R. Solomon, C. M. Spofford, C. L. Strobel, R. M. Strohl, H. A. Sumner, R. S. Sumner, A. R. Swem.

A. J. Taylor, S. A. Taylor, R. D. Thomas, R. H. Thomson, J. L. Tighe, G. W. Tillson, L. R. Tillotson, H. P. Treadway, A. A. Trocon, R. D. Trimble.

S. N. Van Trump.

N. E. Waddell, B. H. Wait, W. T. Walker, G. S. Walsh, J. J. Walsh, T. J. Wasser, T. D. Wardle, H. A. Wells, H. F. Wiedeman, J. R. Wilbanks, F. Wilcox, W. G. Wilkins, G. L. Wilson, W. J. Wilgus, P. B. Winfree, F. E. Winsor, C. C. Witt, D. Witten, J. R. Worcester.

J. J. Yates.

Private Firm Named to Make State Rail Valuation

On Aug. 24 announcement was made of the selection of the engineering firm of Ford, Bacon & Davis, New York City, to do the actual work of appraising all electric railway properties in the State of New Jersey in accordance with the law passed by the legislature last April. When the measure was passed it was promptly vetoed by the governor on the grounds that it was loosely drawn and invited litigation, and was then passed over his veto. According to the measure, the valuation commission is to consist of the governor, the state treasurer, and the comptroller. The governor, however, has refused to serve and the valuation will be carried out under the general direction of State Comptroller Bugbee and State Treasurer Read, who have appointed the firm of engineers to do the actual field work and computations. The law provides that the value found be used in rate proceedings.

David Chauncey Shepard—Pioneer Railroad Builder

David Chauncey Shepard, pioneer builder of the Northwest and one of the foremost railroad builders of the country, whose death in St. Paul, Aug. 7, was announced in this journal Aug. 12, was engaged both as engineer and contractor in railroad building from the age of 20 until his retirement at the age of 66. He was born near Geneseo, N. Y., Feb. 20, 1828, his education consisting in attendance at the district school, the Temple Hill Academy and the Brockport Collegiate Institute. In 1847 he was appointed a member of the engineering corps engaged in the construction of the Genesee valley canal. His first railroad position was secured in 1851 on the old Rochester & Genesee Valley R.R., now a part of the Erie system. From 1853 to 1870 he was, successively, chief engineer of the Atlantic & Great Western, the Milwaukee & Beloit, the Minnesota & Pacific and the Chicago, Milwaukee & St. Paul railroads.

As a contractor Mr. Shepard superintended the construction of railroads in thirteen states and in Canada. The total mileage built by his firms is 7,026, of which 6,666 miles are in the Northwest. W. P. Kirkwood, of St. Paul, in an article in the *Bellman*, several years ago, gives Mr. Shepard's record of railroad building as follows: Minnesota, 1,452 miles; North Dakota, 984 miles; South Dakota, 950 miles; Montana, 858 miles; Iowa, 859 miles; Missouri, 61 miles; Ohio, 40 miles; Indiana, 42 miles; Illinois, 217 miles; Nebraska, 43 miles; Wisconsin, 236 miles; Idaho, 80 miles; Washington, 439 miles; and Canada, 725 miles. In 1882-3 he built 675 miles of railroad from Oak Lake to Calgary, on the Canadian Pacific, in 15 months, a remarkable record for those times. Later, on the Great Northern, from Minot, N. D., to Helena, Mont., he made a new record by laying 100 miles of track per month, laying 643 miles between April 1 and Nov. 18, 1887. While these records were being made, Mr. Shepard had under his direction 9,000 men and 3,500 teams. He retired in 1894.

Program of Ontario Engineers' Professional Meeting

The program of the seventh general professional meeting of the Ontario Provincial Division of the Engineering Institute of Canada, to be held at Niagara Falls, Ont., Sept. 16, 17 and 18, 1920, is largely devoted to the consideration of hydro-electric and waterway developments. On the first day of the meeting an inspection of the Welland Ship Canal will follow an illustrated talk on this waterway. Papers and motion pictures of the Queenston-Chippewa development will precede an inspection of this work on the second day of the meeting. On the third day there will be shown a demonstration of the Gibson method of measuring the flow of water in closed conduits. The meeting is being held under the auspices of the Niagara Peninsula Branch of the Institute.

Water Power League to Meet

The Water Power League of America, whose office is at 116 Nassau St., New York City, will hold a convention in Washington, D. C., Oct. 7-8, 1920, at which representatives of all the states, manufacturers, and power producers will gather to discuss the possibilities presented under the new Federal Water Power Act. The purpose of the convention is to afford an opportunity to the several states that are interested in water-power development to have their representatives come in contact with the Federal Power Commission with a view that there may be evolved a workable program which will co-ordinate the activities in those states with those of the Federal government.

Engineering Societies

Calendar

Annual Meetings

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Sept. 13-17.

SOUTHWEST WATER WORKS ASSOCIATION, Waco, Tex.; New Orleans, La., Sept, 20-23.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA, Sterling, Ill.; St. Louis, Sept. 21-23.

AMERICAN ASSOCIATION OF PORT AUTHORITIES, Montreal; Chicago, Sept. 30-Oct. 2.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Valparaiso, Ind.; St. Louis, Oct. 10-15.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION, Chicago; Atlanta, Ga., Oct. 26-28.

The Detroit Engineering Society held its fall meeting, Sept. 3. Prof. John C. Parker, department of electrical engineering, University of Michigan, spoke on "The Engineer in Organized Society—What Is Hampering His Recognition?" Past-President D. J. Sterrett, delegate of the society at the Organizing Conference, held in Washington, D. C., in June, presented his report on the Federated American Engineering Societies. At a meeting of the society, Sept. 17, Charles Evan Fowler, consulting engineer, New York City and Detroit, will speak on the subject of "Harbors and Harbor Bridges," with particular reference to the proposed Detroit-Windsor bridge.

The Engineers' Club of Lansing, Mich., has been granted a charter as a local chapter of the American Association of Engineers. Officers of the club who will continue as officers of the chapter are: President, C. A. Melick, bridge engineer, Michigan State Highway Department; vice-president, R. K. Steward, professor of drawing

and design, Michigan Agricultural College; secretary-treasurer, J. A. Herzog, chief draftsman, Reo Motor Car Co. There are 109 charter members in the chapter and some 40 additional applications are now under consideration. F. D. Messenger, road engineer of the State Highway Department, is chairman of the membership committee. The club will begin an intensive membership campaign in the near future in conjunction with the membership campaign of the national association.

The Engineers' Club of San Francisco, at a luncheon, Sept. 1, was addressed by Dr. Hermann Von Schrenk of the firm of Von Schrenk & Kammerer, consulting timber engineers, St. Louis, on "Proper and Improper Uses of Preserved Timber."

Personal Notes

Drury Butler, surveyor Sacramento, County, Cal., has been appointed county engineer.

Ernest E. Trimble, engineer with the Union Pacific R.R., has been employed as full-time secretary of the Nebraska State Assembly of the American Association of Engineers, with headquarters in Omaha.

Col. Edward G. Walton, stationed at Washington, D. C., Lt.-Col. Fidelio G. Chamberlain, at San Antonio, and Lt.-Col. Ira L. Fredenall, at San Francisco, have been appointed officers in charge of the district headquarters of the Construction Service in those cities.

John Barrett has retired as director general, Pan American Union, after nearly fourteen years in that capacity and twenty-five in official international service. After assisting in the organization of the new Pan American College of Commerce at Panama, as president of the Administrative Council, with headquarters at Washington, D. C., he will establish connections in Washington, Chicago and New York and at points on the Pacific coast and in the south, as a general counselor and special adviser in international, economic, commercial, financial and cultural relations. He is succeeded by Dr. L S. Rowe.

Major Roger G. Powell, who has been acting as assistant engineer commissioner during the drawing up of the Washington, D. C., zoning regulations, has been ordered to duty as assistant to Gen. Harry Taylor, who is in charge of the river and harbor work of the Corps of Engineers.

D. H. Goodwillie, director of public service and superintendent of water, Toledo, has resigned to become associated with the Edward Ford Plate Glass Co., Rossford, Ohio. He has been connected with the engineering and water departments of Toledo for nine years. Immediately following the construction of the filter plant he became chemist in charge of operation for four years. For a year he was an associate of W. G. Clark, consulting engineer, Toledo, and then returned to the city for three years as superintendent of water-works, a position he has retained for the past two years along with his duties as service director.

C. H. R. Fuller, of Toronto, has been appointed city engineer of Chatham, Ont., succeeding Frank P. Adams.

A. A. Potter, dean of the School of Engineering, Kansas State Agricultural College, has resigned to become dean of the School of Engineering, Purdue University. He will be succeeded by Roy A. Seaton, recently professor of mechanical engineering at Kansas State Agricultural College.

George C. Whipple, recently chief of sanitation of the League of Red Cross Societies, Geneva, Switzerland, has been appointed consulting sanitary engineer to the League. He will return to New York about Sept. 20.

G. M. Williams, who has been for a number of years a specialist in the cement investigations of the U. S. Bureau of Standards, has resigned to become assistant professor of civil engineering, University of Saskatchewan.

L. V. Bean has been appointed chief engineer of the roadway department of the Georgia, Florida & Alabama Ry., with headquarters at Bainbridge, Ga.

M. F. Steinberger has become special engineer on the staff of the vice-president in charge of operation and maintenance of the Baltimore & Ohio R.R., with headquarters at Baltimore.

H. M. Blomquist, principal assistant engineer, water department, St. Paul, Minn., has been appointed superintendent of the Cedar Rapids, Iowa, water-works system. Previous to going to St. Paul, Mr. Blomquist was for several years city engineer of Mankato, Minn.

P. F. Wright, chief draftsman, U. S. Department Engineer's Office, Charleston, S. C., has been transferred to the office of the District Engineer at Baltimore, Md.

Frederick S. Wheeler, formerly resident engineer of the California State Highway Commission, is now associated with the efficiency engineer, producing department, Standard Oil Co., Delano, Cal.

A. W. Kreamer, formerly assistant engineer for the United States War Department, stationed at Wheeling, W. Va., is now with Stone & Webster, Inc., engaged as assistant engineer on appraisal work and designer on structural steel and reinforced concrete work.

A. C. Lagerwall has become engineer of Shawnee County, Kan. with headquarters at Topeka, succeeding J. E. Williams. Mr. Lagerwall has recently been engineer on Federal Aid Project No. 7 in Douglas County.

Obituary

Ernest Voss, a well-known shipbuilder of Germany, died recently at Hamburg, at 78 years of age. Mr. Voss obtained his experience with English shipbuilding firms and was afterwards engineer and surveyor to Lloyd's Register in Germany. He was one of the founders, in 1876, of the firm of Blohm & Voss, which concern, among many other notable productions in war vessels and merchant ships, built the "Vaterland."

William Harley Moore, bridge engineer of the New York, New Haven & Hartford R.R., died Sept. 5 at New Haven, Conn., at 60 years of age. Mr. Moore received his education in the Royal University of Ireland. After about a year's service as draftsman with the New York Central & Hudson River R.R., and three years in a similar capacity on the New York, New Haven & Hartford R.R., he was made bridge engineer of the latter road, in 1889, which position he held up to the time of his death.

Benjamin Smith Lyman, geologist and mining engineer, died at Philadelphia Aug. 30. He was born in Northampton, Mass., Dec. 11, 1835. He graduated from Harvard University in 1855, and studied mining engineering at Ecole des Mines, Paris, and the Royal Academy of Mines, Freiberg. He was mining engineer for the Public Works Department of India in 1870, engaged in the survey of oil fields, and from 1873 to 1879 acted as chief geologist and mining engineer to that government. He traveled extensively in Europe, India, China and the Philippines, making geological researches, and was the author of more than 150 papers on geological surveying.

Dr. William H. Ellis, former Dean of the Faculty of Applied Science, University of Toronto, died Aug. 23 at Lake Joseph, Muskoka, Can., where he was spending his vacation. He was born in England, in 1845, and graduated at the University of Toronto. In 1878 he became assistant professor of chemistry in the Toronto School of Practical Science, and when that institution became the School of Applied Science and Engineering of the University Dr. Ellis was appointed professor of applied chemistry and head of the department of chemistry. He became dean of the faculty in 1914, from which position he retired last year. During his occupancy of this chair, a School of Engineering Research was founded, largely through his efforts. He held the degree of L.L.D from both Toronto and McGill Universities and a few years ago the Engineering Institute of Canada elected him one of its honorary members. Dr. Ellis was for many years provincial analyst of Ontario.

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E. J. MEHREN
Editor

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Plant Seizure in Italy

INDICATIVE of what may happen in Central Europe is the seizure by the workers of metal-working plants in Northern Italy. Without more intimate information one cannot predict the outcome. That the movement has not spread to all industries is encouraging, and indicates a non-soviet solution. The wisdom, or otherwise, of the government's non-interference cannot be gaged at this distance, though one is naturally inclined toward adverse criticism. Pessimism is not warranted at the minute, but the occurrence is an indication of the unstable conditions abroad.

What Is Art?

JUST as the engineer asks of the architect an acceptance of his assurances of strength in a structure, so must he accept the architect's assurance of beauty. Nevertheless strength is measurable and definite; beauty is neither, but too often lies only in the eye of the beholder. So the engineer may possibly be pardoned if he thinks that the Bensalem Avenue bridge, illustrated in this issue, is somewhat overdecorated. Unquestionably this structure is pleasing to look at and testifies in general to the wisdom of architectural assistance in bridge design, but to the engineering eye its embellishment is too profuse and its detail overemphasized. It is a fair question whether the engineer's instinct for simplicity in bridge design is not sound.

Getting Together on Pipe

AN ENCOURAGING feature of the convention of the New England Water Works Association at Holyoke last week was evidence that the Committee on Standard Specifications for Cast Iron Pipe and some, at least, of the pipe manufacturers are getting together. Two members of the committee recently visited a number of foundries and arrangements have been made under which pipe manufacturers will conduct some tests to throw light on questions at issue. Such co-operation is promising. Presumably the get-together spirit will also be shown by the similar committee of the American Water Works Association (the two committees are working jointly) and by still other makers of pipe.

City and County Consolidation

AMONG the causes of insufficient and uneconomical government in minor civil divisions is the maintenance of separate city and county governments where the area and population are largely the same. Engineers are more directly concerned with this inefficiency and extravagance in the duplication of engineering services. For some years past there has been a movement for consolidating city and county governments, but progress is slow. The subject, as applied to Seattle and King County, Washington, is vigorously discussed editorially in the Seattle *Times* of Aug. 4, following Mayor Caldwell's advocacy of consolidation. The *Times* urges that "every possible business economy is thrown to the winds when two separate and complete business administrations perform the same tasks in behalf of the nearly four-fifths of the county population which actually resides in the city." It goes so far as to assert that "the per capita tax of the 389,240 inhabitants of King County will be cut from 30 to 40 per cent, perhaps more, the first year we enjoy the consolidation." The subject deserves careful study by the engineers of Seattle and of other cities where like arguments can be advanced.

Belittling a Good Record

TYPHOID reduction in Massachusetts from 45 to 2.5 deaths per 100,000 in the past 35 years is something the State and the cities and towns of that commonwealth may well be proud of. It is all the more remarkable because it has been achieved with comparatively few water filtration plants and with only a little chlorination, as was pointed out by H. W. Clark in a paper before the New England Water Works Association last week. A member who, according to the secretary of the association, had not read Mr. Clark's paper, sent a written discussion (based on the title of the paper, "Innocence Better than Repentance") designed to show that the Massachusetts authorities have erred in not favoring filtration and chlorination and have thus put or left the people of the state in danger. Among other pleasantries, this critic said that the low typhoid in Massachusetts is due to the grace of God rather than to the State Board of Health. The old board may have been too conservative, but with such a record as it has made it should not be held up to ridicule.

Repaving in Municipalities

THE almost universal lack of an appreciation on the part of American municipalities of the necessity for providing adequate repaving programs is strikingly illustrated in an article by W. A. Bassett, appearing on p. 534. It may be because of the ever-changing character of city administrations, each one striving to establish a record of economy, that many worthy improvements are patched from year to year and passed on as liabilities to succeeding administrations. But it is a fact that real economies, that make for lasting municipal betterments, though large individual expenditures be necessary to insure them, are often overlooked. Proposed extensive construction and reconstruction projects recommended year after year by competent technical heads, are stricken from budgets with the cry that the taxpayer, who is also the voter, will find the financial burden involved unbearable. But in cutting out such improvements the politician both stamps himself as of unsound economic mind, and underestimates the real

intelligence of the taxpayer-voter. If it be economy to extend a net-work of improved highways into every producing center of this country, surely expenditures to keep in condition the streets in the zones of greatest traffic are justifiable. It is just as necessary that a municipality keep its streets in good order as it is for that same municipality to force public utilities, to whom it has granted franchises, to give the public the best of service. The engineer is not usually a wastrel and budget-making and approving bodies would do well to give a serious ear to his recommendations.

Hiding City Plans in the Safe

WHAT the world owes the inquisitive newspaper reporter is beyond estimate. At Bristol, Conn., his curiosity appears to have brought to light a report on city planning that represented some two years' work on the part of an eminent authority but which had been locked in the city safe for some time after the consultant's bill for $5,000 had been paid. The reporter's story of the case, but by indirection only, suggests three reasons why the plans were thus hidden away: (1) The estimated cost of the improvements recommended in the report was $2,000,000 and may have scared the authorities; (2) whether due to the city planner or the city officials or whether wholly unwarranted the idea may have got abroad that the chief aim of city planning is beautification; (3) there may have been too little educational work in connection with the city planning investigation. The last point perhaps deserves the most emphasis. Only a few people in even a fair-sized city have a clear conception of what city planning is. When someone in a given city becomes interested in the subject and succeeds in having a city planning commission appointed and an experienced city planner engaged to make a report, there is nothing done to tie the matter into the city government or to give either city officials or the public at large an understanding of what city planning is—a co-ordination of the many and diverse elements of the city plan and a selective program, extending over a term of years, for carrying out the elements of the plan in the order of their need and benefit to the whole community.

Highway Traffic Etiquette

LESS tangible problems than that which involves regulation of motor truck weights concern our several highway departments. Weight regulation is an out and out question of the exercise of the police power; but more difficult is that other problem—teaching the truck driver plain manners. All too noticeable is the fact that the heaviest cars usurp the highways. "Follow the middle of the road" may be sound moral advice, but it makes a poor traffic rule.

Commercial vehicles frequently surpass an 8-ft. width. On an improved road, whose metalled surface is but 18 ft. wide, such a car, traveling the road center, leaves a scant 4 ft. on either side. The ordinary truck driver, apparently adhering to the belief that might is right, having little fear from collision with lighter vehicles, usually pushes the passenger car to the last inch of road when passing. If that same passenger car is unlucky enough to pull up behind the truck, the chance the owner has of making the truck driver hear a horn above the rumble of engine and truck is doubtful. At street intersections and at crossroads the universal traffic regulation is repeatedly broken.

Educational campaigns carried on by highway commissions and by commercial motor-vehicle organizations for the benefit of their drivers cannot leave their impress upon some individuals. To these latter something more forceful than exhortation must be given. A man of public spirit is at least open minded; but the truck driver who exhibits contempt for anything under ten tons is deaf to ordinary argument.

Not at all passive has been the interest highway departments have exhibited in this disconcerting problem. One state, which has an extensive 1920 concrete program, took under consideration the advisability of constructing a ridge a few inches inside the road edges, the plan being to force the truck drivers, under penalty of arrest, to keep the right hand wheels outside the ridge. Added expense to sufficiently expensive construction, and cumbersome methods necessary for such installation, condemned the plan as impracticable. Nevertheless it is apparent that drastic measures to teach truck drivers the simplest traffic regulations are not an impossibility.

Education and exhortation have accomplished and will accomplish much, but if they cannot convince every driver concerned, physical or legal restrictions are the only alternatives.

What May Happen Will Happen

AN ENGINEER designs a bridge for any load that can possibly come on it, but should he find on his hands a weak bridge, if he be wise, he posts its safe loading. In other words, there is an equal obligation to design with an eye toward future operation and to operate with due regard for design as expressed in construction. If either obligation had been observed at Toledo the failure of the filter-basin baffle wall and roof, described on another page, would never have taken place.

This concrete baffle wall, 17 ft. high and 12 in. thick, was intendend merely to prolong the time of flow of water through the coagulating basin. As such its thinness, lack of reinforcement and horizontal construction joint were permissible and safe. But the layout of the basin was complicated by end transverse baffles which slowed up the flow so that there could be a head set up on the entry side of the longitudinal wall, and the wall, safe enough as a deflector, became decidedly unsafe as a dam. On top of this unstable dam was rested the free end of a flat-slab roof, so that failure of the wall meant failure of the roof.

The only defense of such a design is that it was intended that the flow through the basin should always be at such a rate as to restrict difference in head to a negligible amount. But a 16-ft. concrete wall, unreinforced, untied to roof or floor and only 12 in. thick, would be prohibited as an end support of a slab under any good building code. Because it happens to be inside a reservoir does not add enough to its structural integrity to make it good design. Being in such a reservoir it was not apt to be subjected to wind or one-sided earth load, but it was subject to a possible variation in head, not only from increased outflow but from stoppage of some sort between or around the baffles. Elementary structural design would indicate the advisability of spending a very little more money for columns or a sufficient wall.

Once such a structure was built, however, it was the duty of the operator to use it with due regard for its deficiencies. Possibly it is too much to expect that the operator would do other than accept the structure as safe for any designed conditions, though the weakness of the wall should have been apparent. If there was any head difference set up due to a change in operating standards, either the rate should have been lowered or the structure strengthened.

There have been so many basin-roof failures in the last few years that the real explanation of the Toledo failure was looked for with interest, particularly because this is the first flat-slab basin roof to drop. The report shows that the case is *sui generis* and that the type of roof had nothing whatever to do with it.

The lesson from the failure is rather for the sanitary engineer, who may take a leaf out of the book of the specialist in structures. He always assumes that what may happen will happen. Within obvious limits that is a pretty good maxim for all engineers.

Coming Activity in Railroad Bridge Impact Study

FOR two or three years past the bridge engineers of the Indian railways have been deeply interested in impact effects and impact allowances, with regard to both existing and new bridges. Some months ago this interest culminated in the dispatch of a representative to the United States for the purpose of studying at close range what had been done here. The situation presented by this incident has no less important bearing on American than on Far Eastern bridge development.

It appears that the belief has prevailed among Indian engineers for some time that the impact formulas developed in America, and for that matter the experiments on which they were based, are not directly applicable to Indian practice, in view of the different track gages of the railways there, the lower loads (and, in general, lower speeds), and manifold differences in bridge-construction practice. Whether justified or not, this belief had a gratifying result. it led to the decision to study impact thoroughly, on such a broadly planned basis, as to give prospects that results of greater value than those represented in American impact formulas will be obtained. Should this new activity on the other side of the globe result in reawakening interest among American engineers in the great number of unsettled questions in the impact field, the outcome will be doubly gratifying. We would then have reason to anticipate that the subject may be placed on a final basis of scientific knowledge. It is still far from reaching that stage.

Railway bridge engineers may fairly take pride in what they have accomplished hitherto toward mastering the perplexing intricacies of moving-load action. Their knowledge of impact effect under railroad trains contrasts strikingly with the almost complete lack of knowledge concerning similar effects in highway bridges, as was suggested in these columns last week. Several sets of remarkably painstaking experiments are on record, and formulas are in use that give satisfactory results in design. If the other side of the picture be looked at, however, we must recognize that even in the field of highway bridges our knowledge of impact is very far below the general level of the science of bridge construction.

That engineers in this country are for the moment somewhat apathetic toward the subject may well be thought surprising; yet it is a fact that their present inclination is to rest content with the formula incorporated in the new bridge specifications of the American Railway Engineering Association, and to assume that this disposes of the entire subject. But signs are already evident that the minds of some engineers, at least, are looking beyond this point, and there may soon come a decided resumption of activity in the field of impact.

With all due regard for the merits of simplicity in working formulas, like that in which all our impact tests have been summarized, true engineering cannot be content with these alone. It demands that in addition the fundamental data be brought together in a complete formula or set of laws, which will express broadly and accurately the influence of the various factors in the particular action concerned. So in impact—where our working formulas take note of no variable except loaded length—the engineer frequently needs to know what influence is exerted by other factors, as speed of train, or length of the path of stress (from load to stressed part) What knowledge have we of the effects produced by track irregularities and mechanical unbalance? Little or none. Improvement will of necessity be limited until such knowledge is obtained.

The unanswered questions have practical bearing in many directions. Thus, were it known what portion of the gross impact effect is due to vibration, it would be possible to estimate the gain to be obtained through more rigid construction, and the value residing in solidity of floor or roadbed construction—matters now dealt with in rather impressionistic fashion. Again, impact undoubtedly depends upon type and proportions of bridge, but aside from some uncertain conclusions on the effect of panel length we have no knowledge of these relations. It would be an advantage, further, if critical speeds could be predetermined without actual experiment. So there are many open questions, some of them bearing directly on design, others more on the estimation of the strength of old structures. The field remaining to be explored is a large one.

Auxiliary considerations that arise in connection with impact proper make the problem still more extensive. For example, whether flat wheels should be taken care of through impact allowances may be open to argument, but it is plain nevertheless that the action produced in such cases is analogous to impact action, frequently is combined with the latter, and pertains to the same field of knowledge, and it must be remembered that in the last analysis the railroad-bridge engineer has the duty of producing and maintaining a structure good not only for normal service, but, like any other piece of roadbed, for the abnormal conditions of derailment; under our present practice this contingency, too, is not provided for elsewhere than in the impact allowance.

Referring back to our present knowledge of impact action, the best that can be said is that an approximate range of the impact increment has been outlined by the many experiments already made. Great differences existing between individual observations within this range indicate sufficiently that factors of many kinds probably have influence on impact. Until these factors have all been identified, and their influence determined in at least an approximate way, the subject of impact cannot be considered to have reached a satisfactory stage or one in which bridge design is truly efficient.

Repaving—A Vital Problem for Municipalities

Opinion Held That Almost All Cities Have Failed To Keep Pace With Needs — Specific Examples Show Needs Are Four Times Annual Mileage Laid

By W. A. Bassett
Chief of Engineering Division, Bureau of Municipal Research, New York City

The undertaking of a program of road improvement by the states and counties of this country involving the expenditure of more than $630,000,000, which was contemplated for 1920, is, in a sense, a climax to the program of educational propaganda for "good roads" which has been carried on consistently throughout the United States during the past 25 years. It is true that, on account of the prevailing high costs of construction, there has been a disposition in some cases to restrict

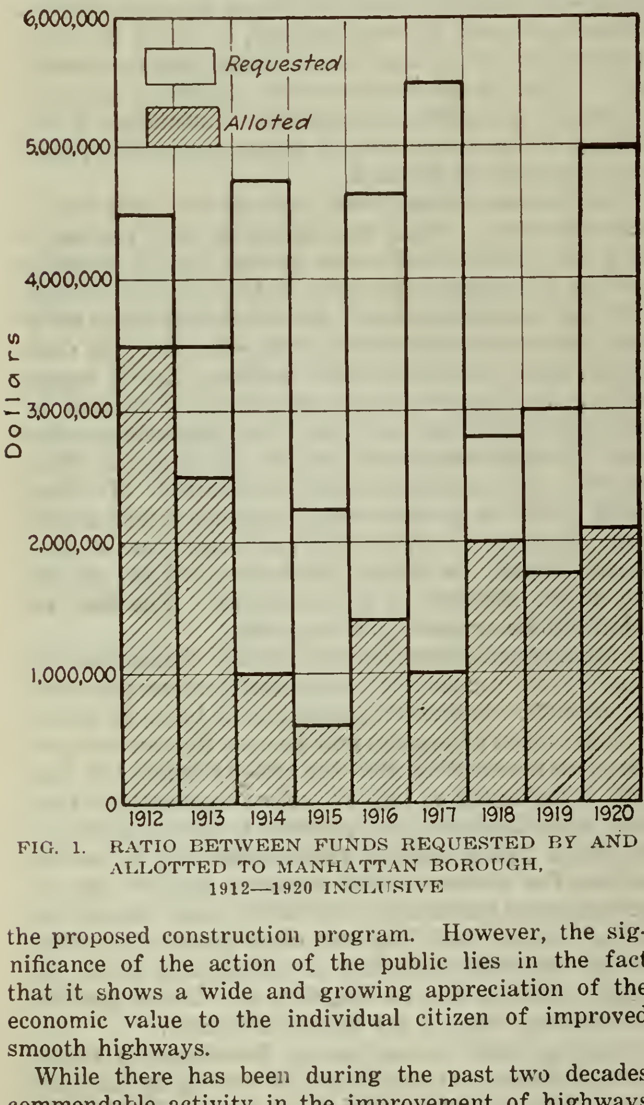


FIG. 1. RATIO BETWEEN FUNDS REQUESTED BY AND ALLOTTED TO MANHATTAN BOROUGH, 1912—1920 INCLUSIVE

the proposed construction program. However, the significance of the action of the public lies in the fact that it shows a wide and growing appreciation of the economic value to the individual citizen of improved smooth highways.

While there has been during the past two decades commendable activity in the improvement of highways outside of the limits of cities, the latter units of government, almost without exception, have failed in their street improvement work to keep pace with the need for these facilities. This applies particularly to the matter of repaving, or the replacement of existing pavements, by those of an equal or more permanent character.

In all cities the need for new street improvements will be determined largely by the growth of the community or material change in the character and distribution of its traffic. Any increase in the mileage of paved streets not only places responsibility on the community for the suitable maintenance of those streets but also that of making provision for their replacement when worn out. In cities which are growing rapidly the problem of providing new pavements may be of greater importance than that of repaving. In the larger cities, however, the problem of repaving far exceeds in magnitude and importance that of new construction. In fact the Borough of Manhattan, New York City, so located as not to permit of physical expansion, and with its streets practically all paved, is an example of a community where the street improvement problem is one of repaving alone.

Pavement Replacement Policy

Any sound repaving policy should provide for the replacement of pavements within their economical lives. The end of the economical life of a pavement is reached when the capitalized annual cost of keeping it in a suitable state of repair approaches the capital expenditure required to replace it. In other words, the ratio between the cost of repairs and the cost of replacement affords a means of determining when repaving should be undertaken. Experience and judgment are required in the interpretation of this ratio as frequently many elements may affect any given case.

Thus the effect of a thorough repair of any pavement, even when it would appear that it had reached the limit of its economical life, may be to extend its period of usefulness several years longer. Also the greater desirability of a new pavement for the accommodation of traffic, or the character and location of the thoroughfare, may outweigh purely financial consideration in justifying a repaving improvement.

Furthermore, sometimes a community is confronted with the economic desirability of resurfacing streets originally paved with stone blocks, bricks or other pavements of a relatively permanent character which have become seriously worn. In such cases it may be found that the actual cost of keeping these pavements in a state of repair that will prevent hazard to the public, when capitalized, would not be sufficient to cover the cost of replacing these pavements entirely, although their condition might be such as to demand improvement. Conditions of this character are in many cases present in those pavements which were laid 25 years ago on sand or macadam foundations. Where these pavements are in large cities on important avenues of traffic their entire replacement by paving with suitable concrete foundations may be entirely justified, even admitting the extra cost. In small communities, however, the element of cost may be a serious factor, and in such cases experience has demonstrated the usefulness of surfacing these streets with some sort of an asphalt wearing surface without attempting to correct

fundamental defects in the pavement section. While obviously a wearing surface of this kind may have a relatively short life, yet the benefits that result from providing a smooth pavement frequently will justify such a temporizing policy. It is of course important that such pavements should be consistently maintained. This merely illustrates the fact that any repaving policy should not demand in all cases a complete replacement of the wornout pavement by a new one of the same or more durable character.

It should be pointed out, however, that the justification of such a policy would depend upon the extent and character of traffic using the streets in question; the relative permanency of the present surface, even if rough; and the probable cost of maintaining the new surface. Each case of this kind must be decided on its merits. It is important, however, to emphasize that any determination of required repaving depends upon complete and reliable data on extent, character and cost of maintenance and repair work done during the life of the pavement in question.

No Uniformity in Pavement Life

It is evident that there can be no uniformity in the average economical life of pavements. The experience of Buffalo, N. Y., according to the report of the city engineer for the year 1918 shows a high average of 23 years' useful life for asphalt pavements. The city of Washington, D. C., with strikingly dissimilar conditions, reports the even greater economical life of more than 25 years for the same type of pavement, while the average useful life of all classes of pavements in the Borough of Manhattan has been estimated in the 1916 report of the borough president as not exceeding 15 years.

Whatever the value of that element is, it, together with the extent and age of paved mileage of the city, gives a basis for determining what provision should be made annually for replacing wornout pavement. For example, in the case of the Borough of Manhattan with more than 450 mi. of paved streets, on the basis of an average useful life of 15 years, it would be necessary to replace not less than 30 mi. of pavement each year in order to keep pace with community needs.

That there has been little if any appreciation of these elementary principles, or at least practically no recognition of them by city administrations, is reflected in the almost universal lack of any consistent repaving policy and the inadequacy of funds provided for these purposes. The extent of the need for repaving may be illustrated by conditions prevailing in two large cities, Newark, N. J., and the Borough of Manhattan, New York City.

The repaving problem of Newark, N. J., is of particular interest as Newark may be justly termed a well-paved city both in the character and distribution of its paved streets. The mileage of paved streets in Newark during the period 1905 to 1918 increased from approximately 158.3 to somewhat over 271.4. Approximately 23 mi. of telford or macadam construction are included in this mileage. The relation between the total mileage of paved streets and the amount of new construction and repaving carried out during the above period is shown in the accompanying chart. An analysis of these data shows that on the basis of an average useful life of 15 years for pavements in Newark, assuming that conditions affecting pavements in that city are comparable with those in Manhattan, the demonstrable need for repaving during those years exceeds by about four times the amount actually laid.

The entire paving problem of Newark was studied by the writer during 1919 in connection with an administrative study of the city government made by the New York Bureau of Municipal Research. Data collected during the study were analyzed and in conference with the engineer responsible for directing street work the attempt was made to measure the actual street improvement needs of that community and to set up a work program for the years 1920-1924 inclusive. The conclusions arrived at were that it view of the insufficiency of the repaving program in the past the situation demanded the repaving of not less than 20 mi. of streets annually. If such a program were carried out the mileage of repaving required for subsequent years would be at somewhat less variance with the annual increase in new mileage. It should be noted that the above estimate was not based on complete replacement of pavements in all cases, but in its preparation it was assumed that where justified resort would be had to expedients of a relatively temporary character in order that a greater mileage of smooth wearing surface would be provided.

Perhaps the most striking example of complete lack of consistent policy in the matter of repaving, and the influence that political expediency has had in controlling expenditures for this important work, is that of the Borough of Manhattan. This is well illustrated by a consideration of the accompanying chart in which are plotted the requests for funds for repaving purposes made by the engineer through the borough president to the Board of Estimate and Apportionment, and the allotments made by that body for the years 1912-1920 inclusive. These years are selected because they are the only ones for which reliable data are available.

Repairing in Manhattan

While it is admitted that requests for budgetary and other funds made by city officials are sometimes predicated rather on getting "all the traffic will bear" than upon actual need, it is believed that the request made for repaving during 1912 represented a reasonable measure of the actual needs at that time. If all the requirements in this matter had been met up to 1912 the repaving need for that and subsequent years would be represented by a straight line. Admitting that such is not the case, if any consistent repaving policy had been adopted at that time the curve of requirements could be plotted as parabolic in character, rising until past needs for repaving had been met and then flattening to parallelism with the X-axis when the repaving program keeps pace with the needs of the community.

The chart shows a complete disregard of the fundamental principles that should govern a repaving policy and program. In fact the absolute failure to meet the obvious requirements for repaving work on the part of the Board of Estimate and Apportionment is a striking commentary on the lack of appreciation of that body of the important influence that smooth pavements bear on the economic welfare of the community at large.

The serious need of adequate funds for repaving in the Borough of Manhattan was forcefully presented in the report of the president of that borough for the year ending Dec. 31, 1916. This report states that:

The denial of appropriations which we have asked for repaving not only has prevented us from laying about 100 mi. of new pavements which the need of Manhattan demands but also has forced us to overtax our repair gangs and has resulted in an annual expense for repairs on such streets far in excess of the proportionate annual costs for the new pavements. This spells inexcusable waste. It is unfair to the taxpayers and also to our borough government, whose administrative expense is increased against its best business judgment. The average useful life of pavements in Manhattan is 15 years. Therefore, in order to keep our 456 mi. of pavement in proper condition and to prevent the necessity of repairing old pavements beyond the point of economy we should, under normal conditions, annually lay

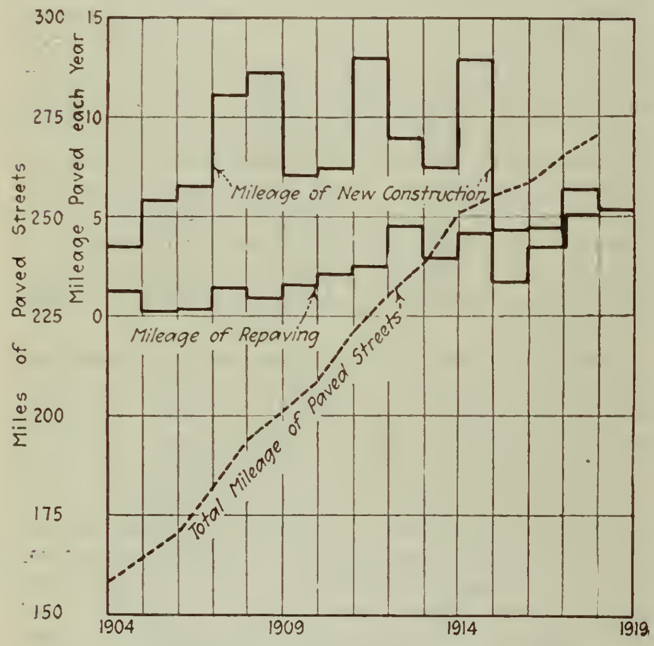


FIG. 2. ANNUAL PAVING AND REPAVING DONE, AND TOTAL MILEAGE, NEWARK, N. J., 1904—1918 INCLUSIVE

about 30 mi. of new pavement. In order to continue our policy of laying annually the normal amount of about 30 mi. of new pavement and also to replace the 100 mi. of pavement that has for several years needed replacing we should lay annually for a period of ten years about 40 mi. of pavement. This would entail an annual cost of about $4,000,000. At the close of this period the abnormal conditions would be overcome and the annual repaving appropriation would then be reduced to the normal amount of about $3,000,000.

Inasmuch as the money made available for repaving since 1916 has been materially less than that required to meet the normal need, the situation is today far more serious than at that time.

Repaving Necessity General

The examples of Newark and Manhattan are cited as illustrating conditions in two important large communities. The same serious problem either in greater or less degree faces practically every other city in the United States. Failure to recognize the value of keeping the streets of a city suitably paved is one of the most serious elements of economic waste that confronts society in those communities. It is reflected in congestion of traffic and delays in handling foodstuffs, frequent results of which are loss of perishable foods, increased cost in operation of motor and other vehicles as reflected by both high repair costs and shorter useful life of vehicles, and a loss of time in transacting business, which, in the last analysis means financial loss. If these various elements of loss could be capitalized, it would be seen that expenditure of sums far in excess of those expended today would be justified to prevent them. That there is nothing academic about this claim has been demonstrated by the results of a series of tests conducted during 1918 by the Portland Cement Association to determine the amount of gasoline required to operate motor trucks over different types and conditions of roads. This information, a résumé of which was published in the *Engineering News-Record*, Nov. 7, 1918, p. 843, shows variations in the cost of operation due to this element alone ranging from 16 to 90 per cent above that required for operation over a smooth road surface. Moreover the comparison made is between a smooth brick or concrete pavement taken as standard and other types of road in fair to good condition. If the owners of automobiles and other motor vehicles who use the streets of a city could be made to realize that poorly paved streets may double the amount of gasoline required to operate their machines within the city, it is reasonable to believe that there would be little or no opposition from them to a sound repaving policy and program.

The effect of road improvement in economy of transportation has been demonstrated conclusively throughout this country. Perhaps one of the most striking experiences of this character is that of Los Angeles County, California, described in the *Engineering News-Record*, July 31, 1919, p. 214. A comparison of accurate traffic censuses with haulage contract prices over both improved and unimproved roads in that county indicates that, on the basis of saving in haulage per ton-mile up to the time that report was made, three of the main roads out of Los Angeles had paid for their original cost and maintenance about nine times during the preceding four years. There does not appear to have been recognition of the possibilities of analagous saving over city streets subject to intensive traffic. At this time when there is the greatest need for conservation combined with maximum production, it is particularly imperative that those who are responsible should recognize the extreme importance of a sound repaving policy.

Caribou Hydro-Electric Project

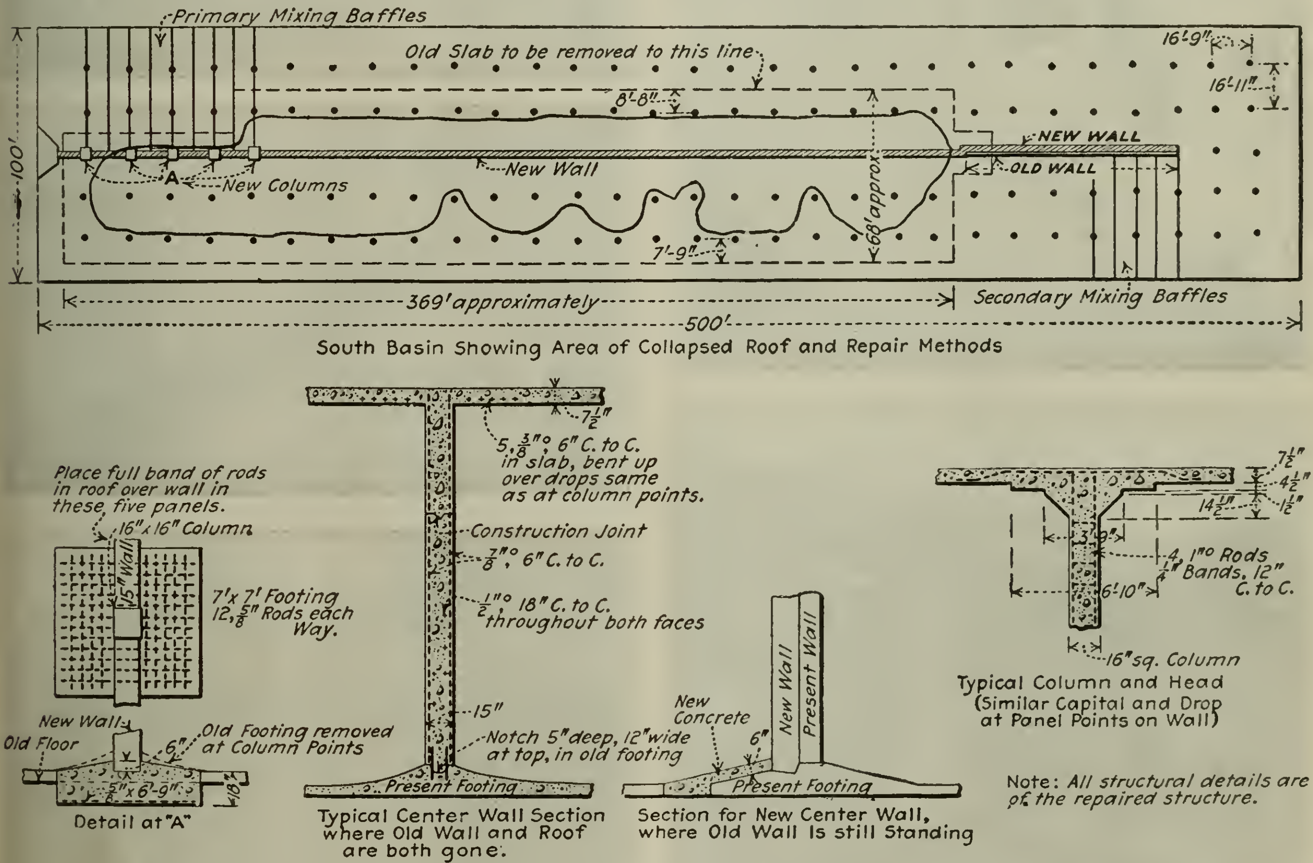
The hydro-electric development known as the Caribou Project which the Great Western Power Co. is constructing on the Feather River in California has reached such a stage that completion early next year is now believed to be assured. Construction of the 165,000-volt transmission line for a distance of 185 miles from Caribou Power House to Valona substation is well under way. Most of the towers are up and the aluminum conductor cable, which is approximately 1 in. in diameter has been delivered. The line is to be completed this fall some time before other parts of the project can be finished. The Caribou Plant, which is next to the uppermost in a proposed chain of seven plants to utilize successive drops in the 75-mile stretch of the Feather River between Lake Almanor and Oroville, will have an ultimate capacity of 120,000 kw. in six 20,000 kw. units. Two 20,000 kw. units are to be installed now. The water wheels will be of the impulse type operating under a head of 1,008 ft.

Collapse of Basin Wall and Roof at Toledo

Filling Sedimentation Basin Too Rapidly Builds High Head Against Thin Baffle—Roof Pulled Down by Wall

FOLLOWING the too rapid filling of a sedimentation basin at the Toledo, Ohio, water filtration plant a 350-ft. length of concrete baffle wall, 12 in. thick, collapsed Aug. 1, at 11 a.m. carrying with it 54 panels of concrete roof slab and 16 columns. The baffle wall extended nearly the whole length of the basin (Fig. 1) and so that it finally rested just beyond the bottom portion. The wall was keyed into both the roof and the floor of the basin, but had no reinforcement connection with either.

The difference in water elevation on the two sides of the longitudinal baffle wall before the failure was computed by noting the difference in water depth (9½ ft.) in the basin after the wall was down and the depth on the high side (11 ft. 10 in.) as indicated by the water mark and taking into account the relative areas (see Fig. 1). This computation showed the difference or head of 5½ ft. already mentioned. The difference at the inlet-outlet end, or at the primary mixing chamber



FIGS. 1 AND 2. SOUTH BASIN SHOWING AREA OF COLLAPSED ROOF AND REPAIR METHODS

not only served as a baffle but was also utilized in carrying the roof instead of a line of columns. It divided the basin into an inlet and outlet side which contained primary and secondary mixing chambers at opposite ends of the basin and on opposite sides of the longitudinal baffle wall, as shown in detail by Fig 3. The loss of head caused by the secondary mixing chamber baffles created a difference in water level on the two sides of the longitudinal baffle wall, which increased with volume and velocity of the water passing through the basin. The nominal rate for which the baffles were designed were 22,000,000 gal. daily but 30,000,000 gal., the recent rate of operation, was considered safe. The rate of filling which caused the collapse of the wall by building up a head supposed to be 5½ ft. was 45,000,000 gal. The wall that failed was not reinforced and for much of its length had a construction joint at two-thirds its height. The wall apparently broke along this joint. The bottom part tipped over and was pushed into the outlet side of the basin as much as 10 ft. The top portion was carried with the outrushing water was of course greater by the loss of head in the primary mixing chamber.

No one saw the collapse, but two operators had just come from the reservoir top and they report nothing unusual. Approximately the same high rate of filling had been used for eight months during alterations and additions to the filters. There seems no doubt however but that the part of the longitudinal wall along the primary mixing chamber collapsed first, because one section of the stilling wall just beyond the passes fell backward toward the passes indicating a sudden release of water from the mixer section. The openings in the walls of the mixer system consist of 2½ x 2½-ft. slide gates cutting off the gutter and 2 x 2½ ft. swinging gates at the wall side. The latter was counterweighted to open under a 1-ft. head. Two of them were found to bind slightly on the concrete but could be operated by pushing with the foot. Another in the last baffle back of the collapsed portion of the stilling wall was out of its bearings and one bearing was bent around 90 deg. Originally there were "over" baffles between

How Baffle Wall Failure Damaged Toledo Basin

4. When Wall Fell Roof to South Dropped Like a Curtain. 5. North Wall Roof Collapsed Irregularly. 6. Stilling Wall Fell Backward Against Baffles. 7. After Removal of Débris—Under Passes at End of Passes—Swinging Gates in End of Over Passes. 8. Derricks Remove Débris—Men Cutting Roof Slab. 9. Shows Shearing Around Column Heads—Slots Cut to Remove Slab to One-half Panel Line. 10. Cutting up Concrete Wall.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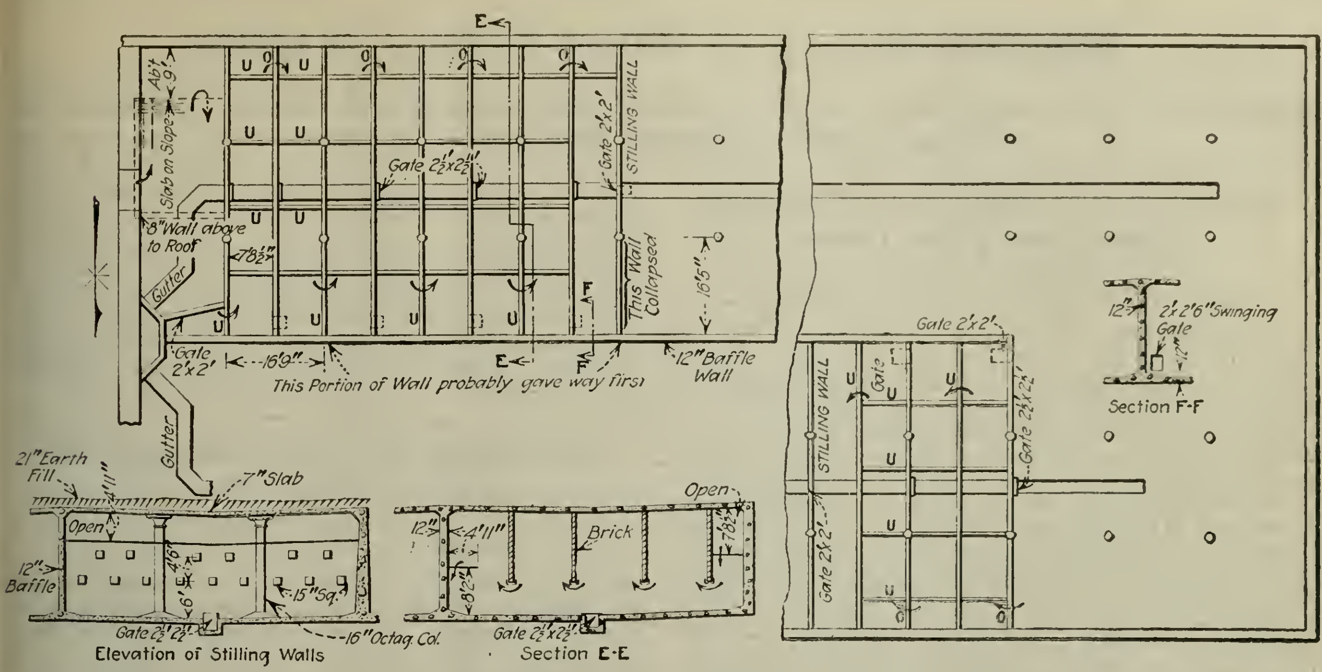


FIG. 3. PRIMARY AND SECONDARY SYSTEM OF MIXING BAFFLES AT TOLEDO FILTRATION PLANT

successive "under" baffles. Because of the excessive loss of head these "over" baffles were removed about three years ago.

The top of the slab is at El. 157.58 over the baffle wall and the floor of the basin at El. 140, so that with the 7-in. slab and 12 in. pyramidal base, the clear height of the wall is 16 ft.

The flat-slab, 7-in. roof supporting 20 in. of earth is one of the early C. A. P. Turner types with bands of eleven ⅜-in. round rods spaced 8-in. on centers running longitudinally, transversely and in both diagonal directions. Over the wall the longitudinal band was omitted and no column-head bars were placed. The wall was used simply as a rest. When it fell it broke 16 columns thus letting down the panels back of the columns. The slab over the high (south) side parted on the construction joint midway of the panels and that portion nearest the columns dropped nearly intact and hung by the rods like a curtain. The photographs show this condition and the manner of the collapse on the other side where the columns were broken.

Repairs were undertaken immediately, two derricks with 60-ft. booms being used to hoist the débris out of the reservoir to the south side. The hanging curtain of slabs was released and the mass of tangled reinforcing was cut up by oxy-acetylene flame and bull nippers. The larger blocks of concrete were broken up by sledges and the roof cut back to the lines indicated on the drawing by sledges.

A new reinforced-concrete wall capable of withstanding the full pressure of the water will replace the old one, a 5-in. notch at the bottom being cut in the old base, in order to permit using each half of the basin independently if desired in the future.

Opposite the primary mixing chamber regular columns are to be placed at the panel points in the wall so that the wall between columns can be built separately and torn out should a new set of mixing baffles be desired.

For the five panel lengths of wall which did not fall the new wall is to be built alongside the old one using the latter as a form.

The roof panels are being replaced by a 7½-in. flat slab designed to meet the Pittsburgh building code requirements. Fifteen ⅜-in. round bars spaced 6-in. on centers are to be placed in each band instead of eleven bars. The bands will be raised over the column heads which are to be square and dropped 4½ in. Considering the punishment the old slab has stood it was felt unnecessary to use the more rigid Chicago code requirements.

Rather than attempt to salvage the line of columns on the break they are being removed and the slab cut back to the one-half panel line. This was done to secure an advantageous construction joint. A crack or a construction joint already existed on this line. Details of the reconstruction are shown in Fig. 2.

W. G. Clark is consulting engineer on the repair work, which is under the general direction of D. H. Goodwillie, director of public service and superintendent of water.

The Best Type of Improved Highway

The Bureau of Public Roads frequently receives requests for information as to the best type of road. Some of the letters asking for this information come from persons not versed in the technicalities of road construtcion and the question is put with the evident assurance that return mail will bring a specific answer to the inquiry. Engineers ask the same question—not so blandly but when the letter is stripped of its technicalities it amounts to the same thing.

This is the way that Thomas H. MacDonald, the Chief of the Bureau, answers such inquiries:

The best type of road to build must be judged by adequate service to the road user. As local conditions differ, so will the best types of road. The best type of road is the one which at the least cost will give the best service. A road that will give adequate service is the first requisite. It is probable that a number of types of road will give that service. Consequently some one of those types must be selected. A proper selection is the one which best meets local conditions. It is an offense against the public to transport materials for long distances when adequate substitutes are available locally.

Progress Shown in Water-Supply Practice

Abstracts of Papers Read Before the Thirty-ninth Annual Convention of the New England Water Works Association, Holyoke, Mass., Sept. 7-10, 1920

Instructions to Employees at Pumping Stations and Filter Plants

By Dow R. Gwinn
President and Manager Water Co., Terre Haute, Ind.

IN OPERATING water plants the author has tried to find the best way of doing things, and then to adopt them as standard methods, even if they are difficult, and holding to them until better ways have been found. The instructions are typewritten and are kept in a loose leaf binder. Changes can be easily made and additional sheets may be readily added. No method is so sacred but what it can be changed by the manager. The employees are encouraged to suggest better methods and when tried and found to be advantageous they are substituted for old ones. Each employee is supposed to read the instructions once a month; he may select his own time while on duty for the reading. A sheet of properly ruled paper is enclosed in the file on which is the list of employees and each employee records the date when he reads the instructions.

The Terre Haute plant takes its supply from the Wabash River and is a direct pumping plant. For pumping into the distribution system there is a 10,000,000-gal. vertical triple expansion and a 6,000,000-gal. vertical compound; also, smaller pumps. For delivering to the sedimentation basin there is a centrifugal pump operated by a compound high-speed engine connected with a rope drive. Steam is generated in water tube and fire tube boilers with hand firing. A vacuum pump for exhausting air from the suctions of the principal pumps is a part of the equipment. There are 22 mechanical pressure filters. There is a sedimentation basin with sufficient capacity for approximately 2 to 5 hours subsidence. This is only used when the turbidity exceeds say 60 on the Jackson turbidimeter, or about 55 per cent of the time. The turbidity of the river water ranges from 25 to 3,000. The pumps work against 70 lb. domestic pressure and 125 lb. fire pressure. The available fire pressure at hydrants in the business or high hazard district is 100 to 110 lb. While the fire department is equipped with pumpers, they are seldom used—the pressure from the plant being usually sufficient. There are 100 miles of mains, 62 per cent being 8 in. and larger diameters. There are 1,155 public fire hydrants. There are 8,240 consumers; 97.7 per cent of all service pipes are metered, including private fire lines for automatic sprinklers.

At the plant a program clock is provided which summons the attendants every half hour to examine the water. This is just a visual examination of the raw and filtered water and a record of the appearance of the water is made. This is necessary because of sudden changes in the turbidity of the raw river water.

A record of fire alarms is kept, showing the length of time extra pressure is maintained, increase in pumping rate, time of receiving alarm and strike out; also hydrants used and condition after fire. Inspectors answer alarms received from high hazard districts during day and second alarms at night. Engineers and firemen are on duty 8 hours; that is, they are off duty 16 hours per day for six days and the seventh day they are off 24 hours. Monday is change day when each man moves up one watch, the duties during the eight hours being performed by other employees. The changes are made at 7 a.m., 3 p.m. and 11 p.m. Employees are given two weeks' vacation with pay. Baths are provided for the men, also books on engineering and technical publications. The grounds on which the station is located were laid out by a landscape gardener and are very beautiful. A fine tennis court is provided. Long periods of employment are the rule, one engineer having recently completed thirty years of continuous employment. The company arranges and provides for an annual picnic on the station grounds for employees and their families.

The instructions which follow have been found to be satisfactory for the Terre Haute plant and while they would not be suitable in every particular to any other water works plant, they may be suggestive and valuable to other operators. [Separate instructions, not here reprinted, cover all elements of the plant—Editor.]

The Management and Finances of the Holyoke Water-Works

By Patrick J. Lucey
Engineer Water-Works, Holyoke, Mass.

THE Holyoke Water Department is operated under a commission of three unpaid members appointed by the Board of Aldermen. The commissioners select the officers and employees of the department, levy the rates, and collect and disburse the funds of the department through their own treasury.

The Water Department is self-supporting; in only one instance was it ever granted an appropriation raised by general taxation and that was in the early days before the department finances were well established, when $10,000 was granted. In 1901 this loan with interest at 4 per cent for the whole of the period was returned to the city treasurer.

The present rates, which were established in 1909, provide for the sale of water by both the fixture and the meter measurement methods. The annual fixture rates are as follows:

For each family	$3.00
For each bath-tub	$2.00
For additional bath-tub	$1.33
For closet	$2.40
For additional closet	$1.60
For garden hose (limited use)	$2.40
For rotary hose	$9.60
For automobile	$1.60
For washing machine	$1.60

Metered water is charged at the flat rate of $5\frac{3}{8}$c. per 1,000 gal., the bills being rendered monthly and 10 per cent discount allowed for prompt payment. A minimum yearly charge of $5 per apartment is established for all apartment houses on the metered service.

Meters are owned, installed and repaired by the Water Department and the annual rental for their use is from $2 per $\frac{5}{8}$-in. and $\frac{3}{4}$-in. upward.

Assuming that the unaccounted for water was 30 per cent of the total quantity passed by the master meters in 1919, the cost to the consumer of water sold by meter measurement was $5\frac{1}{4}$c. per 1,000 gal.; by fixture rate, 11.8c.; and the average cost to all the consumers 8.3c. per 1,000 gal.

The total cost or book value of the Water Department at the close of the last fiscal year was $1,969,892. The bonded debt was $441,000 and the amount in the sinking fund to meet that portion of the debt financed on the sinking fund method was $193,207, making the net debt $247,793, or $12\frac{1}{2}$ per cent of the total cost, and the net cost of the plant to the water takers $1,722,009.

The gross receipts from all sources for the year 1919 were $168,805, equal to 8.6 per cent of the total cost.

The largest item of department expense after salaries and wages is the one generally called "payment of taxes" to the City of Holyoke, this being so far as is known to the writer, the only water department where such payment is made under legislative enactment. The various municipal departments are required to pay for water used and for fire hydrants [$8 per public hydrant] the same as to a private water company.

The total of all payments made by the Water Department to the city treasurer under these provisions is $422,556, and the amount received by the Water Department from the other municipal departments is $215,863, making the net cash contribution made by the water takers for the benefit of the general taxpayer $206,693.

Office Methods and the Water Consumer

By Reeves J. Newsom
Commissioner of Water Supply, Lynn, Mass.

THE new consumer, when he applies for water in Lynn, is presented with a card form of contract which he is required to sign, and when he does so he has practically forfeited all his rights, as the contract contains these stipulations:

"In consideration of the supplying of said water, said owner hereby agrees to pay for the same in accordance with such rates as are from time to time established, and this agreement to pay shall remain in force and be binding upon him so long as the city of Lynn shall continue to supply water to the said premises, unless he shall have notified the said city in writing that he no longer desires the water service and shall have stated in said notice the name of the new consumer. He agrees to be bound by the rules and regulations of the Water Department and all subsequent changes therein and to pay all charges for excess piping or special construction as prescribed in those rules and regulations. It is understood and agreed that the city of Lynn does not guarantee to furnish constant pressure nor uninterrupted service."

[Regulations to cover various contingencies are given in the original paper, after which meter consumers are considered.—Editor.]

It was recognized by the writer that it is very essential for the department to have complete control of the meters, but with 5,500 services unmetered, and the hope that they will be metered in the near future it was desirable to contrive some means of keeping this control without having to furnish the capital for the installation of so many meters.

Control of Meters

The following paragraphs from the regulations show how the proposition is handled:

"All users of water through metered services shall pay the cost of a proper sized meter installation and thereafter the maintenance of same shall be by the Water Department, which shall include all ordinary repairs and replacements. All repairs of injuries to meters from freezing, hot water, or external causes shall be charged to the consumer. Charges for a new meter installation will, at the discretion of the Commissioner of Water Supply, if requested by the consumer, be levied in equal parts, due and payable with each of the first four quarterly water bills, and all such charges when paid shall be retained by the Water Department and credited to such meter installation and in the event of failure to make payment of such charges when due, the Water Department shall have the right to shut off the water under the same procedure as for other Water Department charges.

"The proper size of meter required for any given service shall be determined by the Water Department, which shall in all cases furnish the meter to be used, the same to be such type and make as said Water Department shall deem proper.

"All meters shall be set by an employee of the Water Department, and shall not be moved or disturbed except by the same.

"The department shall have the right to remove, repair, or replace any meter at any time it sees fit. All meter installations on services which cannot be shut off for meter repairs shall be equipped with a by-pass at the expense of the consumer.

"If, in the opinion of the Commissioner a meter does not fit the conditions of the service installation, the Department shall have the right to change such meter and charge or refund the difference in value of the meters exchanged."

No new accounts are opened except for metered water. The fifty-five hundred fixture accounts are hold-overs, and are gradually being done away with. The houses on fixture rates are inspected and billed twice yearly. The metered consumers receive bills quarterly, but as a matter of service all meters are read monthly, and any excessive flow of water is called to the consumer's attention that he may put a stop to it at the end of the first month.

It is interesting to note that it costs as much in a year to make 11,000 inspections in houses having fixtures as it does to make 90,000 meter readings.

Operation of a True Siphon on a Main Supply Pipe

By Wallace R. Braun and Charles W. Sherman,
Supt. of Water Works, Hallowell, Me. — Consulting Engineer Boston, Mass.

TRUE siphons in water-works practice are of very rare occurrence—so rare that the writers have not been able to find any published record of the operation of such a siphon. It may, therefore, be interesting to water-works men to learn of the conditions encountered in operating such a siphon on a main gravity supply pipe.

A supply of water for Hallowell was originally obtained from the headwaters of Cascade Brook, about 1.5 miles northwest of the city. Two small reservoirs were constructed on the brook, and a 6-in. pipe laid from the lower reservoir to two distribution reservoirs just west of the built-up portion of the city.

The intake in the reservoir is approximately 8 ft. below spillway level. The pipe leads from the reservoir across a valley perhaps 40 ft. lower, and then rises, crossing a ridge at a distance of about 6,000 ft. from the reservoir. The elevation of the surface here is approximately 9 ft. above the high-water level in the reservoir, and the pipe is about 3 ft. above high water. From this point the pipe descends sharply to distribution reservoirs which are about 41 ft. lower than the supply reservoir.

The portion of the ridge lying above the elevation of high water in the reservoir is 500 or 600 ft. in length, measured along the pipe, and it would have been necessary to excavate at least this length of trench in rock to locate the pipe below the hydraulic grade line.

The method of operating the siphon was as follows: Valves at the inlet and discharge ends of the supply pipe were closed; the air valve at the summit was opened, and a supply of water from a small reservoir, 20 or 30 ft. higher in elevation, was drawn through a 2-in. pipe into the 6-in. pipe to charge the siphon. When all the accumulated air had been expelled at the summit, the air valve was closed and the supply cut off from the upper reservoir; the gates at the inlet and discharge ends of the pipe were opened, and the siphon would operate without attention until a sufficient quantity of air had accumulated at the summit to break the siphon. The efficiency of the siphon began to decrease almost immediately and gradually fell off until the flow practically ceased. It was the custom to manipulate the valves at 7 and 11 a.m. and 4 and 7 p.m., and under this scheme the siphon was operated with a fair degree of success.

It was suggested [by Metcalf & Eddy, consulting engineers, Boston,] that if some automatic means could be provided by which air could be removed from the summit as it accumulated there was no reason why the operation of the siphon should not be made continuous. An electric power line crossed the summit in close proximity to the pipe so that electric power was readily available, and there was no reason to doubt the practicability of providing an automatically controlled air pump for the removal of the air. No definite information as to the quantity of air to be handled could be obtained. From the fact that the siphon had been operated with a fair degree of success when operating the valves at intervals of 4 or 5 hours, it seemed obvious that the accumulation of air could not be very rapid. The matter was taken up with C. O. Rogers, engi-

neer for the Charles J. Jager Co., Boston, who suggested the following equipment for this installation:

1 Receiver 24 in. diameter by 36 in. in length, of reinforced-steel construction, with supporting cradies and 6 in. flanged yoke.
1 Water glass and fittings for indicating water level in the float chamber.
1 Copper deposit float with necessary connections for the operation of float switch.
1 Triple pole float switch of the enclosed type.
1 Gardner compressor unit, 3 x 3½ in., air cooled, with extended motor base and belt and idler drive. Capacity of compressor 8 cu.ft. of free air per minute.
1 1½-hp., 3-phase motor, 1,800 r.p.m. for 220-volt current.

After some consideration an order was placed with the Jager Co. for this apparatus.

A vault 12 ft. long, 6½ ft. wide and 8 ft. deep was built enclosing the pipe at the summit, where a T-branch was set, turned up. The air tank or receiver was mounted upon this T and a small wooden building previously located over the air valve, was placed over the entrance to the vault. Considerable rock excavation was involved in this construction. The total cost of the installation is estimated as $1,600.

The apparatus was put in operation on Dec. 15, 1918, and has been in practically continuous service ever since. The operation is entirely automatic and the siphon is maintained in continuous operation. It is, of course, necessary to throttle the valve at the discharge end of the supply pipe where it enters the distributing reservoir, in order to prevent breaking the siphon, due to the excessive drop in this leg of the siphon, and also to avoid depleting the reservoir too rapidly.

During the year 1919 the cost of electric power for operating the vacuum pump was $85, the price being 9c. per kw.-hr., and in addition the cost of electric lights for the vault was $9, making a total cost of electric current $94. If interest and depreciation on the investment be assumed at 7 per cent, or $112 per year, the total cost of operating the siphon during 1919 was $206.

When the apparatus was first installed, the pump operated only about once an hour. It was found, however, that at times when the water in the reservoir is comparatively low, much more air accumulated, and in July of this year the pump was found to be operating about once in five minutes. The difference in water level in the receiving tank, between the time of starting and stopping the pump is about 6 in., corresponding to an accumulation of air of approximately 3 cu. ft.

It is probable that when the water in the reservoir is low, more air enters the pipe at the inlet end in solution or in suspension in the water, and it is also possible that some air is drawn in by vortex action. The period of low water in the reservoir also corresponds to the time of low ground water, when a greater amount of the pipe which is below the hydraulic grade line, and therefore subject to negative pressure, is below ground water level. Under these circumstances more air would probably be drawn into the pipe, through joints, than when ground water is high.

The pump maintains a vacuum of approximately 21 or 22 in. of mercury, corresponding to about 24.5 ft. of water. The hydraulic grade line at the siphon is therefore about 24.5 ft. below the pipe at the summit of the siphon, and 20 or 21 ft. lower than the water in the reservoir.

Water-Works Service Pipes

By D. A. Heffernan,
Superintendent Water-Works, Milton, Mass.

Many inquiries are made to water departments relative to different conditions existing in the house service. Although in many cases the responsibility of the water-works ceases at the meter, it is the opinion of the writer that any information of importance relative to preventing serious damage to the property should be given to the owner by the department.

I believe that the service pipe should be laid by the water department from the main to the meter and that this pipe should be under control of the department. This is the procedure in Milton. The department lays the pipe to the meter, set either in a manhole, inside the property line, or in the cellar, at the cost of the applicant. This pipe is absolutely controlled by the department. Repairs to it are made free of charge in the street and at actual cost inside the line.

From my experience, I prefer a service laid in this manner: Corporation inserted far enough into the main so that it will at least be flush with the inside of the main; goose-neck lead connection rather than a rigid joint; cement-lined wrought-iron pipe with lead-lined couplings for the service pipe; stop and waste cocks of the plug round-way pattern; and meter connected with brass fittings. Where the pressure is in excess of 60 lb., we recommend setting a pressure reducer on the house side of meter to reduce excessive strain on the piping and fixtures. A pressure of 40 lb. is ample for house supply. Direct pressure should be given the sill cock supply. Some consumers use a so-called water strainer which is intended to intercept foreign material before it reaches the pressure regulator. The principle is good but attention is required or it will cause stoppage of the flow by filling up. The main cellar shut off should, as I have said, be a round way cock, as in case of a frozen service, a compression cock or flat way cock will present an obstruction preventing the insertion of a thawing tube.

It is also a good plan to install a cock or valve without waste on the house side of the meter to prevent siphonage in case a pressure boiler is used, and also to prevent water flowing back over the cellar floor when a meter is being changed or repairs are being made.

Boating and Fishing in Water-Supply Ponds and Reservoirs

By X. H. Goodnough
Chief Engineer, State Department of Health, Boston, Mass.

One of the most serious difficulties with which water-works officials and health officers have to contend is the enforcement of necessary sanitary regulations for the prevention of the pollution of water-supply reservoirs. This is especially true of that most serious source of danger which results from the use of such reservoirs for boating and fishing.

If present tendencies continue, unless the public can be awakened to the situation, many naturally pure waters are likely to become contaminated and there is grave danger that in places where the public is now getting the benefit of the very best uncontaminated drinking water recourse will have to be had to methods of purification or sterilization, and the uncertainties of the human element will be introduced in order to make the waters safe for drinking. Where there is now an almost ideal condition as shown by actual death rates for water-borne diseases, an uncertain state of affairs is sure to arise in a field where uncertainties are most to be deplored—in connection with the public health. We may not doubt that with the growth of knowledge of these methods, the public will eventually protest against the use of polluted waters, whether purified or not, when we see the people of Lawrence ready to expend large sums of money to avoid the necessity for drinking the polluted water of the Merrimack River, no matter how well purified it may be.

Year after year bills are presented to the Massachusetts Legislature to authorize boating and fishing on ponds and reservoirs used as sources of water supply, and as time goes on their advocates become more and more insistent in their appeals for such privileges. The Department of Public Health and the water departments of the various cities, towns and districts are constantly urged to grant such privileges.

[Many epidemics of typhoid fever, attributed to the pollution of surface waters were reviewed by Mr. Goodnough. Some of the conclusions based upon this review, together with supplementary arguments follow.—Editor.]

1. That a very slight pollution by typhoid fever germs

may infect reservoirs of very large capacity sufficiently to cause great epidemics of typhoid fever.

2. That the typhoid germ can survive the severe winter weather of a northern climate and retain its virulence.

3. That the germ can be carried long distances in water and may survive through many weeks of time.

In some of the epidemics the exact cause was never discovered, and this fact brings up another discovery of modern sanitary science relating to this disease, namely, that there are typhoid carriers, so-called, who though apparently in good health, are capable of spreading the disease.

Furthermore, there are so-called walking cases of typhoid fever—that is, cases so mild that the patient is never obliged to go to bed, and there are others who are infected for a period of several weeks before finally coming down with the disease. Where numbers of persons are allowed to resort to ponds and reservoirs for boating and fishing there will inevitably be carriers or possibly walking cases among them, and the infection of the water supply is not only possible, but probable.

To us in this day the lessons taught by the great epidemics of the past united to those instilled by many lesser ones seem self-evident, but they are very far from being so regarded by the boatmen and fishermen who demand access to water supply reservoirs and by many of the legislators and city councillors upon whom such demands are urged. If through the fatuity of legislative bodies, state or municipal, the policy of the strictest sanitary protection of water-supply reservoirs is broken down or impaired, calamities such as those herein recalled and which now seem relatively remote many easily follow. Furthermore, more memorable and far-reaching consequences may result to those directly or indirectly responsible for such a calamity than was the case in the great epidemics of earlier years when sanitary science in its application to water supplies was less developed than is the case at the present day.

Quicksand: Its Nature, Behavior and Methods of Control

By Charles R. Gow
Consulting Engineer and Contractor, Boston, Mass.

CONTRARY to popular impression "quicksand" is not a material but rather a condition of a material, which under different circumstances may possess no such characteristics. Furthermore, quicksand, as such, rarely occurs in nature but usually is artificially produced by the acts of man.

Any material of a granular nature may become a quicksand if there is an upward movement of ground water through it of sufficient velocity to lift and carry the individual particles. On the other hand, no such material will become "quick" in character unless there is such a flow of water. One of the best and most inclusive definitions of the term quicksand which the writer has ever seen was given about twenty years ago by one of our fellow members, Allen Hazen, in a discussion of the subject before the American Society of Civil Engineers wherein he stated that quicksand is "A sand containing for the time more water than would normally be contained in its voids, and therefore, with its grains held a little distance apart, so that they flow upon each other readily." Such a definition is applicable to any material, irrespective of its composition which manifests the conditions and behavior usually ascribed to "quicksand."

The smaller the individual particles of sand are, the easier it becomes for the water to lift and hold them in suspension. Also the voids generally speaking will be smaller and more numerous in this case and the passage of water through them more difficult. The result is, therefore, that fine grained sand displays the quality of "quicksand" much more readily than does a coarse grained material. The writer has seen coarse sand and gravel, however, which displayed all of the characteristics of a "quicksand" under conditions of high velocity of water inflow, but in the main the term is chiefly applicable to sands of extremely fine texture.

[The author presented a number of sketches to show that in engineering construction "quicksand" is caused by unbalanced pressure which may be controlled by sheeting, ordinary pumping, pumping from well points or perforated pipe, and in some cases by sinking a cylinder, placing a small suction pipe in the center, filling between the cylinder and small pipe with sand and then gravel, and finally withdrawing the cylinder. An experience recorded by Mr. Gow and some other practical observations conclude this abstract.—Editor.]

It has been the writer's observation that fine wet sand in its normal condition will sustain quite as great a foundation load as will the coarse grained sands. The usual aversion to using fine wet sand as a bearing material has its chief basis, in the writer's opinion, upon the fact that we usually see much sand in its abnormal and not its normal state.

Some years ago the writer had occasion to construct some pier foundations upon coarse wet sand. The test borings indicated a firm layer of sand but when the excavation had progressed to this point it was found by the inspector that he could readily force a rod into the soil for a considerable depth. Because of this apparent instability, he ordered that the excavation should be carried deeper until satisfactory material was encountered. The foreman suspended work for the time being and allowed the ground water to rise in the pit to its normal level. Upon attempting again to demonstrate the soft quality of sand by means of the same rod, the inspector was surprised to find that he could make no impression upon the surface of the sand now that there was no longer an upward flow through it.

A perusal of the building regulations of the several large cities will show that fine wet sand and "quicksand" are allowed bearing values of from ½ to 2 tons, while coarse sands are allotted much higher values. It has been the experience of the writer in making tests upon the fine wet sands that they will carry quite as much load as the coarser sands, provided the ground water stands at its normal level.

The chief danger in using such materials for foundation loads lies in the possibility of future excavations being made in the immediate neighborhood which may be carried to a lower depth than that of the foundations referred to in which case there may be a flow of surrounding soil toward the new opening thus undermining the foundation. Such damage, however, will occur whatever may be the unit loading upon the soil.

The writer has never hesitated to recommend loadings as high as four tons per square feet upon sand which, during the excavation process permitted the workmen to sink to their knees in it. Nor has there ever been to his knowledge, any observable settlement in such cases.

Cinders are also useful during the process of excavating into quicksand for the purpose of maintaining a footing upon which the workmen may stand without sinking into the sand. A frequent liberal sprinkling of this material over the bottom of the trench will be found very effective in preventing miring.

It will also be found in the handling of many quicksands that the ordinary garden fork is more efficient for the purpose than is the type of shovel usually employed. This is due to the fact that fine wet sand has a very pronounced "suction" which causes the blade of the shovel to stick and requires a greatly increased force to remove it.

City Planning Promotion at New Orleans

The Board of Directors of the New Orleans Association of Commerce has voted to endorse efforts being made by one of its committees to secure a city plan for New Orleans, including whatever legislation it may be necessary to secure to put such a plan into effect. Charles A. Farrot is chairman of the City Plan Commission of the association, and Milton B. Medary is city planning specialist engaged by the commission to collect data and to conduct publicity work.

Hoover Discusses National Policy on Engineering Problems

In Presidential Address Before Mining Engineers Urges Profession To Exert Itself in Public Interest

HERBERT HOOVER in his presidential address before the American Institute of Mining and Metallurgical Engineers in Minneapolis, Aug. 26, called attention to some of the engineering problems which are national in scope and can be solved to the best interest of the people of the United States only by the formulation of a national policy based on a broad conception of the influence of these problems in the life of the nation. He believed a department of public works an aid to the study and formulation of such national policies.

His address in full follows:

The time has arrived in our national development when we must have a definite national program in the development of our great engineering problems. Our rail and water transport, our water supplies for irrigation, our reclamation, the provision of future fuel resources, the development and distribution of electrical power, all cry out for some broad-visioned national guidance. We must create a national engineering sense of provision for the nation as a whole. If we are to develop this national sense of engineering and its relations to our great human problems it must receive the advocacy of such institutions at this.

We, together with our sister engineering societies, represent the engineers of the United States. It is our duty as citizens to give voice to those critical matters of national policy which our daily contact with this, the fundamentally constructive profession, illuminates to us. Just as our medical associations voice the necessity of safeguards to national health; as the bar associations safeguard our judiciary, so the engineers should exert themselves in our national engineering policies. We have none, but we need some, or the next generation will face a lower instead of a higher standard of living than ours.

Solution Beyond Individuals

The development of our transportation, fuel, power and water under private initiative has been one of the stimuli that have created the greatness of our people. It has been easy to compass when the problems were more local and filled with speculative profits. There, however, arises a time when this haphazard development must be co-ordinated in order to secure its best results to the nation as a whole. This system has given us a 50 per cent result; if we are to have 100 per cent we must have a national conception and national guidance. This last 50 per cent involves problems beyond individual initiative alone.

Not only is individual initiative insufficient because the problems involve political, financial, interstate matters beyond corporate ability, but we have, with practically unanimous consent of the country, adopted a policy of the limitation of profits in the operation of public transportation and power and some other utilities, and through the pressure of public opinion we are rapidly coming to a limitation of profit in the development of other large sections of national resources which tend to become natural monopolies. While the limitations of these profits makes for public good, on the other hand they also militate against individualistic development of national resources and necessitate the co-operation of the community as a whole to secure initiative for wider development in the national sense.

Certain of our national resources have always been in national ownership, such as waterways. Certain others, such as reclamation, irrigation, distribution of water for power, are rapidly coming under Government control. In others, such as timber, coal, and oil, the possible exhaustion brings their conservation or provision for the nation's future into national concern. In our railway problem national action has until recently been directed wholly to limitation of profits. Latterly it has undertaken to regulate wages and give some small recognition to the necessity of equipment. But microscopic attention has been given to the greater problem of how to get more transportation, to get it so organized as to secure real economic operation in its broad sense.

We have a long list of such problems. Some of these have been discussed before the Institute on previous occasions. I may refer to our discussion of eastern bituminous coal. During the past year the Institute undertook to look into the economic situation of this industry as a national whole. It was demonstrated to be the worst functioning industry in the country. Owing to seasonal and other irregularities of demand, the average term of employment in the bituminous industry is less than 190 days per annum. If this industry could be operated a normal work year 125,000 men could be turned to other production. It is an industry in which 30 per cent more capital is invested than would otherwise be necessary. The cost of coal to the consumer and the risks to the operator are greatly increased, and, above all, it presents a great human problem fraught with all the terrible misery and strikes and justified discontent that flow from intermittent employment.

I am not proposing nationalization of the coal mines; far from it. What is required is that we should realize that with our necessary social view of prohibition of combination there remains a national problem beyond the solution of any individual coal operator or any group of operators. It must have national guidance and national plan for its solution, a co-operation of great consumers, railways, operators and miners—but what individual operator can do this?

In respect to our coal supplies again, if we would look forward to the next generation, we have a problem of conservation of immense importance. In this connection, it has been ably proposed by our members that the national government should co-operate in investigating the possibilities of the establishment of a great electrical trunk line throughout the great power consuming districts of the northeast, and that we should feed into this great power road power generated at the mines and available water sources, drawing from it at every town and city. The consummation of this project means cheaper power to all consumers. It means a great economy in consumption of coal. It means more regularity in output. It thus means greater ability to compete in world manufacture. It means great relief to the railways from expansion. It means an increased standard of living and a decreased cost of living to a very large section of our population. We have again much such a problem in providing adequate power resources upon the Pacific Coast, where today hundreds of thousands of acres of fertile land are practically non-producing for lack of pumping power.

Conservation and Transportation

Of other problems akin to this, we are confronted throughout the west with the fact that a large portion of our average low water supply is already under engagement for irrigation and power. The time has come when that expansion of the land available for cultivation, or into more intensive cultivation, is a factor of mountain storage of water to increase our stream flows in the low season. We have thus a storage problem on a scale we have not hitherto dreamed of, and, again, it is a problem involving co-operation in financial, economic, distribution, navigation—interstate questions, in which individual initiative must have the assistance of the community.

Another series of such problems lies in our oil supplies. If we are to have a mercantile marine and to maintain our navy on a basis of equivalent efficiency with foreign navies, if we are to maintain the development of the gas engine—the greatest lift in our standard of living and saving of labor in fifty years—we are confronted with the necessity of securing additional oil supplies from outside our own boundaries. Our own supplies, so far as now known, do not represent twenty-five years at our present rate of consumption. The Institute many mouths ago was the first to give warning to the Federal Government of the gradual absorption of all of the oil sources of the world by other great

powers, and that within a short time we should be dependent upon the good will of those powers for our necessary oil supplies. No private individual can compete with foreign governments in the measures that they are adopting to hog the resources of the world. This problem again is an engineering problem that requires more than private initiative.

A problem of even more pressing importance than these is the whole question of transportation. Our inability to move the commodities which we create is stifling production. It is increasing the cost of distribution and has placed a tax on the American people in decreased production and increased cost of distribution greater than all the taxes imposed by the war.

We have today in Minneapolis ample proof of the frightful cost imposed on the farmer, consumer and public. There is a premium over freight cost from 10 to 20c. a bushel for wheat at the mill door compared to wheat in the elevator a few hundred miles away, solely because cars are not available. Either the farmer is losing the amount or the consumer is paying it. Furthermore, to carry the picture further, the railways, in endeavoring to remedy this, are diverting cars from the lumber industry. Already certain mills are partially closed; men are thrown out of employment in the mills and in the building trades. Is this not a price in human misery and national efficiency that warrants some national concern? It is a problem that does not lie alone in expansion of railway facilities. It lies also in the proper expansion of waterways and their co-ordination with the railway transportation of the country.

Congressional Waste

We have been dabbling in the improvement of water transportation of the United States for 100 years, and so far as I know never yet have we considered it as a problem requiring complete co-ordination of the entire transport problem for the whole country. We have spent enough money improving useless creeks to have made several competent waterways. Every Congressional district in the United States has looked for appropriations for carrying mud from one hole to another as their proper participation in the national plunder. They have never considered that the taxes taken from the people as a whole should be devoted to those points that will benefit the people as a whole.

One result of the policy pursued has been that our waterways have been so badly handled that they have not been able even to compete with the railways, and today, with an enormous increase in railway rates, we find ourselves utterly unable to handle the great bulk commodities of the country at the possible lower charge over our waterways. The opening of the St. Lawrence to ocean-going vessels means 5c. a bushel to every farmer in ten states. Likewise. of no less importance to the people of the entire country are our internal waterways.

These projects have a simple result in the engineer's mind: they make greater production possible with less human effort; they increase the standard of life; they provide for our children. All these problems are much akin, and the time has come when they need some illumination, guidance, and co-operation in their solution from the Federal Government. Nor do I mean a vast extension of Federal bureaucracy in Federal ownership. If, in the first instance, through an agency of the central government, we could have an adequate study and preparation of plan and method made of these problems of engineering development over the next fifty years, viewed solely in their national aspects, we would have taken the first step toward the adequate provision of an increasing standard of living and a lower cost of living for our descendants.

The second step is to determine that our government will be a government of co-operation, limiting profits surely, but holding to individual initiative as the single hope of human development. In order that we shall have some central point in the Federal government were these problems may be adequately considered, from which they can be ventilated for the verdict of public opinion, where the business brains of the country can be called into conference and co-operation with the government, and therefore with the people, the engineers of the United States have proposed time and again that a Cabinet department should be established in Washington, either new or to replace the Interior Department, to which should be assigned the whole question of public works.

You are familiar enough with the advantages of such a department from an everyday administration point of view, and enormous saving to the government from the duplication or competition of the six or seven departments now engaged in engineering construction work of this character, but on this occasion I wish to call your attention to the fact that such a department has become an essential from the point of view of proper consideration and presentation to the American people of these broader national engineering problems, upon which the next generation must depend if our country is to march forward.

Gravel Plant Record Has Lesson for Contractors

Estimates of Capital Investment, Production Cost and Plant Equipment Based on Analysis of County Outfit

Highway contractors without experience in the production of washed and screened gravel stand in grave danger of underestimating the task of developing local pits to produce small yardages. Records of actual experience by contractors are lacking. The published operating records of commercial and municipal plants are usually incomplete. They may be given a measure of usefulness, however, by analysis. Such an analysis has been undertaken in the article which follows in the hope that it will develop authenticated figures from actual experience. The subject is of growing interest and readers are asked to contribute any information which may help to establish the facts.—Editor.

Pit development to produce washed and screened gravel is not financially a light undertaking. The technical problems also require judgment and foresight in their solution. A screen and washer unit is expensive. The costs of pit preparation and of operating rights are often large. Mechanical equipment for handling material from the pit to the plant may require a heavy investment. A fourth cost, which is exceedingly important, is the wash water supply. Finally, the task of estimating these costs is complicated by the fact that published records of operation, which fit the contractor's requirements, seldom include all the cost items.

On all of these several counts, the experience last year of Wayne County, Michigan, in producing washed and screened gravel from a local pit will repay analysis. Quoting from official records, an article in *Engineering News-Record*, Nov. 27-Dec. 4, 1919, p. 944, gave the cost of the producing plant at $7,200 and the cost of production at 53c. a cubic yard. Later records, permitted by a more comprehensive calculation, change these amounts to $8,000 for plant investment and to 75c. cubic yard for production cost. In neither case may the figures be accepted as true costs under ordinary conditions, because in this installation certain items of plant cost and of production cost either do not appear or were omitted in the calculation.

Equipment

The equipment consisted of rotary screens surmounting and delivering to elevated bins and charged by an inclined belt conveyor from a ground hopper. Its out-

put averaged 200 cu.yd. a day. All machinery was standard and modern. Briefly it consisted of a 1½-in. sizing screen, a jacketed ¾-in. and ¼-in. washing screen. a sand settling hopper and an overflow chute. The conveyor was 125 ft. long on centers, and was fed mechanically from the ground hopper. Bins, with chutes, a conveyor trestle and a supporting frame completed the gravel plant as a unit, which was operated by a 15 hp. electric motor.

A small stream fed by local springs provided an abundant source of wash water. The point at which water was taken was ¼ mi. from the washer and was 50 ft. lower than the washer foundations. The height of the screens above the foundations was 30 ft. From suction to delivery, the lift was, therefore, 80 ft. Ordinarily a 4-in. or 4½-in. pipe line would have been installed, but as the County had a quantity of 3-in. pipe on hand it was decided to employ a double line of 3-in. pipe. The friction head in this line amounted to nearly 80 ft. making a total head of 160 ft. A two-stage 5-in. centrifugal pump having a capacity of 400 gal. a minute against 200-ft. head was installed and is operated by a 50-hp. electric motor. In service, the capacity of this plant proved ample but not in excess of the requirements.

Mechanical equipment for excavating the gravel and charging the conveyor hopper was not installed. It was considered that the amount of gravel, about 10,000 cu.yd., required for the construction which was contemplated, did not warrant the investment cost. Four teams and scrapers, with four drivers and two scraper holders, were employed. This outfit cost $42 a day in wages or 21c. a cubic yard based on a 200 cu.yd. output.

Plant Investment

In round figures the plant investment was $8,000. This cost included all the machinery of the washing unit except the motor; all the water supply outfit except the motor; ¼ mi. industrial railway incline into the pit, and certain other expenses of pit preparation, but not the pit investment cost. Two facts are to be noted.

Motor costs are not included in the $8,000 investment cost. A 15-hp. motor was required for the washing plant and a 50-hp. motor for the wash water pump. It was possible in this instance to rent the motors and electric current was available at a moderate cost for connections. Ordinarily the investment cost of $8,000 would be increased by the cost of the power units and of making the necessary line connections, if electric motors were used.

The second fact to be noted is that about $800 of the plant cost given was required for pit development and preparation, exclusive of the producing equipment. This expenditure was required in a pit which had been worked and for which, therefore, a portion of the development investment had been made. It does not include the cost of gravel in place. In this instance a pit rental of 15c. a cubic yard was paid and was charged to operating expense. However it may be distributed, the fact to be grasped is that there is always this pit cost, either a straight purchase price or a rental charge in some form, and it must be entered in an appraisal of the cost of developing and outfitting local gravel supplies.

Reverting to the production cost of 75c. a cubic yard, it is essential to observe that this cost does not include interest on the investment nor depreciation. Neither does it include any overhead charge of the county road department nor any charge for general superintendence, insurance, etc. An additional qualifying fact to be observed is that the pit-run gravel is nearly of the proper composition for concrete aggregate and, therefore, there was practically no charge for waste. On the other hand, this 75c. production cost includes a pit rental charge of 15c. per cubic yard.

Having the broad facts concerning the Wayne County gravel plant as stated, general conclusions are possible concerning plant requirements, capital investment and production cost. Warning is called against applying these conclusions to specific cases. They are merely indicative of general facts.

1. Except possibly in one particular, the plant described meets the requirements of pit development for a single-output concrete paving operation. A small steam shovel and cars or a light cableway dragline would have reduced the cost of excavating and handling gravel to the washing plant, and for a greater total output than 10,000 cu.yd. would certainly prove a justified investment. One fact to be noted attentively is the magnitude of the plant for supplying wash water. This is emphasized because to the inexperienced pit man the volume of wash water required by even a small gravel washer is surprisingly large.

2. The capital investment for the plant described is given at $8,000. The costs of 1920 for the same equipment would be more. Including the cost of motors, which in this instance were rented, at $20 per horsepower for one 15-hp. and one 50-hp. machine, we have an additional investment of $1,300 or say $1,500, including installation costs. A dragline of any of the commercial types, say a ½-cu.yd. bucket with a hoist equivalent to a 7 x 10-in. double drum steam hoist, would add from $3,500 to $4,000 to the amount already given. The costs given are low yet they aggregate $13,000 even when using the smaller figures for each item. Roughly, a pit producing daily 200 cu.yd. of washed and screened gravel, calls for a capital investment of never less than $10,000 and often as much as $15,000.

3. The production cost at the Wayne County plant is given 75c. a cubic yard including 15c. a cubic yard pit rental. On the $8,000 investment the interest charge at 5 per cent would be $400 and the depreciation at 20 per cent would be $1,600. Based on a season's output of 10,000 cu.yd., the interest and depreciation charge would be 20c. a cubic yard. Adding reasonable charges for overhead cost, insurance, waste, etc., the cost reaches well over $1 a cubic yard.

4. Even at the production cost finally arrived at, the Wayne County gravel plant was highly profitable. At Northville where the plant is located, commercial pebbles in 1919 cost $1.25 a ton on railway cars. It cost about 25c. a ton to unload the railway cars into industrial cars. At $1.50 a ton the cost per cubic yard was $2.25. Besides this direct reduction of cost there was the indirect saving of possessing always the constant supply of aggregates at a time when car shortage and other transportation restrictions made continuous supply by railway a practical impossibility.

British National Debt

The total British national debt was reduced £234,000,000 from December 31 to June 30 last, the new total being £7,845,000,000 ($38,177,700,000 at normal exchange).—*Commerce Reports.*

Hydraulic Fill at the Miami Conservancy Dams—II

Improved Sump and Pump Layout Reduces Losses of Head at Suction—Manganese Steel Doubles and White Iron Quadruples Pump Output Life

BY C. S. HILL
Associate Editor, *Engineering News-Record*

WITH one minor exception of 150,000 cu.yd. of fill placed by direct sluicing the placing of hydraulic fill is entirely a pumping operation. Plant location and design and pump construction and operation assume great economic importance, therefore, under any conditions. Having to pump a heavy glacial gravel containing stones up to 6 in. size, causing great wear and developing high friction heads, complicates the conditions and raises pumping practice to nearly paramount economic importance. Intensive study has therefore been given to all factors and improvements of exceptional economic worth have been developed.

Plant Location—So far as a common plan of pumping plant location could be contemplated for all five dams of the Miami Valley flood-protection works this plan has been to place main pumps at the toes of the embankments and as the fills are built up to assist the main pumps with booster pumps at higher levels on the discharge pipe lines. Actual practice exhibits a conformity with and a variation from this common plan which are determined by the local conditions at each dam.

On the plans of Fig. 1 (*Engineering News-Record*, Sept. 9, p. 487) the circles and the arrowheads indicate approximately the locations of the main pumps and the directions of the borrow pits. At three of the dams one location of the main pumps satisfies the requirements of convenience to the borrow pit and of moderate average lengths of discharge pipe line for the entire hydraulic fill operation. Under 1,500 ft. is the average distance of discharge at these three dams. The character of the borrow pit is instrumental in the three changes of pump location at Taylorsville. Here the borrow pit is a long and narrow side hill cut required to clear the earth overburden from the rock cut for the outlet channel (*Engineering News-Record*, July 29, 1920, p. 196) and the pump sumps have been shifted along the toe of this cut as conditions required.

Changes of pump location at Englewood record the effort to keep down the friction heads by hauling the material by train to higher elevations before delivering it to the pumps. Sump 2 is 33 ft. higher than Sump 1 and Sump 3 is still higher by 17½ ft. The 1919 fill was made from Sump 1 and pumping is in progress for the 1920 fill with both No. 2 and No. 3 locations, from the former for raising the 1919 fill to elevation 850 and from No. 3 to fill the channel section. Cross dam 1 has been carried up to elevation 850 to make separate pools.

Sump Design and Pump Layout.—For the sluicing operations at Lockington and Taylorsville, sump construction has been little more than a pit, walled in and provided with a grating. At the hog-box installations for the other three dams more elaborate sump construction has been undertaken. With the changes of pump location at Englewood a development has taken place in sump design and pump layout by which smoother operation and larger outputs have been secured.

In the original layout at Englewood, shown by Fig. 4, the sump for each pump was an 8 x 8 x 10 ft. concrete box with a pyramidal false bottom of timber. The pumps were set above the sump water level, took their suction through pipes inclined 45 deg., and delivered their discharge horizontally to the toe of the embankment, where a 25-deg. elbow shifted the direction up the slope of the dam. As practice has prevailed in the past, this layout was successful, but operation revealed a number of faults:

(1) Because of the shape of the sump the solids dropped to the bottom and formed an inert mass from

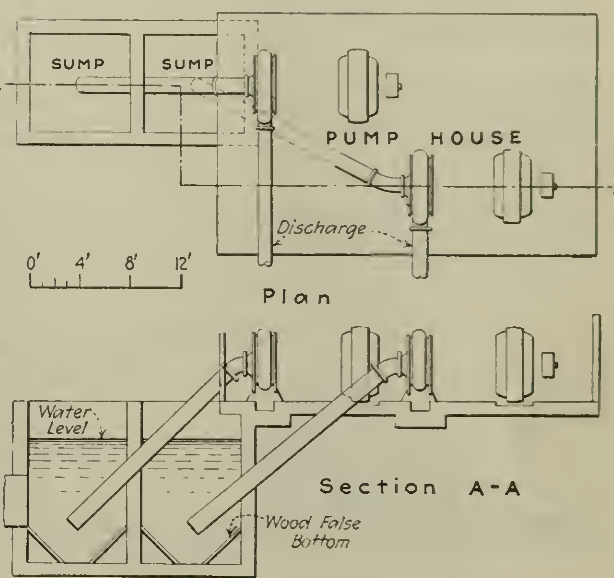


FIG. 4. ORIGINAL LAYOUT GAVE HIGH SUCTION HEADS

which they had to be sucked up by the pump. In case the delivery from the hog-box was rapid the solids piled up and then suddenly sloughed down and buried the end of the suction which condition caused some danger of plugging.

(2) The suction was not efficient. The pumps had suction lengths of 18 ft. and the center of the suction as it entered the pump was 7 ft. above sump water level. The pump while operating showed as much as 16 in. of vacuum, equivalent to 18 ft. head. The loss of head in the suction pipe was therefore about 11 ft., maximum. This was due in part to velocity head and in part to friction in the pipe because of its length and curvature and the shape of its suction end, which was square cut.

(3) There were priming troubles. Ordinarily the priming operation was simple, but occasionally sand would collect in the injector and it had to be cleaned out. In the aggregate, delays due to priming amounted to a considerable loss of time.

Uneven feeding of the solids and danger of choking the suction were alleviated to some degree by the installation of the rotary screen previously described, but with the installation of layouts Nos. 2 and 3 a

fundamental change in design was undertaken as is indicated by Fig. 5. In this new layout the pumps are set 8 ft. below sump water level; the suction pipe is straight and horizontal and only 5½ ft. long; a bellmouth suction end reduces contraction of the entering jet and the pipe supplying water to the sump delivers its flow in direct line with the suction. Between the delivery end of the water supply pipe and the bellmouth of the suction the bottom of the sump has the form of a 21-in. circular trough, the theory being that the current from the delivery pipe continues through this trough into the suction pipe and the solids from the rotary screen are fed into a living stream of water, which conserves to some extent the velocity with which it issues from the supply pipe.

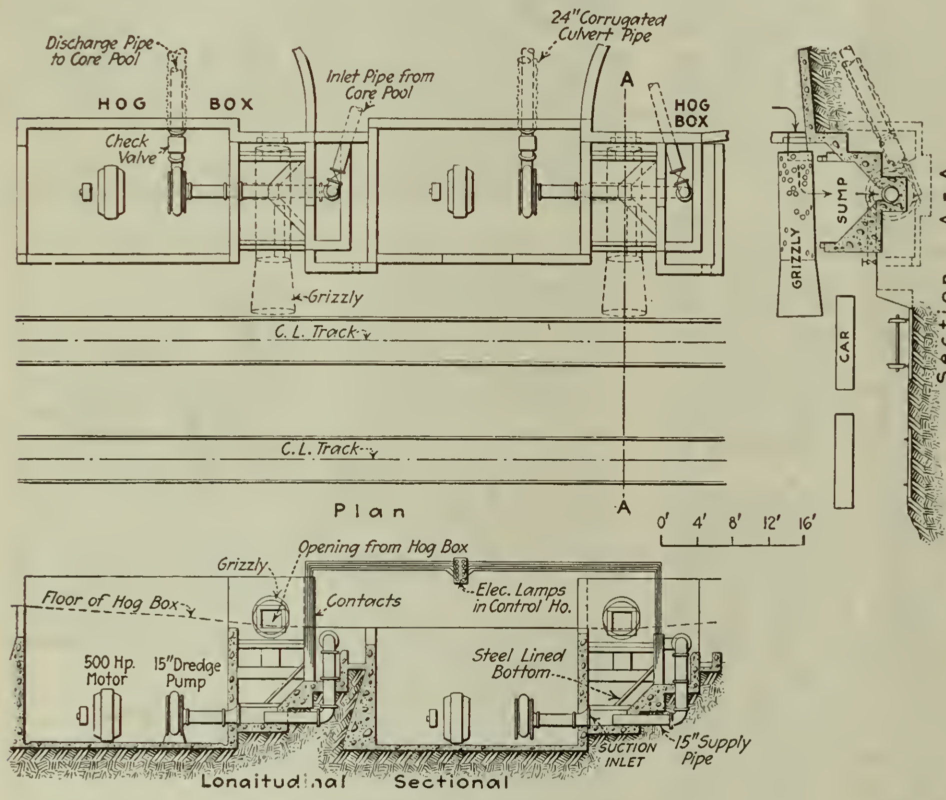


FIG. 5. IMPROVED SUMP PLACES PUMPS UNDER PRESSURE

With the new layout, loss of energy at the pump suction has been more than cut in two. Another saving of head is secured by setting the line of discharge of the pump at an angle of 27 deg. from the horizontal. By this inclination the discharge pipe leads off from the pump in a straight line up the slope of the dam. Considering suction and discharge together, the only deviation from a straight line occurring in the travel of the pumped material takes place in the pump itself or is incidental to the pumping action.

Sump design and pump layout considered for all dams permit of general conclusions as follows: (1) Placing the pumps under pressure from the sump, as in the final layout at Englewood, with the straight line suction and discharge pipe arrangement, is a material improvement in which the continuing current of water from supply to suction through the trough-shaped sump bottom is perhaps a contributing factor; (2) overloading the sump, with consequent choking of the suction, is an always imminent danger which has to be eliminated. Means are provided by the rotary screen feed to the sump when it is practicable to install this device. Likewise a slip-pipe suction (*Engineering News-Record*, July 29, 1920, p. 234), as installed at Lockington, helps to meet the danger; (3) access to the sump and the suction is sufficiently important to warrant the construction of the sump so that it can be drained, even if to do this it is necessary to pump the supply water; (4) in general sump design has not set the limits of pump output; it has been set by the ability to bring the materials to the sump continuously in the required volume.

Pump Construction and Service.—Pump construction has followed a development from the regulation commercial product to the high-durability centrifugals now in operation. While the process of improvement is still going on it will for the future consist in refinements of detail. The broad steps in advance have been made. Briefly characterized, they are strides toward a much longer output life of dredge pumps.

A 15-in. pump was adopted as the standard for all the hydraulic fill operations. The determination upon this size was influenced by two main facts: (1) A 15-in. pump will build up the embankment about as fast as it seems likely that hydraulic fill should advance and be certain to settle and dry to solidity; (2) a larger pump would have materially increased the difficulty of water supply and disposal. The pumps are electrically operated by 500-hp. motors at Englewood and 350-hp. motors at the other dams. The Englewood and Lockington installations have two pumps, not including boosters, and the other locations have one-pump installations.

The first pumps installed had cast-iron shells and runners, which had a life in pumping the heavy glacial gravel of about 12,000 cu.yd for the runners and about 160,000 cu.yd. for the shell. The first development was to substitute cast manganese steel, probably about 5 or 6 per cent manganese, for the runners. These runners show wear at about 50,000 cu.yd. and can be used for 100,000 cu.yd., but with doubtful efficiency as this age is approached. Later a full manganese steel pump was adopted and this gives a shell wear of between 180,000 cu.yd. and 200,000 cu.yd. with a shell thickness of 2½ to 3 in.

Shell wear in the manganese steel pumps does not pierce the metal; instead, after the shell has become thin, it splits circumferentially. Repairs of split shells by placing U-shaped clamps at intervals and riveting a plate to the inside, suggested a shell design which involves U-shaped ribs as an integral part of the casting, the theory being that the ribs will hold the shell from splitting until it wears much thinner than it has been

wearing before it has split. In this new design increased thickness of shell was also sought. To increase the shell thickness was difficult if manganese steel were used. This coupled with the cost of 26 to 27c. a pound of the alloy steel led to experiments with white iron at a local foundry. A shell of white iron from 4 to 5½ in. thick, with seven reinforcing ribs, has been cast and installed. In pumping 150,000 cu.yd. at Germantown this shell has shown a wear of not over ½ in., which indicates an estimated life of about 400,000 cu.yd.

Experience with impellers has led to three accepted practices, besides changing the metal from cast iron to cast manganese steel: (1) Compensation for variations in head by using runners of different diameters; (2) use of removable shoes and (3) scrapping the runners or shoes as soon as a reduction in efficiency due to wear begins to be evident. With the pumps working against constantly increasing heads, as from 25-ft. to 150-ft., for example, power is economized by increasing the diameter of the impeller as the head increases. A 38-in. and a 42-in. runner have been adopted as standards. The smaller runner takes a 38-in. and a 40-in. shoe and the larger takes a 42-in., a 44-in. and a 46-in. shoe. The renewable shoes not only keep the runners longer in service but also accomplish the very important object of maintaining the pump at high efficiency. A quick change of shoes when the efficiency begins to drop down because of wear restores the runner to its original efficiency. Experience has disclosed that there is no economy in keeping a badly worn pump in service, and the practice, generally speaking, is to discard the worn impeller as soon as a material decrease in efficiency due to wear is evident.

Control of Suction and Flow.—Maximum output is realized when there is a steady flow, to the capacity of the pump, of solids into the suction and out of the pump through the discharge pipe line. Unless this condition is realized the pump is operating below capacity, or is operating under an overload with the possibility imminent of a choked suction or a plugged discharge. It is therefore of the utmost importance that the pump operator shall be continually informed as to the conditions of flow, with particular reference to the load of solids which is being carried. On the flood control dam operations three methods of furnishing the operator with this information have been employed.

(1) The first method, as it was employed at Englewood, involved a control tower overlooking the sump feed and screens. In the tower there were pressure and vacuum gages, an ammeter, a telephone line to the end of the discharge pipe and electric bell connections to the monitor men and the pump men. Watching his gages and receiving telephone information of conditions at the end of the discharge pipe, the towerman could signal for faster or slower feeding from the hog-box or for more or less power on the pumps. The weak factors were that the operator could not see clearly the water level in his sump and that the gages did not act swiftly and surely. In particular, a plug in the discharge or suction pipe could get under headway before the gages would indicate that it had started, and then frequently the information was too late to be of much value.

(2) An electric indicator, Fig. 6, met the requirements of quick information of the start of the plugs in the discharge pipe. Its operation is based upon the fact that the first sign of plugging is manifested by a reduction in velocity of discharge. The mechanism is a steel clapper working on a hinge and forming contact at one end with an insulated wire running to the pump house and at the other end with the jet from the pipe. With a full jet, double contact is had and the circuit is closed, and when the jet fails the top contact breaks and opens the circuit. Lights on the circuit, one at each monitor and one at the pump, indicate to the operators when the flow is being checked by an incipient plug and they check the rate of feeding solids to the sump and throw more power onto the pump to meet the condition. Objections to this indicator are that it requires long electric circuits and has to be removed and reset for each new length of pipe added. Moreover, the indication is not quantitative; it shows that the flow is greater or less than that for which the flapper is adjusted, but how much greater or less it does not tell.

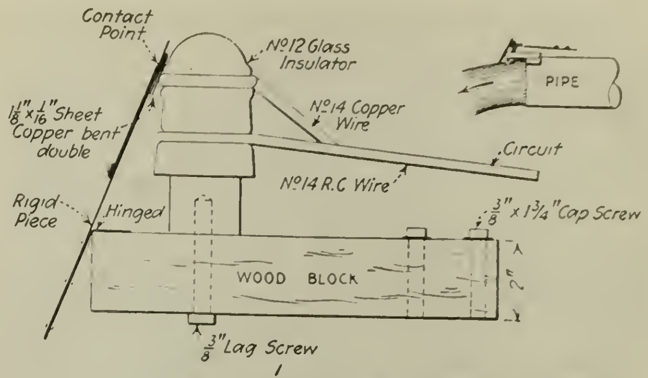


FIG. 6. FLOW INDICATOR ON DISCHARGE PIPE

(3) Regulation of flow through control of the water level in the sump is the latest development. This was accomplished at Germantown, and later at most of the other dams, by giving the pump operator a clear view of his sump. The size of sump is made such that the water level responds readily to the demands of the pump. In operation the valve in the supply pipe is opened to the point giving the proper flow as determined by trial. With an equal feed of solids from the hog-box a speeding up of the pump causes a corresponding lowering of the water level in the sump. Conversely, decreasing speed of the pump causes the level of the water in the sump to rise. With a constant speed of pump increased feed of solids from the hog-box causes the water in the sump to rise and decreased feed allows it to lower.

In actual practice the pump operator knows that if the water in the sump rises and the pressure gage shows increased pressure at the same time that the ammeter shows decreased electrical current his discharge line is being heavily loaded. If, on the other hand, the water level in the sump lowers while the pressure gage shows decreased pressure and the ammeter indicates increased power consumption, then he knows that the pump is handling less solid material. A warning device based upon these phenomena has been installed at Sump No. 3 at Englewood, where the operator cannot see his sump direct. It is necessary only to keep the pump man continually informed of the fluctuations of the water level in the sump and with his gages he can tell for a certainty what is taking place. The immediate warning comes from the water level in the sump; the gages simply explain the cause of the fluctuation.

It was found by trial that the fluctuations of the water level in the sump for ordinary working conditions are confined to the top 2 ft. When the sump is full danger of a plug is impending; when the water level is 2 ft. down from the top the pump is not handling all the solids of which it is capable and it is up to the monitor men to sluice in more material. (In practice the monitor men have instructions to flush the material into the sump as fast as they can unless warned off by the pumpman). It was decided that indications of the water level should be shown to the pumpman at 6-in. intervals. To do this at Englewood, where direct view of sump is cut off, No. 0 gage solid copper wires ⅜ in. in diameter are suspended vertically, the bottom of one being at the level of the top of the sump, the bottom of another being 2 ft. below the top of the sump, and three others ranged equally between. These wires are connected in circuit with incandescent bulbs in sockets on the control board in the pump house, one above another in the same relative positions as the terminals to which they are attached. To protect the eyes of the pump runner from the glare of the lamps they are incased in a box with a ground glass front, the top compartment being red to indicate the danger warning. The top circuit is also connected to a lamp on the giant to give the monitor man warning when the sump is full and feed should be slackened. The arrangement of this device is shown in Fig. 5.

Booster Pump Practice

In their essential dimensions and in their construction booster pumps and main pumps are alike. Practice in the location of the booster pump varies. At Lockington the booster is set between the two main pumps on the same floor and is connected up to work with either main. At Huffman the booster pump is located straight up the dam slope from and 15 ft. higher than the main pump. Later two boosters will be used set higher and farther along on right and left discharge pipes from the main pump. At Germantown the discharge line from the main pump extends diagonally up the embankment slope and the booster is located on this line at an elevation 42 ft. higher than the main pump. At Englewood and Taylorsville booster pumps have not yet been installed. The pumps as located have all performed the required work, but further than this statement conclusions are not available.

The problem of synchronizing main pump and booster pump operation has been simply solved by installing at each pump an adaptation of wattmeter in addition to the ammeter and the vacuum and pressure gages. If, for example, the main pump operates on three fingers of the switch board a portion of the current shunted through the wattmeters swings their pointers to mark three. Should a heavy rush of solids require the operator of the main pump to throw down another finger the added current swings the pointers to mark four and the booster pump operator, observing the change, synchronizes his pump with the main pump by throwing down his fourth switch finger. With reasonably alert operators this method of synchronization has been satisfactory.

So far as observed booster pumps show no differences from main pumps in wear or operating troubles. At Huffman it has been felt that the condition of pressure on both sides of the booster has somewhat increased trouble from sand in the bearings, but this trouble has not been pronounced.

Pump Outputs.—Pump outputs which fairly represent pump capacities have been recorded only during isolated short periods of operation. In general it has been impracticable with the means employed to bring to the sumps all the yardage that the pumps were capable of handling. At all dams the pumps are operated two 10-hr. shifts a day.

At Englewood, where two pumps have been operated, and where the highest yardage records have been made, a maximum of 148,000 cu.yd. have been pumped into embankment in a month. In one run of 8 hr. 48 min. one pump averaged 522 cu.yd. per hour, and in another run of 4 hr. 51 min. one pump averaged 576 cu.yd. per hour. These are high records. At Germantown, operating one pump, the rate of fill has been about 60.000 to 70,000 cu.yd. a month. In one month the output was boosted to 91,500 cu.yd. and in another month, January, 1920, due to cold weather, it dropped to 42,500 cu.yd. Under good weather conditions about 60,000 to 70,000 cu.yd. per month is being recorded at Lockington and at Huffman.

[*Part III, in next week's issue, will consider pipe friction and wear and embankment building. All work is being performed by the construction department of the Miami Conservancy District, Arthur E. Morgan, chief engineer; Chas. H. Paul, assistant chief engineer, and C. H. Docher, construction manager. Much credit for the success of the hydraulicking operations is due to the division engineers at the dams. All of them have given caerful thought and study to the problems encountered and have made valuable suggestions for improvements in design. They are: Arthur L. Pauls, Germantown; H. S. R. McCurdy, Englewood; Barton M. Jones, Lockington; O. N. Floyd, Taylorsville, and C. C. Chambers, Huffman. G. L. Albert, hydraulic engineer, has given special attention to the hydraulic fill installations and operations at all of the dams and S. M. Woodward, consulting engineer, has offered valuable advice and suggestions.*]

Increase in 1919 Building Operations

Complete returns made to the U. S. Geological Survey from the building departments of 141 of the larger cities of the country show a large increase in building operations in 1919 compared with 1918, according to a recent bulletin issued by the Geological Survey. The building operations in these cities in 1919 cost $1,302,998,607, as against $430,014,365 in 1918, an increase of 202 per cent. Much of this increase is due, of course, to the increase in the cost of labor and materials, but this does not cover all of it, for the number of permits for buildings increased from 210,538 to 362,811, or 72 per cent. The average cost per permit or building increased from $2,042 in 1918 to $3,591 in 1919, and the average cost of new construction increased from $3,309 in 1918 to $5,088 in 1919.

An interesting fact brought out by the Geological Survey's report is the large proportion of wooden buildings erected even in the larger cities, where, it may be expected, structures of such material would be limited by local regulations. Wooden buildings represented 67 per cent of the total number of classified operations in 128 of these cities, 73 per cent of all new operations, and 69 per cent of all additions, alterations, and repairs.

New Concrete Conduit for Denver Water Supply

Old Wood Stave Line Replaced by Concrete Pipes Made on Ground from Local Material—Self-Propelled Pipe Layer

ONE of the first construction moves found necessary by the City of Denver after acquiring the water plant from the Denver Union Water Co. late in 1918 was the replacement of certain wood stave flow-lines. Conduits Nos. 1 and 3, 30-in. and 40 in. in diameter, 30 and 18 years old, respectively, were found near the end of their lives and in need of continual repairs of breaks to keep them in service. For three days in 1919 the consumption exceeded the total conduit carrying capacity. In consequence any serious breaks necessitated drawing heavily on the single day's storage within the city.

Late in 1919 plans were prepared to replace 48,000 ft. of conduits, Nos. 1 and 3, with a 54-in. reinforced-concrete conduit. A contract was let Oct. 31, 1919, for 10,000 ft. with a provision that the city might order the laying of the remainder or an additional mileage of the pipe when the 10,000 ft. was finished and money became available. Other than local points of interest in this new line are (1) a change of policy as to type of conduit from wood stave to concrete, (2) a pipe making plant at the center of the line utilizing aggregate obtained on the ground, (3) a self-propelled pipelaying machine.

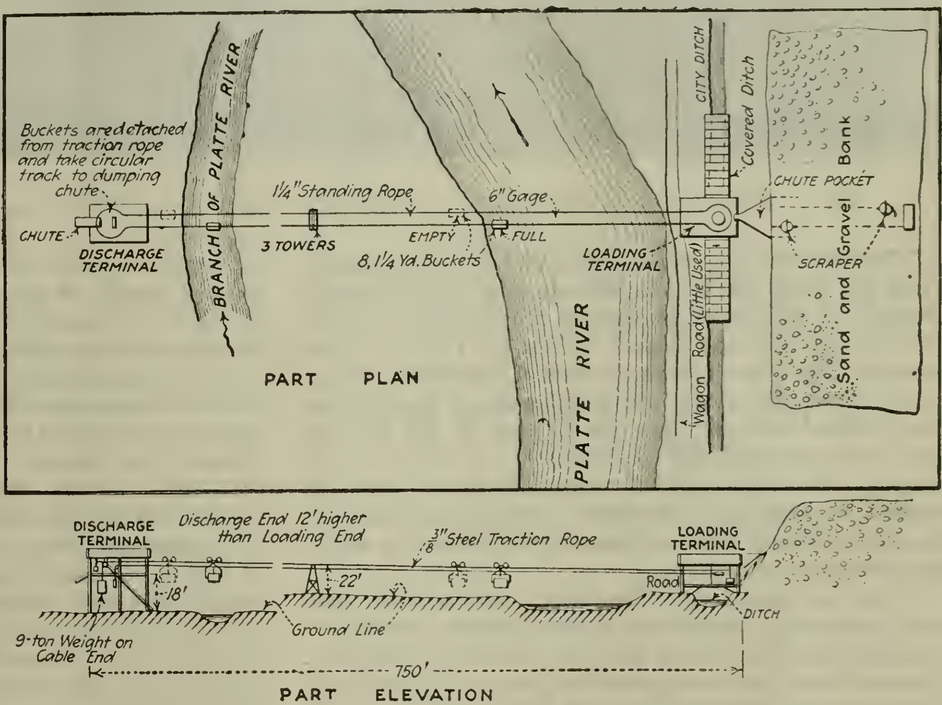


FIG. 1. AERIAL TRAMWAY HANDLING SAND AND GRAVEL

Choice of concrete rather than cast iron was based on cost and the impossibility of obtaining cast iron in the time and quantities needed. Wood stave at the time the estimates were made was one-half as expensive as concrete for the same carrying capacity. Some of the wood-stave lines 30 years old are still in service, although reduced in thickness to a mere shell, but another line, laid only four years ago, has reached practically the end of its usefulness without extensive repairs. Although poor lumber might be accountable for localized breaks, there were places found by the engineers where one side of the pipe would be entirely sound and the other side so far gone that staves could be punctured readily by hand with a nail. Alkali or some other chemical in the soil was considered the cause of this condition, but repeated examinations of the soil failed to indicate any areas having a specially high alkali content.

In addition to the uncertain durability of the wood stave pipe, the Board of Water Commissioners was of the opinion that a municipality should adopt as permanent a construction as practicable. Freight congestion and the delay incident to transporting materials were factors in the selection of the type of conduit, since the time element was important, the engineers and members of the board wishing to minimize the chance of a serious water famine.

The location of the new line follows closely that of conduit No. 3 on a 100-ft. right of way paralleling the Colorado & Southern R. R. for the whole distance. This greatly facilitates the distribution of the pipe, since the traffic of this narrow-gage railroad is not heavy and pipes can be unloaded opposite the point of laying.

A central location for the pipe making plant was found near an elevated bank of gravel on the opposite side of the Platte River. Switch tracks were run from the railroad and connection with a crushing and screening plant was made by a 750-ft. aerial tramway across the river. This tramway is shown in Fig. 2, and the pipe yard plant in Figs. 2 and 3. Gravel is pulled into a hopper feeding the cable buckets by a ½-yd. ox-bow scraper operated by a 9-hp. hoisting engine. The cableway is driven at a speed of 300 ft. per minute by the engine that operates the crushing and screening plant. The elevation of the gravel bank is such that the three cableway towers are about 20 ft. high and permit the buckets to discharge into the crushing and screening plant 18 ft. above the ground. Because of the swampy condition and the nearness to ground water all equipment had to kept well above the surface.

A 1½-in. rotary screen 5 ft. long receives the gravel, the rejections passing to a jaw crusher set to produce 1 in. stone. Material which passes the screen, together with the crusher discharge, is fed by a screw conveyor to a flat screen, the upper 2 ft. of which has a ¼-in. mesh and the lower 6 ft. has 1-in. holes for the large aggregate. The rejections from this 1-in. screen are returned to the crusher. Thus everything is finally graded, although a few stones may pass the crusher a number of times The sand is further reduced by sand rolls located at the upper end of an inclined belt over the stock pile. The resulting sand is exceptionally well-graded up to ¼-in. size. Its six per cent clay content has a distinct advantage in producing watertight concrete.

FIG. 2. ELEVATED GRAVEL PIT (IN FOREGROUND) IS CONNECTED TO PIPE YARD BY AERIAL TRAMWAY

Wheelbarrows convey the sand and gravel aggregate from the stock pile to four mixers of 10 cu.ft. capacity located in a row under an elevated cement shed. Cement is hauled up inclines at each end of the shed by a gas engine. Two mixers serve one side of the double casting yard. They discharge into a flat storage pan feeding 1-yd. conical buckets. The pan is made so flat that the men must work out the concrete, thus giving a second mixing. In effect a third mixing is given when the conical buckets are discharged. Batches of only 3½ cu. ft. are mixed and the mixers are inclined to accentuate the mixing action.

A steel gallows frame mounted on a 10 x 10-ft. portable platform propelled by a 30-hp. hoisting engine has a cantilever head piece, the outer ends of which are directly over the centers of the forms for the pipes. This traveling crane, which was used formerly on the Winnepeg aqueduct work, moves at the rate of 600 ft. per minute. Each 10-ft. pipe with 5½-in. shell contains 3 cu.yd. of concrete. In the regular schedule, operations on twenty pipes are carried out each day. In the morning forms are removed from the previous day's pouring. Twenty pipes three or four days old are turned and rolled onto the skids. Inner forms, cages and outer forms are set, and the copper expansion joints (held in spiders) are placed. Pouring is done usually in the afternoon. Every operation is in duplicate and is carried out by the traveler.

The general layout of the pipe-casting yard is shown by Fig. 3. It consists of a double row of casting slabs flanking the 8-ft. track on which the traveling crane runs, with 40-ft. skids of 6 x 8-in. timbers on short piles outside of the slabs, the skids being elevated so that the pipe can be rolled directly onto flat cars. The rolls for bending the reinforcing and the mandrels on which the steel cages are put together are located at

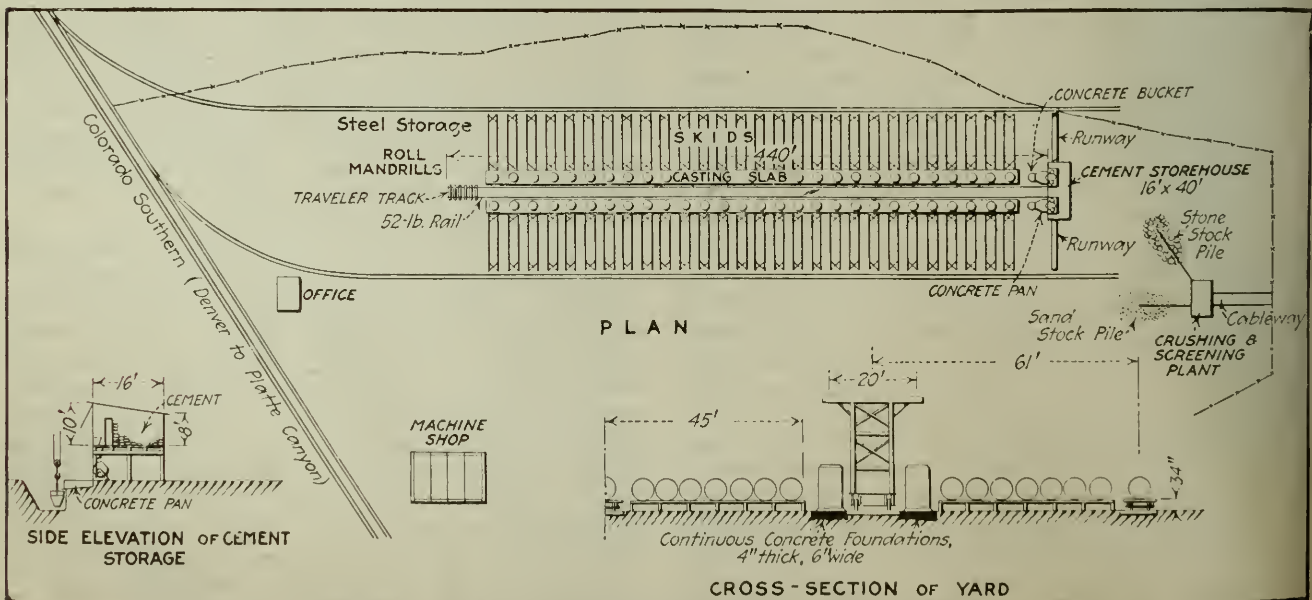


FIG. 3. LAYOUT OF YARD FOR MAKING CONCRETE PIPE

one end of the yard, between the two switch tracks. Seven men are employed in putting the cages together and can turn out twenty cages in a day. The supply is kept only one-half day ahead of the pipe pouring.

Each pipe after pouring is covered with a canvass jacket and steam is admitted to keep the concrete warm and moist and to hasten setting. Steam is left on for three nights during warm weather and the pipe are turned and rolled onto the skids in three or four days. Forms are removed in 24 hours. Twenty forms and 60 bases are provided, everything being in duplicate. In 15 days the pipes are delivered to the trench, where several weeks usually elapse before they are used. No sprinkling is done, as the density of the 1:1½:2½ mix after the steaming effectually holds sufficient moisture for the final crystallization.

The pipelaying machine, Fig. 4, consists of an A-frame derrick with a bull-wheel mounted on a portable platform 24 ft. square on which is a 40-hp. steam hoist propelling the platform forward and back over a track consisting of three sections of 32-ft. 80-lb. rails spiked to 8 x 18-in. sills. The hoist also operates lines from the ends of booms lashed to each side of the platform frame. As these lines are used only for dragging the track sections forward, the booms extend 18 ft. in front. The 40-ft. boom from the A-frame is a 16 x 16-in. trussed stick and extends to the rear. A 3-in. shaft across the front of the outfit has a niggerhead on each end for handling the lines of the forward booms. When the track sections have been moved ahead as far as possible by the niggerrheads the rope from the end of the boom pulls the section half a length forward until a clamp can be put onto the center of the rail, the section being then swung forward to place.

So much difficulty from irrigation and river water was anticipated by the contractors bidding on the work of trench excavating in the swampy, gravelly ground that the city concluded to do the excavation and backfill. Six 4-in. centrifugal pumps belt-connected to gas engines were provided. Except when the whole area was under water from river floods, these pumps have been able to keep down the water in the trench without difficulty, although seldom less than three pumps are in operation. Both excavation and backfill are done by ½-yd. excavators, using a ditcher scoop for the former and a skimmer scoop for the latter. Where the trench passed through swamp muck it was made with 3½-ft. cut and 1½-ft. cover. The slopes on the embankment are 1½ to 1.

Pipe joints are made with copper expansion joints. The pipe is laid directly on the natural gravel, which is worked under the pipe while it is still suspended. Soon after the pipe is laid the invert joint or the lower one-third of the joint is filled with 1 to 1 mortar, care being taken to see that the copper overlaps the wire mesh extending from the spigot end of the abutting pipe. Before the balance of the joint is made backfilling by hand is carried up 1 ft. above the top of the pipe. After this primary joint has set and the pipe has had time to take settlement the secondary joint, on the inside of the pipe, is made with finely ground neat cement mortar placed with a trowel.

Tests under a 125-ft. static head, being that due to the elevation of the water in the clear water basin of the slow-sand filters at Platte Cañon, are called for after the line is in place.

Gate valves and blow-offs are set every mile. Where there is no chance to place a blow-off, manholes are provided from which the line may be dewatered by pumping. Manholes are vented through air valves and are cast monolithic with the pipe, the reinforcement being attached to the manhole casting. To admit air when draining the line, 4-in. ppies are set at each manhole in addition to the regular air valves.

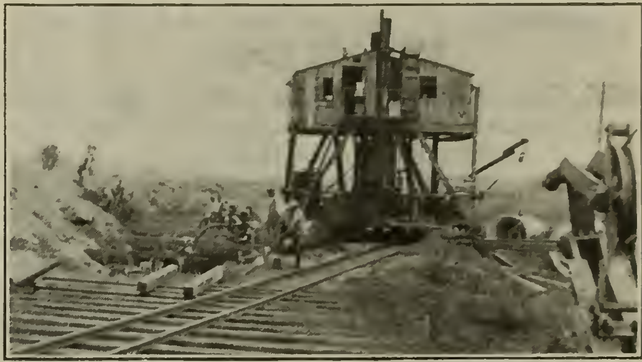


FIG. 4. PIPELAYING MACHINE CROSSING A RAILWAY

The work is being done by the board of Water Commissioners, for which W. F. R. Mills is manager. Designs were made and construction is being carried out under the general direction of Burton Lowther, chief engineer and general superintendent. T. J. Lahey is resident engineer in charge. For the Lock Joint Pipe Co., which has the contract, the work is in charge of J. C. Mitchell, general manager, and P. H. Gentz, superintendent.

Great Falls Development Might Block Railroad Route

THAT the right of way of the Chesapeake and Ohio canal is being considered as a low-level railroad route was revealed at the hearing before the Federal Power Commission on the Great Falls project. Objection was raised to any system of dams on the Potomac, near Washington, which would occupy the entire river basin. It was argued by Lafe Pence, a former member of Congress, that the canal, when filled in, offers the ideal short line route from the coal fields to tide-water on Chesapeake Bay and would give an outlet to the Western Maryland, the Norfolk & Western and the Cumberland Valley railroads and would increase the capacity of the Baltimore & Ohio R.R.

Representatives of the Pennsylvania Railroad explained at the hearing that present conditions preclude any thought of transition from steam to electricity for its lines in the Washington region. It also was stated that no thought is being given to any plan for the electrification of the terminal at Washington.

The development of Great Falls was urged at the hearing by representatives of the civic organizations of Washington and by witnesses from near-by sections of Virginia and Maryland. Representatives of the Potomac Electric Power Co. opposed development of the Falls on the ground that it is not commercially feasible. The uncertainty injected into the power situation by proposals to develop the Falls is having an adverse effect on the power company, it is stated, which is called upon to provide $1,000,000 annually in extending its steam plant to accommodate the increasing power needs of Washington and vicinity. Col. Charles W. Kutz, engineer commissioner for the District of Columbia, told the Power Commission that Great Falls should be developed.

Concrete Track Ties and Electric Poles in China

High Cost of Wood and Low Cost of Labor Make Concrete Economical — Rods in Poles Form Lightning Conductors

By Donald F. McLeod
Formerly of Chinese Government Engineering College

Reinforced concrete railway ties and electric transmission poles are used by the Kailan Mining Administration of China, and the following information was obtained during an inspection of the process of manufacture through the kindness of L. Demaret, assistant engineer in chief, at Tongshan.

Several thousand ties of the type shown in Fig. 1 have been made and some of them have been in use under heavy traffic for four years. The reinforcement consists of old wire cable which has outlived its usefulness for hoisting at the mines. It is not believed

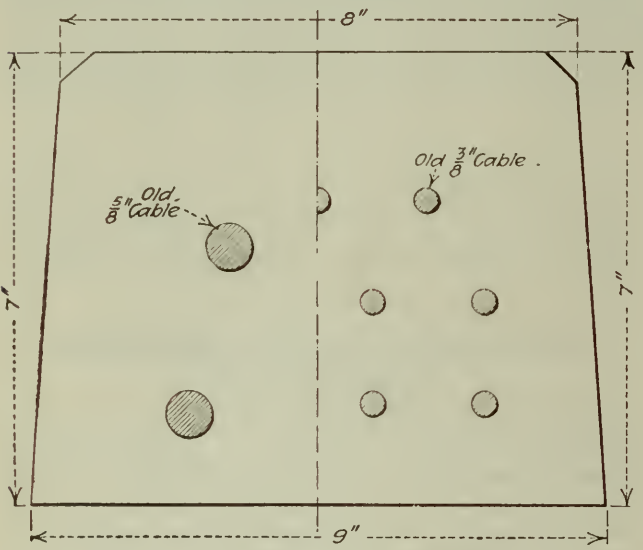


FIG. 1. REINFORCED CONCRETE TIE

that the cables have any advantage over ordinary reinforcing bars, but they are of low cost as the old cables have only a scrap value. Wood forms are used, composed of three planks held in place by clamps. The concrete mix is 1:2:4, made with crushed limestone, and the ties are cured by lying in water in shallow basins for several weeks.

The success of these ties Mr. Demaret attributes to the care that is taken in getting an even bedding on solidly packed earth. He has found by experience that a sufficiently even bedding cannot be had if ballast is used. The concrete ties are cheaper in initial cost than wood, and are used altogether for replacements, except at switches. On new lines new ties are used at first, until the roadbed gets well settled down under the action of traffic. Any unevenness of bedding, such as would occur on a new roadbed or with the use of ballast, leads to cracking the concrete ties.

Bolted clips fasten the rails, the bolts passing through holes cored in the tie, two at each rail seat. These bolts have square necks fitting square holes in a plate on the under side of the tie, the threaded ends extending through tie plates and carrying the clips and nuts. The ends of the bolts are battered with a hammer to prevent the clips and nuts from working loose, but more especially to prevent them from being stolen.

A considerable mileage of high-tension electric transmission line is maintained, all the poles being of reinforced concrete with structural steel cross arms. These poles are of rectangular section, as shown in Fig. 2, and the concrete mix is the same as that for the ties. The 40-ft. poles are 14$\frac{3}{8}$ and 6$\frac{3}{8}$ in. square at bottom and top, hollow except for about 20 per cent of the length at the top, and have a shell 2$\frac{1}{2}$ in. thick reinforced with twelve 1-in. round bars and with flat

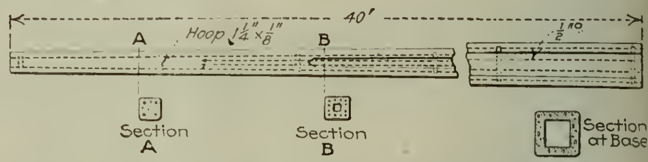


FIG. 2. REINFORCED CONCRETE POLE FOR TRANSMISSION LINES

bands 1$\frac{1}{4}$ x $\frac{3}{8}$ in. spaced about 4 ft. 7$\frac{3}{8}$ in. The 50-ft. poles are 17$\frac{5}{8}$ and 7$\frac{3}{4}$ in. square at bottom and top and 3 in. thick, reinforced with 16 bars and hoops spaced about 5 ft. apart.

For curing the poles are covered with litter which is sprinkled periodically. Some of the reinforcing rods project from the top of the pole to serve as lightning rods and extend below the base of the poles to connect with metal plates buried in moist earth. Each pole is set in a block of inferior concrete containing something over a cubic yard.

Forms for the poles consist of planks sheathed with sheet zinc and held in place by clamps. The inside form, or core is hollow, except at the ends, and the surface of the zinc which encases it is scraped and soaped each time the core is used. There is no difficulty in withdrawing this core, as it has a small screw jack at its base pushing against the concrete shell of the pole. A 40-ft. pole weighs something over a ton. The poles are erected by the use of gin-poles and ropes, the cost of erection not being a serious matter in a country where a laborer, to work at pulling on a rope or lifting, costs less than half a dollar (Chinese) a day.

That this type of electric transmission pole is a success is shown by the fact that in the many miles of line there has not been a single case of failure and no expense for maintenance, as far as poles are concerned. Although there is much wind of comparatively high velocity sleet storms (such as cause damage to transmission lines in America) are rare and storms of damp, clinging snow are practically unknown.

Cost Data

The dollar used in China was worth about nine-tenths of a U. S. dollar, May, 1920. Portland cement obtained from a mill near the mining administration's works costs $1.50 per bag, but the bag is twice as large as an American cement bag. Steel for reinforcement costs about 4c per lb. The price of wood may be estimated from the fact that an ordinary railway tie, 6 x 8 in. x 8 ft., costs $2.25. The concrete tie costs about 60c, but the rail fastenings cost over $1 per tie.

A 40-ft. concrete pole, as described above, costs about $60, not inclusive of the initial cost and wear and tear on forms. The poles are made by a Chinese contractor. He has a forge to weld the reinforcing bars and fabricate the bands, the reinforcement for each pole being built up into a unit which is kept in place in the form

by means of little blocks of concrete. The extremely reasonable cost of labor is shown in the fact that all mixing is done by hand, and that the contractor's price to the mining company for the complete fabrication of a 40-ft. pole, including keeping the poles damp until they set, is only $4.50 per pole.

Last of Federal-Aid Highway Funds Become Available

THE last of the Federal-aid funds for highway construction became available July 1, 1920. These funds, part of which are derived from the 1916 appropriation and part from that of 1919, aggregate $100,000,000. This entire amount, eliminating $3,000,000, or 3 per cent, as an administration allowance, is available to the states according to the accompanying distribution. Failure of any state to obligate its Federal-aid funds within the specified time will result in the reapportionment of funds thus not taken up. The table given herewith shows the appropriations for each state to the nearest dollar only.

State	Apportionment of Last Installment of 1916 Federal Appropriation	Apportionment of Last Installment of 1919 Federal Appropriation
Alabama	$526,221	1,578,663
Arizona	343,411	1,030,233
Arkansas	421,299	1,263,884
California	763,668	2,291,007
Colorado	438,940	1,316,819
Connecticut	153,337	460,012
Delaware	40,669	122,005
Florida	286,862	860,585
Georgia	674,288	2,022,863
Idaho	306,512	919,537
Illinois	1,091,267	3,273,801
Indiana	671,763	2,015,290
Iowa	720,332	2,160,997
Kansas	717,811	2,153,433
Kentucky	487,939	1,463,817
Louisiana	340,558	1,021,673
Maine	240,058	720,173
Maryland	216,750	630,249
Massachusetts	368,197	1,104,592
Michigan	722,917	2,168,751
Minnesota	710,522	2,131,567
Mississippi	451,889	1,355,668
Missouri	846,975	2,540,925
Montana	501,748	1,505,243
Nebraska	533,435	1,600,306
Nevada	319,086	957,258
New Hampshire	103,710	311,129
New Jersey	296,889	890,667
New Mexico	399,617	1,198,851
New York	1,242,973	3,728,920
North Carolina	569,763	1,709,290
North Dakota	384,057	1,152,171
Ohio	926,562	2,779,685
Oklahoma	575,620	1,726,859
Oregon	394,038	1,182,114
Pennsylvania	1,147,987	3,443,960
Rhode Island	58,314	174,943
South Carolina	359,005	1,077,014
South Dakota	403,945	1,211,835
Tennessee	565,478	1,696,435
Texas	1,465,400	4,396,199
Utah	282,394	847,182
Vermont	112,519	337,558
Virginia	494,418	1,483,255
Washington	361,157	1,083,471
West Virginia	265,038	795,115
Wisconsin	636,236	1,908,709
Wyoming	308,429	925,287

Public Works for Greece

A dispatch received in the State Department from Athens recently is to the effect that the Greek Minister of Communications will prepare for publication in the newspapers a brief synopsis of public works to be undertaken soon in Greece. Such works are said to include the construction of railways, draining of marshes, harbor improvements, irrigation work and hydraulic plants. It is understood that the Greek Government will welcome American competition.—*Commerce Reports.*

Piping Oil from Havre to Paris

BY the provisions of a decree published in the *Journal Officiel* of July 28, 1920, a French company, the Compagnie Francaise des Transports de Mazouts et Petroles, of Paris, has been granted permission to construct a pipe line between Havre and Paris for conveying petroleum oils from the former port to Paris and intermediate points, according to a recent issue of *Commerce Reports.* In presenting the decree to the president of the French republic for signature, the Minister of Public Works called attention to the fact that, owing to the shortage of coal, it had been found expedient to use crude oil for industrial and domestic purposes, and that, in view of the difficulties encountered in securing proper and regular transportation for oil, granting of a concession for the construction of a pipe had been considered necessary.

Some of the provisions of the concession granted include (1) the use of public roads along the line traced for construction purposes; (2) the pipe line must be capable of transporting a minimum of 2,400 metric tons of oil daily; (3) reservoirs capable of holding a minimum of 6,000 tons must be built at each end; (4) plans must be submitted to the ministry within two months of the date of granting the concession, and within a year from the date of approval of the plans the pipe line must be completed; (5) a maximum rate of 46 francs per ton is allowed for the transport of oil, and such a rate must be subject to increase or decrease by the Minister of Public Works as may be found necessary on account of the cost of labor or other items entering into the account; (6) the duration of the concession is 50 years.

It is stipulated in the concession that the headquarters of the company must for the whole duration of the concession be established in France and that the president of the administrative council together with a majority of those holding powers of attorney, the accountants and more than half of the other administrators must be of French nationality. Another condition imposed upon the company is that only French materials may be employed. Permission to purchase material abroad may be obtained from the Mnister of Public Works if it can be proved that it is impossible to procure such material in France at reasonable prices and terms of delivery.

The length of the pipe line will be approximately 125 mi.

Canadian Building Permits Show Increase

The Montreal *Financial Post* supplies figures of building permits for the current year which show considerable progress. In the seven months to July 31 permits had a value of $68,540,000 as compared with $35,656,000 in the corresponding period last year. Toronto is again in the lead with $15,570,000, a gain of 82 per cent, while Montreal permits represented $9,660,000 a gain of more than 120 per cent. Fourteen cities of the Northwest and British Columbia reported permits issued during the first seven months of 1920 having a value of $21,671,000 as against $6,766,000 for the same period last year. Winnipeg is well to the front with $6,596,000 while Edmonton makes a claim of permits of $2,983,000. By the end of the year, it is estimated, the total value of building permits in Canadian cities will approximate $100,000,000.

Quays More Economical Than Piers for Comprehensive Port

Proper Freight Handling and Storage Demands Wide Area With Many-Storied Warehouses To Utilize Land

By F. T. Chambers
Captain, Corps of Civil Engineers, U. S. N., Chief Engineer, Port Facilities Commission, U. S. Shipping Board

In the quicker turnaround in port is the greatest opportunity for economy of ship operation, which is the main commercial problem today before the American shipper, and secondarily the American manufacturer. It is a well-known fact that at the present time a ship of only moderate size costs its operators $5,000 per day in overhead, port and salary charges. Some months ago the Shipping Board analyzed the turnaround of a 6,450 deadweight ton vessel in the port of New York. She brought in only 2,713 tons of mixed cargo from Italy and loaded only 3,783 tons of mixed supplies for Archangel, Russia, and stayed in port 15 days. We concluded that six days would have been an entirely reasonable figure for the complete turnaround.

The analysis showed that such an improved performance would have saved in interest on investment, insurance, depreciation, supplies, wharfage, wages, stevedorage, etc., $18,596.34 and in daily profits almost an equal amount, so that by staying six instead of fifteen days in port the saving would have been in the neighborhood of $36,000. Putting it another way, in the nine days saved the vessel at its rated speed could have been 2,376 miles on its next voyage, or if it had the same saving on each trip would be in the way to make nearly eight voyages across the Atlantic instead of six per annum. Such savings are not only well worth having but may well mean success as against failure otherwise. The question arises: How can this be accomplished? The answer: By economic construction and equipment of the terminals on the one hand and their co-ordinate, economic management on the other. The first is an engineering problem, purely if not simply. To it we will address ourselves.

It may be taken as an axiom that the wharf structure must be on deep water or sufficiently close thereto so that with a reasonable amount of dredging the required depth may be had. It should also be plain that proper access is to be had to the railway systems of the port in question, for it is only by close co-ordination between ships and railways that the best results can be attained. There must, therefore, be room on the wharf for both direct transfer between ship and car and for transfer after classification between ship and car. There must also be room for city trucks as well as local industrial trucks to operate. Last, though not least, there must be room for storage of mixed cargo in classified piles, for it is not of bulk commodities that we are at present treating. Mixed cargo or package freight must be kept moving through the transit shed or congestion will result with the entailed delay and loss of economy. The transit shed problem is different from that of the storage warehouse. If the goods are to be handled at the best speed, high stacking cannot be practiced. It may sometimes be resorted to, but it is not reasonable to assume that high stacks can be erected and broken down for the same cost as those made hand high. Furthermore, aisle space for trucks of all classes must be maintained. In our calculations we have assumed aisle space of twenty per cent. It is, furthermore, necessary for the best economy that the material brought in or to be taken out by a particular ship must be stowed in the transit shed opposite that ship. Again, it is taken as a recognized fact that labor will maintain its present high wage rate and that skilled labor will be always difficult to get in quantity. From this it is assumed that more and more we must employ the

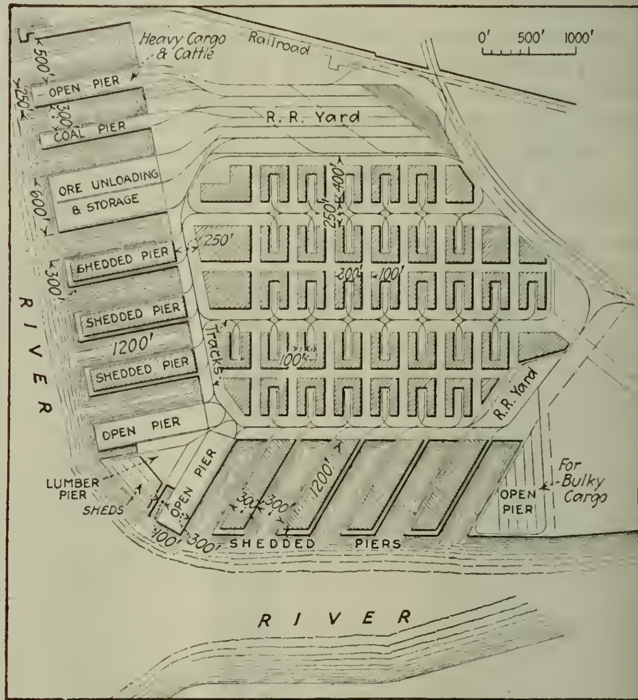


FIG. 1. PIER LAYOUT FOR A PORT AT JUNCTION OF TWO RIVERS

mechanical handlers already so successful in our factories and adapt them to the varied character of package freight.

All of these requirements make their several and individual claims upon space, some larger than others but all together totaling such an area that, if we start to design a pier with berths on each side for ships, even though we assume at once a two-story transit shed, we find our pier growing to a width of several hundred feet. Where land is valuable, as it usually is on a busy waterfront, first costs under such conditions become enormous and fixed charges for operation correspondingly great. Under such circumstances intensive use of the available area becomes imperative and loft building construction is indicated.

Short piers of moderate width can be operated with fair economy but we must, where we can, get away from the long, narrow pier construction into which some of our ports are drifting. It is not the writer's intention to take a kick at a project already so thoroughly assailed by port engineers as to make condemnation almost unanimous, but the Staten Island piers now under construction offer too good an illustration to neglect. A busy street in a metropolitan wholesale district should be as wide as the majority of these, so it stands to reason that there is insufficient room for rails, storage, etc., where so much through traffic must be provided for.

Of course there are localities where none but piers can be constructed within the means of the owner. Such

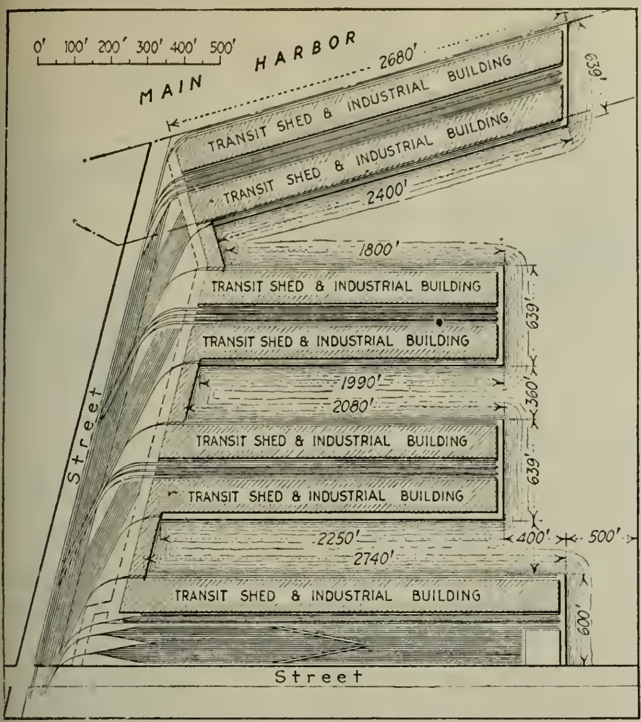


FIG. 2. QUAY LAYOUT FOR SAME AREA AS SHOWN IN FIG. 1
Prepared by Port Facilities Commission, U. S. Shipping Board

owners must effect the best economies of design within their power but cannot expect to have the most efficient. Railroads alone require running tracks as well as standing tracks on long wharf systems and in addition some nearby full and empty trackage besides the proper classification yards necessary to each group terminal. Such trackage cannot find space on the usual narrow American pier.

While lighters and barges play a prominent part in port business, there must be available means for unloading them into the transit shed. The merits of the so-called burtoning method, using a combination of the ship's winches with portable winches ashore for the transfer of cargo, are recognized and it is not necessary to enter a special plea for cranes as against portable winches, but the latter will not lend themselves readily to lighterage cargo and cranes will. The usual American transit shed, constructed close to the stringpiece of the wharf, bars forever the gantry crane as a handler on the waterfront of the pier, yet for efficiency some device must be provided for unloading purposes. The sum of the spaces required for each of the foregoing utilities, all of which are necessary to an efficient whole, results in widening the pier until it becomes something else. Open substructure construction is out of the question. Solid fill must be used and we have not a pier at all but a solid tongue of land, surrounded by a wharf or quay wall, in other words a quay system, so expensive per square foot of area that the most intensive use must be made of it to make it pay—just as New York must build skyscrapers on Broadway, so must we build loft buildings on the waterfront.

Fortunately, there is good use for these lofts. They are in the best possible location for a ware housing business and until fully required for this ultimate purpose are available for rental to jobbers, small manufacturers, etc. The first floors are for outgoing cargo, the second for incoming, and those above for pure storage. The second floor is so located that cargo coming from the ship's hold can be handled thereon without additional lift and can be discharged by gravity to trucks or railway cars below. The tongues of land are so wide that the system once adopted and the plans drawn for future expansion, all but the part required for immediate business or allowed by available funds, may be disregarded, the fill made only for the quay under development.

The most modern construction in England is on the quay principle and Dock No. 9 at Manchester is probably its best example. Here there are four-story transit sheds practically continuous along the quay, service ships on one side only, and having to each floor more area for cargo than most of the best American piers can boast as a total. They have gantry cranes, too, and ample railway trackage both on the waterfront and at the rear of the shed. The port of Hamburg, Germany, offers excellent examples of a similar nature.

The Port Facilities Commission of the Shipping Board has made studies and advised ports along these lines and as a case in point there are offered herewith two general plans laid out for the same property at the junction of two rivers on deep water. The first, shown as Fig. 1, was made some years ago by a prominent engineer on the pier principle, with an industrial development in the central area behind the piers. He was unusually liberal in his pier width but a comparison of the available industrial floor area, on the basis of six-story loft buildings, as indicated in the alternative quay plan, Fig. 2, will show the vastly greater floor area in the quay plan design. But best of all, in the quay plan we have our storage directly over our transit sheds, while his plan requires railroad cars and tracks for all transport between waterfront and storage. Not every dock lends itself to such a plan, but there are plenty that do so. The whole shallow fore-shore at Bayonne in New York Harbor should be devoted to such a plan, which would tap eight trunk

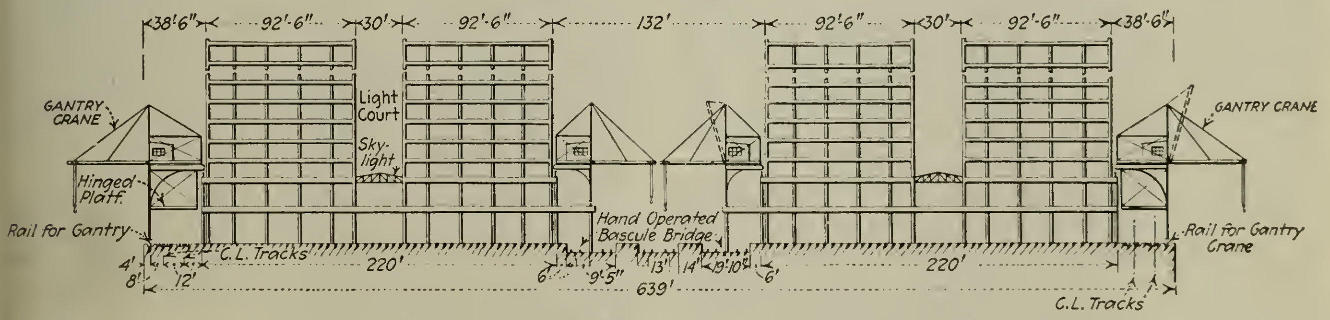


FIG. 3. TYPICAL DEVELOPMENT OF A QUAY LAYOUT FOR A PORT

line railroads at its rear. The Jamaica Bay area should have similar treatment. Baltimore and Tacoma could do the same. The cost would be large for the completed project in each case, but only part need be constructed now and the result would justify the expense.

We must do away with port authorities who are satisfied with seven and a half per cent interest on the invested capital, and look upon the port as the property of the people, for the best advancement of the city and country as a whole. The port of New York, for instance, should be viewed as a national enterprise and not as the chattel of Manhattan and Brooklyn. The result in material prosperity to the port and nation as a whole should be the ultimate goal.

The United States Government, through the Shipping Board and the Board of Engineers for Rivers and Harbors of the War Department, is now authorized by law to assist port development and an organization is being perfected to advise upon port terminal construction.

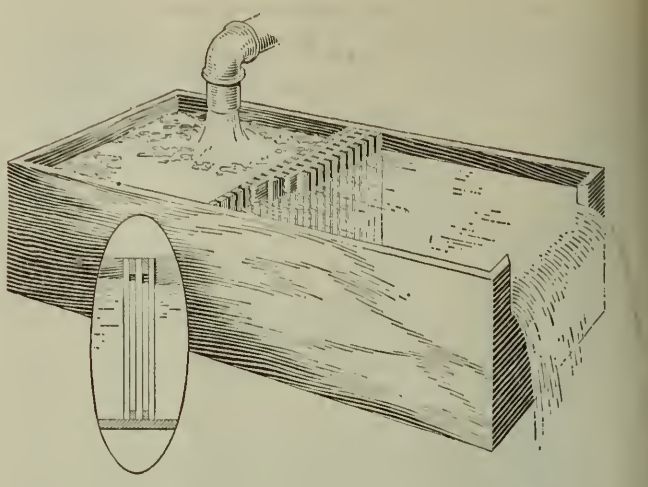
A Stilling Rack for Weirs

By George Sydney Binckley
Consulting Hydraulic Engineer, New York City

The problem of securing a smooth and uniform flow of water toward a measuring weir is one of the minor aspects of hydrometry, yet from the writer's observation it is one in which the engineer often finds much annoyance and considerable difficulty. Almost any one who has had to do with the use of water can let his memory run back a bit, and there will come before him a series of schemes for stilling water in a weir box, all the way from a number of baffles, alternating top and bottom, to a floating mass of débris held in place somehow on the surface above the weir. Long approach channels, baffles where the water is discharged into the channel above the weir, and many other devices give more or less result, but none except the one shown in the sketch herewith has ever been found entirely satisfactory by the writer.

The device referred to, which I call a "Stilling-Rack," was the child of necessity as on one occasion I found it imperative to provide a means by which, using a very short weir box, I would be enabled to obtain a reasonably close measurement of water discharged from one centrifugal pump and one or two pulsating pumps, all operating at the same time. These conditions could hardly be worse, under the circumstances, as the turbulence produced was not alone extreme but irregular. Faced with this condition, I developed the principle of this "stilling rack," about fifteen years ago, and have used it with complete success ever since. In its original application, under the circumstances described above, the turbulence had not the slightest effect on the flow over the weir, and the pulsations were so minimized as to be easily averaged and corrections applied.

The principle upon which this "stilling rack" is based is extremely simple. The rack is composed, as seen in the sketch, of strips of wood, placed with spaces between them about one-third their width, or less, there being three sets of these strips ordinarily (although I have used more at times), separated from each other by horizontal strips, at top and bottom only, and nailed to these last, forming a unit which fills the cross-



SKETCH AND SECTION OF STILLING RACK FOR WEIRS

section of the weir box, and which is secured to it. The vertical strips in the middle series are so placed as to come opposite the openings on each side. In this way the water is deflected in its flow through the stilling rack.

In the cross-section sketch, it will be seen that the obstruction to flow caused by this rack (exaggerated in the sketch), is divided into three stages of head-loss. Hence, the momentary variations of head behind the rack, due to turbulence, cannot be transmitted to the water on the other side, as the flow is through these spaces from surface to bottom of the channel, and momentary effects of turbulence must pass in sequence and with rapidly diminishing result, these different static levels.

Employing this "stilling rack," exactly as shown, an astonishing amount of turbulence may exist behind it, and yet the flow from its face toward the weir be smooth as oil. The use of this device makes a long approach channel quite unnecessary, and indeed it may be placed in a very short weir-box, only a few feet up-stream from the weir, and results will be perfectly satisfactory.

The simple and very cheap device is so superior to any other means I have ever seen employed for this purpose that I feel justified in calling it to the attention of those who have to do with the measurement of water over weirs.

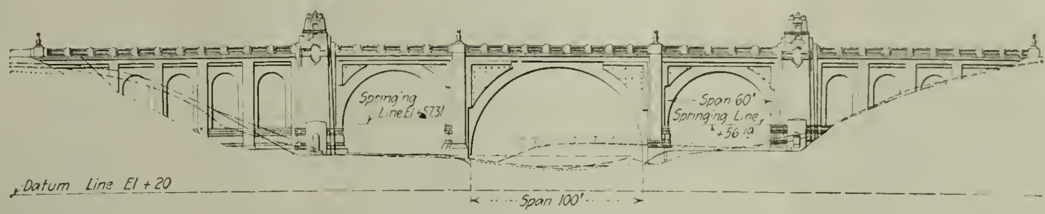
Electrification in South Africa

Electrification of two sections of line on the South African Government Railways, as the first step in a program of electrification for certain important parts of the system, has been decided upon by the Railway Administration. The general program was reviewed in *Engineering News-Record* of Jan. 29, 1920, p. 227. The two present sections are the suburban line from Cape Town to Simonstown, 22½ miles, and the main line from Durban to Pieter Maritzburg, 45 miles, the latter being the initial part of the electrification of the heavy-grade main line from Durban to Glencoe, 249 miles. Multiple unit trains are to be used on the suburban line and electric locomotives on the main line. The estimated capital investment is $2,245,830 and $2,400,000 for the two sections respectively (at present rate of exchange). Merz & McLellan, London, England, are the consulting engineers.

Bensalem Ave. Bridge—An Essay in Ornamentation

Details of Design and Construction of a Monumental Concrete Structure for Philadelphia Park System in Which Special Attention Was Paid to Appearance

CARRYING the Lincoln Highway across Pennypack creek in the northern outskirts of Philadelphia is the new Bensalem Ave. bridge. Structurally the bridge is not particularly distinctive, except for the rib details of the central arch but so much effort has been put into ornamentation and decoration that it takes the place amongst the notable of recent bridges. The crossing is in one of the newest city parks and, in addition to being on the main automobile route between Philadelphia and New York, is above a riverside road which it is expected will be quite heavily traveled. Attractiveness to those using the bridge and to those passing by or under it is therefore equally important.



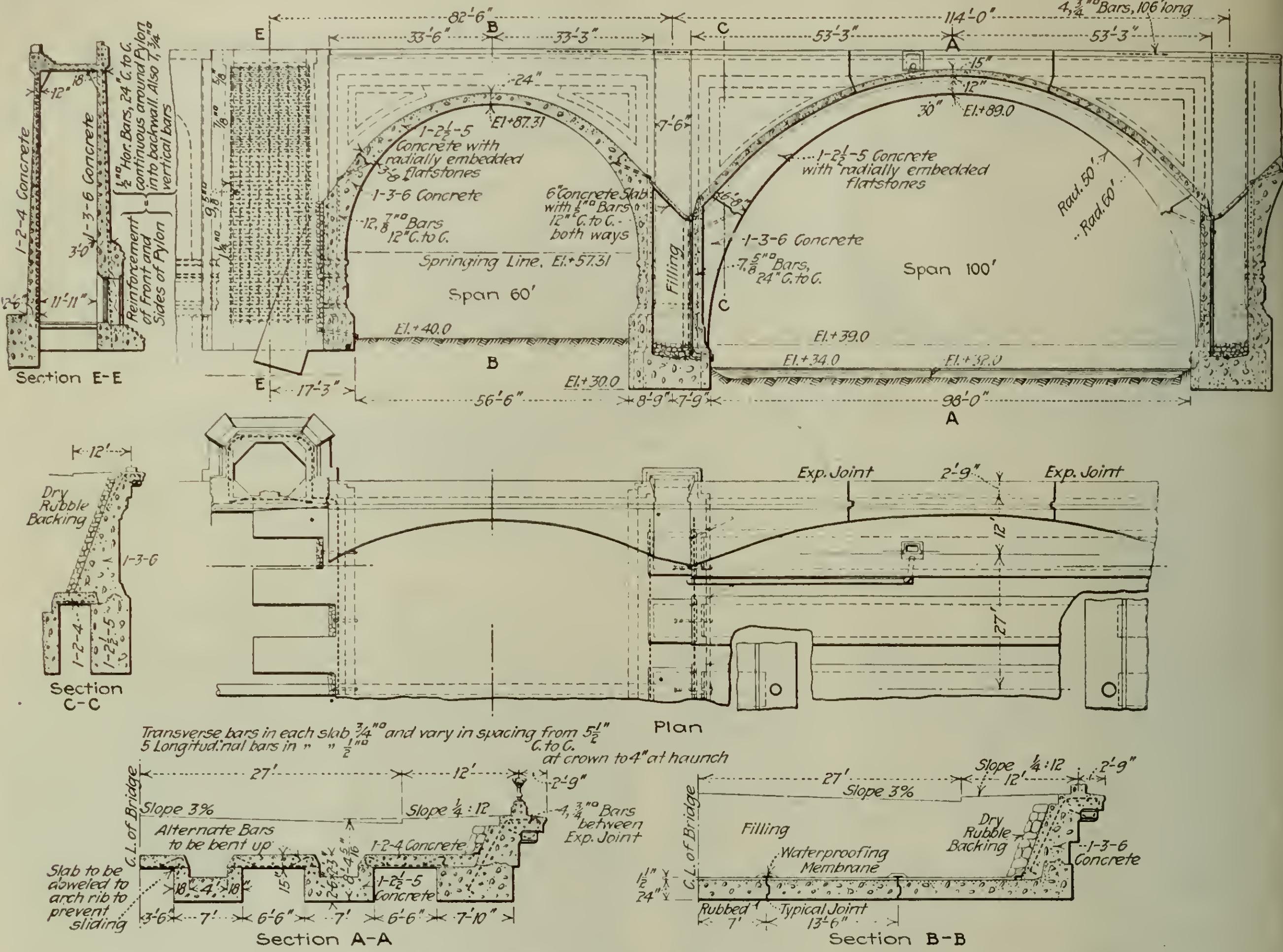
ELEVATION OF BENSALEM AVE. BRIDGE ACROSS PENNYPACK CREEK NEAR PHILADELPHIA

The bridge is 585 ft. long, made up of a central 100-ft. arch, two approach arches of 60 ft. span, and about 150 ft. of approach retained fill on each side. It is 78 ft. wide with a 54-ft. roadway and two 8-ft. sidewalks with intermediate strips of lawn 4 ft. wide. The hand rail is 69 ft. above the creek bed. Details of the construction are shown on the accompanying drawing. The two approach arches are of solid concrete of semicircular section with solid concrete spandrel walls and earth filling for the roadway. The abutments are carried down to solid rock in six buttresses, each 7 ft. wide spaced 6 ft. 6 in. apart. The approach walls are of gravity mass concrete section, with earth fill.

The central arch of 100-ft. span is made up of six arch ribs of mass concrete of 1:2½:5 mix, each 7 ft. wide and 2 ft. 6 in. at the crown, increasing to a thickness of 6 ft. 8 in. at the springing line. The earth fill of the roadway is carried on these main ribs and reinforced-concrete slabs 15 in. thick which span the main ribs resting on 12 x 18-in. projections above the main section of these ribs. These slabs, as will be noticed from the drawing, are reinforced with rods in transverse frames, bent up at about the third point to the upper part of the slab, and with continuous longitudinal rods. The outside faces of these slabs are sloped back in order to permit a free entrance of the fill to the opening in the arch ribs. The slabs are of 1:2:4 concrete and the spandrel walls, which, as will be noted from the drawing, are bonded to the outside ribs by projecting steel rods and by irregularities left in the top surface of the outer ribs, are of 1:3:6 concrete. These spandrel walls are provided with expansion joints at about the third point, as shown on the drawing. Dry rubble backing is placed against the inner slope of the spandrel wall before the fill is dumped onto the arch.

Details of line intended to add to the appearance of the bridge include the use of heavy pylons at the abutments of the two side arches, of lighter pylons at the abutments of the main central arch, or quoin line markings on the pylons and voussoir markings on the arch ribs, heavy corbels and added ornaments on the railing, and special indent markings uniformly placed in the triangular recess on the outer spandrel walls. The approach walls have recess arches on the spandrel face and are curved in plan at the approach. The main ornamental details, however, are the four large pylons between the 60-ft. arches and the wing walls. These extend from the creek level to 25 ft. above the sidewalk level on the Lincoln Highway. The top of each pylon is made into a huge lantern by means of ornamental iron work containing orange colored glass. An iron-

THE COMPLETED BENSALEM AVE. BRIDGE



DETAILS OF THE MAIN AND SECONDARY ARCH OF THE BENSALEM AVE. BRIDGE

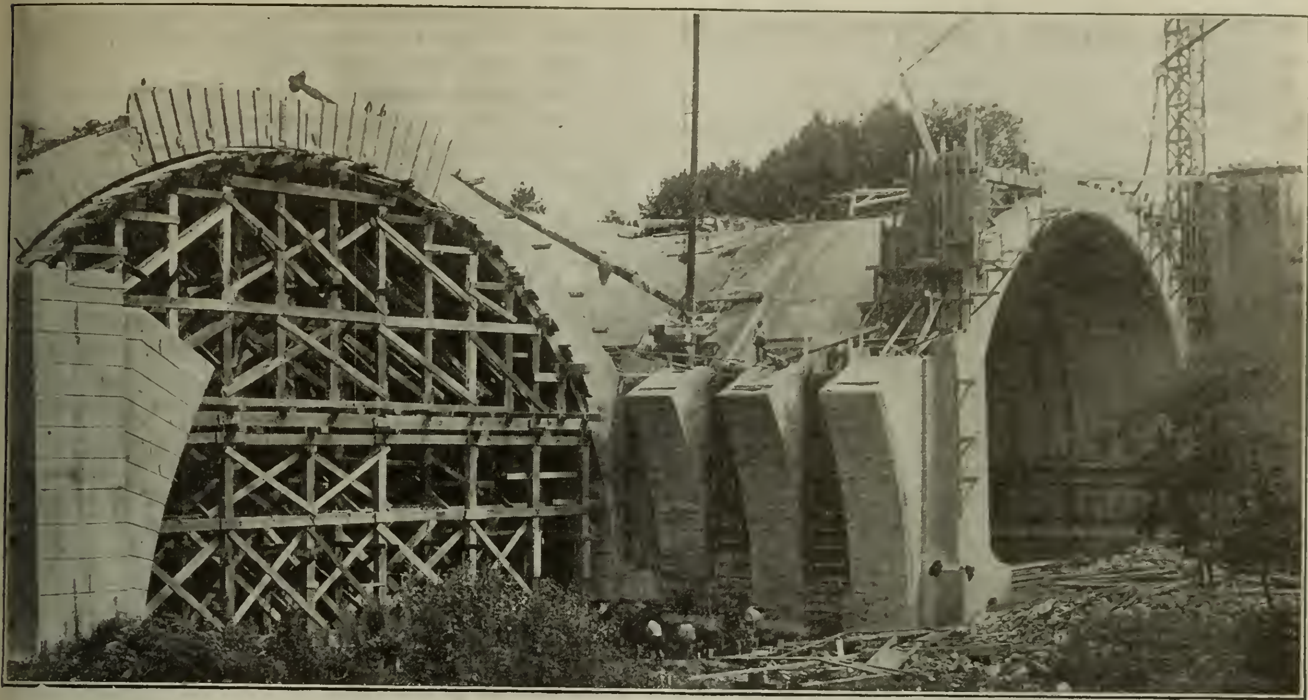
studded oak door opens into a guard house in each pylon at both street levels. The two compartments are to be connected in the future by means of a circular stairway inside the pylons. As shown on the close-up photograph the concrete detail of the four houses which hold the lanterns is very elaborate and required an extreme complication of formwork.

All exposed surfaces on the sides of the bridge were given a scrubbed finish, the outside concrete being of a different mixture than the body concrete and containing ⅜-in. screened pebbles of a yellowish color. The forms had to be stripped in time to allow the concrete to be scrubbed before it became too hard. Extreme care was necessary in judging the time to strip the forms to obtain the desired finish, at the same time not weakening the construction. Scrubbing was done with ordinary steel bristle brushes and water, but generally it was first necessary to scrape the concrete in order to expose the pebbles. Form marks and imperfections were easily removed, giving a uniform appearance to the exposed concrete surface. The intrados of each arch was rubbed with carborundum brushes and a cement wash.

The most elaborate formwork was necessary to take care of the several types of concrete ornaments, all of which were built monolithic with the mass concrete excepting the pre-cast railing. The concrete in the overhanging coping, for instance, weighing 1,200 lb. per linear foot, was supported on wooden brackets bolted to the sides of the bridge by means of anchor bolts, which bolts also supported scaffolding.

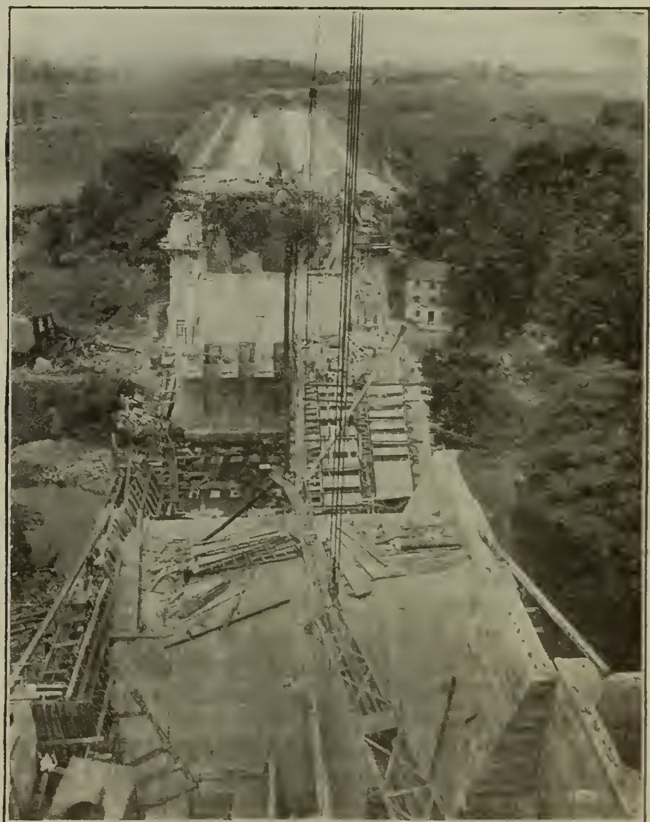
The 60-ft. arches were carried during construction on steel centers which were used three times for each arch, the shifting being done by rollers. The 100-ft. arch, on the other hand, was built on timber falsework of sufficient width to take care of three ribs, or half the arch. This centering was supported on concrete piers in the river bed and wooden cribbing, and was rolled on 6-in. hardwood rollers, the power being supplied by three 30-ton hydraulic jacks. Three men were able to move falsework, with additional men to replace rollers, etc. The lower part of the falsework, consisting of nine bents, was made into a truss by using horizontal and diagonal wooden bracing with steel cables for tension members. By this means the weight of the falsework was concentrated on three points of support, necessitating only three sets of rollers. The falsework was used twice for the arch construction after which it served as a scaffold for the use of the men who finished the intrados of the arch.

The construction plant was described in *Engineering News-Record*, April 26, 1917. As originally laid out it consisted of a central concrete mixing plant, guy derricks, and an industrial track on which were operated cars for the distribution of concrete. The two cars were connected by a cable and the grade of the track was such that the loaded car from the mixer would pull an empty car back into position for loading. The mixing plant consisted of one large mixer which was fed from overhead bins, these bins in turn being loaded by a guy derrick operating a 1-yd. clam shell. This same derrick also unloaded material from railroad



FORMWORK UNDER HALF OF CENTRAL ARCH TO BE MOVED OVER TO THREE RIBS JUST STARTED AT RIGHT OF ARCH

HIGHLY ORNAMENTAL LANTERNS AT TOP OF MAIN PYLONS OF BENSALEM AVE. BRIDGE



LOOKING ACROSS THE BENSALEM AVE. BRIDGE UNDER CONSTRUCTION

cars. After the arch work was started the concrete was handled from a 140-ft. wooden tower by spout.

The Bensalem Ave. bridge was designed in the Bureau of Surveys of the City of Philadelphia and was constructed when George E. Datesman was director of the Department of Public Works and Chester E. Albright, chief engineer, with Jonathan Jones assistant engineer in charge of bridges. The architectural details of the bridge were prepared by E. B. Baker of the Bridge Division, Bureau of Surveys. The bridge was built by Day & Zimmerman, Inc., of Philadelphia, with C. R. Camp as general superintendent of construction. The original designs were made when George S. Webster, the present chief Engineer of the Bureau of Surveys, held that position under a previous administration.

Notes from Foreign Fields

WHAT ENGINEERS ARE DOING IN GERMANY

By E. J. Mehren
Editor, *Engineering News-Record*

In a previous article the general conditions in Germany were described. The engineering conditions are not less interesting.

The war and the provisions of the Peace Treaty have created new engineering problems. There will be coal and raw-material shortage for many years, while, owing to change in source, due to areas lost to Germany, many of the materials will differ from those used before the war. The composition of the iron ore, for example, is apt to be different from that of the Lorraine mines, the chief dependence of the German steel industry before the war.

There is need, therefore, for the most efficient use of coal and raw materials. For engineering materials derived from new sources studies must be made to determine the properties and to write new specifications. These situations the German engineers have grasped, and with characteristic energy are trying to find solutions.

For example, a Bureau of Heat Economy has been formed, under the joint direction of the Verein Deutscher Ingenieure (the all-embracing engineering society of Germany), the Association of Central Electric Stations and the Association of German Iron Manufacturers, to conduct researches in fuel economy. The work is being pushed with vigor and reports are already beginning to appear.

With the same general purpose in mind there has been formed the Standards Committee of the German Industries (Normenausschuss der Deutschen Industrie) which, though organized less than two years ago, has already published 160 standard sheets and has 400 in process. Unlike the standardization work in the United States the committee is dealing with manufacturing rather than with materials standards, for in the present crisis it is important to effect as quickly as possible such standardization and simplification of design as will save both labor and materials.

The attack has been begun on design standards, also, because the Germans do not know definitely where some of their raw materials will come from.

The standard sheets already issued cover a surprisingly wide field, from tool grips, gages and wood screws to window frames for small dwellings. Standardization of parts for machine tools, automobiles, agricultural machinery and locomotives is being studied. A subcommittee has in hand the standardization of rolled shapes, while a number of subcommittees are working at high speed on the elements—doors, stairs, roofing, plumbing, etc.—of small dwellings, of which there is great shortage in Germany and on which much labor and material must be used as soon as Germany has the financial resources.

The co-operation which this committee is receiving is extraordinary, and could not, I was told, have been secured before the war. Now the necessity is such that no one is appealed to in vain. The manufacturers appreciate that small savings per piece, either in materials or labor, make large aggregates.

At the great testing laboratory at Lichterfelde, Berlin, I found the same keen appreciation of the part that engineering must play in the restoration of German industry. The great laboratories are prepared, as one by one the sources of raw materials are definitely known, to make extensive studies on the determination of properties so that there will be little delay in giving German industries full information regarding the new materials. The research men there are pushing their inquiries with the vigor that has always characterized this great testing station, and I saw much work under way on structural steels and on building materials.

Industrial Management

On industrial operation there is just as keen inquiry as on materials and design. With its colonies lost, its foreign trade gone, with ample labor but restricted materials, close study is being given to the lines along which German industry must be recast. In the past Germany exported large quantities of raw and semi-finished materials. The thinking is now directed toward a diminution of raw and semi-finished exports and an increase in finished goods. They want to market their labor rather than mere materials.

There is intimate study of methods of management and cost-keeping. Our experiments and experiences with "scientific management" are being carefully studied, and progress is being made in the adoption and utilization of such features as seem adapted to German conditions. For furtherance of management studies and exchange of experiences, there has been formed an Association of German Works' Engineers. Already there are branches in fifteen manufacturing centers, while a dozen questions, such as wage and cost systems, making and use of time and motion studies, have been formulated for study by committees and discussion at meetings. Employment methods, the influence on industry of the standardization of design, the function and place of testing in industrial works, and the lay-out and organization of factories, are other questions that are being taken in hand.

Another indication of the determination to use every resource to the utmost efficiency is the extended study being made of psychological tests for determining the individual fitness for vocations and positions.

On the matter of costs and their effect upon the industrial future of Germany there are no illusions. There are four factors that will increase the price of German goods and make it difficult for her to compete with Great Britain and America:

1. Shortage of coal and steel (imported steel will be very expensive due to the exchange, which must continue adverse to Germany for a long time).

2. High wages (which must continue until supply approximates demand).

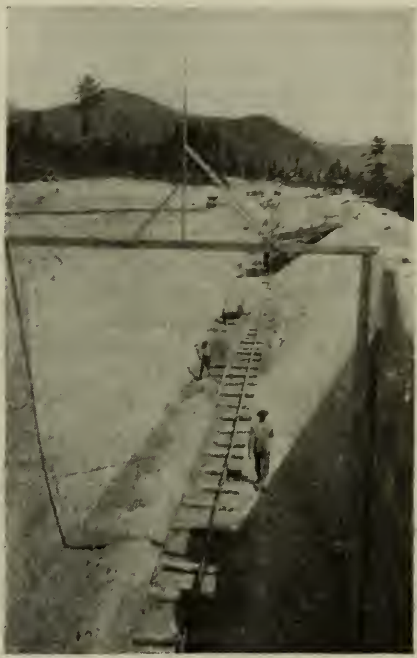
3. The heavy public debt, which necessarily throws a burden on industry.

4. The high selling costs due to the complete destruction of Germany's world-trade connections.

Realizing these conditions, the German manufacturer is giving more and more thought to the production of goods that are not only excellent but of a type not made elsewhere, realizing that if he has goods of a type and

quality not elsewhere obtainable he can get higher prices than if he competes on ordinary types and qualities. At the same time, no possible means of reducing production costs is without very thorough study. The effects of standardization, of reduction in the number of patterns produced in a given factory, of specialization by shops and individuals, are being carefully studied. In other words, not merely are direct costs—labor and materials—being subjected to critical analysis, but the overhead as well.

But even these categories do not exhaust the resourcefulness of the German industrial mind. There is extensive co-operation on commercial as well as technical lines between the big industries. Common purchase of materials, selling through trusts and cartels, and other forms of commercial co-operation are being considered with a view to reducing the costs of materials and distribution.



ON THE WALCHENSEE HYDRO-ELECTRIC WORK IN SOUTHERN BAVARIA
On the left, two of the engineers in the cofferdam of the Isar; on the right, the open canal from the Isar to the Walchensee

In the work of restoring German industry the Verein Deutscher Ingenieure is playing an important part. This organization of 25,000 members has, as already indicated, participated in the organization of the Bureau of Heat Economy; it also played a prominent part in the organization of the Standards Committee, and the offices of both bodies are in the society's headquarters in Berlin. It has also been responsible in greater or less degree for the organization of the Association for Metal Study, whose purpose is to make an extensive research into the properties and uses of metals; of a series of committees on the application of engineering to agriculture, a movement springing out of the German food shortage; of the Association of Building Construction Interests, embracing engineers, contractors, and manufacturers of building materials, resulting from a shortage in dwelling accommodation, and of the Association of German Works' Engineers, already referred to.

The publishing activities of the Verein are extensive, so extensive, in fact, that it has recently organized a publishing division, which is run, practically, as an independent publishing house. It is entirely under the control of the Verein and has its offices in the Verein's headquarters, but its business is kept separate from the administrative affairs of the society.

Since the war the publishing activities have been greatly increased. The pre-war publications included the *Zeitschrift* (the proceedings), published as a weekly engineering journal; *Technik und Wirtschaft* (Engineering and Business), a monthly; a Year Book of contributions to the history of engineering and industry, and *Forschungsarbeiten* (Research Papers), which appear irregularly. Since the war the following publications have been started: *Der Betrieb*, which discusses all phases of industrial management and is the medium for the announcements of the Standards Committee; *Technik in der Landwirtschaft*, a monthly devoted to the applications of engineering to agriculture (in this enterprise the society has the co-operation of the German Chemical Society and problems of fertilization, of crop rotation and of every phase of scientific agriculture are taken up, as well as the applications of engineering to agriculture); *Technische Zeitchriftenschau*, a monthly digest of engineering publications in all languages. In addition the Verein has undertaken the editorial direction of a propaganda organ, supported by some of the large industrial associations and published monthly in German, English and Spanish. The editorial section is strictly technical in character, the Verein having made it a condition of its participation that propaganda material of the usual type, exploiting particular machines, designs, types and processes, should not be used. In addition to these publishing activities, the society's publishing branch is handling the publications of the Bureau of Heat Economy. All of the publications carry advertising and a force of advertising salesmen is employed.

From this brief statement it is apparent that the Verein has been successful in its effort to become the co-ordinating factor in the co-operative applied-science studies and activities of Germany. Its work is carried on with singular energy and foresight, and a high devotion to the needs of the German people. We (and English engineers too) would be inclined to doubt the advisability of a technical society conducting a commercial enterprise like the publishing branch of the Verein, but from what I heard in Germany the technical activities of the organization do not seem to have suffered.

It is apparent from what is here set down that German technical development in the next 10 years will deserve the very closest study. German industrialists

and engineers in the 30 years following the Franco-Prussian war changed Germany from an agricultural to an industrial nation. The genius, the patience, the perseverance, the thoroughness that created that economic revolution are still to be found in Germany. What is more, they are now driven by dire necessity, and realize that they must bend every effort to the new and heavy task. If before the war Germany's technical progress was rapid, it will now, under the new conditions, be so accelerated that we can safely look for extraordinary technical progress in the near future. From the engineering standpoint Germany in the next decade should be the most interesting country in the world.

Deutsches Museum

For years I had heard the *Deutsches Museum*, at Munich, referred to as an engineering museum of a very unusual type. In fact, I had read descriptions of it, but they had merely strengthened my original conception that the institution was a museum, though a museum in which the exhibits were wonderfully set out.

Our American conception of an engineering museum is that of an orderly curiosity shop. Learning in them is difficult. The collections are not invitingly set forth, nor do the explanations (if any) lead one easily along the path of knowledge.

The *Deutsches Museum* is not merely a museum; *it is a people's university and laboratory*, where the explanations are inviting even to the man of average intelligence, and the principal laws of science may be demonstrated experimentally by the visitor himself.

Take, for example, the operation of a steam engine. I have seen many sectioned, movable models where the student could painstakingly learn the inter-relation of the movements of the slide valve and the piston, and follow the admission and expansion of the steam and the discharge of the exhaust, but these sectioned diagrams are a Chinese puzzle compared with the apparatus in the *Deutsches Museum*. Here the visitor can make the diagrammatic parts of a steam engine pass through their successive positions; as each important step occurs, such as the uncovering of the ports, and the movement of the piston under the expansive force of the steam, complete explanations appear at openings adjacent to the pertinent parts of the diagrammatic engine. A child of ten would have no difficulty in following and understanding what was happening.

In another room was a great variety of apparatus where the visitor, be he a boy of fifteen, a student from the *Technische Hochschule*, or a man of mature years, could perform experiments demonstrating the principles of the lever, the screw, the parallelogram of forces, etc., while adjacent were other pieces of apparatus where experiments on simple applications of these principles could be performed. The reactions of forces or loads on a beam, the lifting power of various combinations of pulleys, etc., could be studied. Similarly, there were other rooms for experiments on sound, light, heat, hydraulics, electricity, etc. In every case the development of the particular art was shown by thoroughly explained exhibits, placed alongside or near the apparatus, on which the visitor demonstrated the fundamental principles. Each piece of demonstration apparatus, moreover, was accompanied by a placard which explained with the utmost clearness the principle demonstrated.

In general, in the explanation of its exhibits, the museum is unexcelled. The placards made the asking of questions or the carrying of guidebooks unnecessary

I wish that space permitted a description of some of the exhibits and demonstration apparatus. In the astronomical division was the best apparatus I have seen for explaining the cause of night and day and the seasons, a subject difficult to grasp without a model, unless one has an unusual imagination. The ball representing the earth, of a diameter of about 15 in., revolved on an orbit with a major axis of about 15 ft., while a strong arc light placed correctly with reference to the orbit represented the sun. With the room darkened and the earth revolving both on its own axis and along the orbit, the reason for the variation of the seasons and of the relative length of day and night was apparent.

Also in this section were a number of telescopes of different magnifications in which the planet Saturn could be seen in the magnification proper to the particular telescope and with its appropriate illumination, the whole being fully explained by accompanying placards

While making a people's university and laboratory of the museum the historical feature has not been neglected. The development of processes and machines is well set forth.

The museum at present is housed in a building inadequate in size; in fact, it has overflowed into a second large structure. To provide it an adequate home there had been begun before the war a great reinforced-concrete structure with a plan area of 100 x 100 m., situated on an island in the Isar. The structure had been roofed in when the war came, and there it stands today in its uncompleted condition with the date for finishing probably far in the future by reason of high costs and material shortage.

The great institution owes its conception and its past and present virility to a distinguished Munich engineer, Dr. Oskar von Miller, sometime president of the Verein Deutscher Ingenieure. In building an institution of great value to the German people and German industry he has builded for himself an extraordinary and fitting monument. After it the engineering museums of the whole world may well pattern.

Hydro-Electric Power Work in Bavaria

While in Bavaria I had an opportunity of seeing under construction an interesting hydro-electric development and of learning of the plan for creating in Bavaria a great electric-power transmission network.

The Walchensee hydro-electric plant is being built under the direction of Dr. von Miller, the founder of the *Deutsches Museum*. A lake lies in the mountains so near the valley that by a tunnel and a pipe line, both short, a head of 200 m. can be developed. The watershed of the lake itself, however, will not be the sole reliance for water supply. An intake is being built on the Isar and from it 25 cu.m. per second will be taken and led to the lake. The Walchensee plant will be used to carry the peaks of both railroad and general power networks, and under maximum load will use 60 cu.m. of water per second.

Aside from the economy of the development, it has great interest because of the fact that in the one power house both Francis turbines and Pelton wheels will be

used. The four Francis units will be of 24,000 hp. each, with speeds of 500 r.p.m.; the four Pelton units will be of 12,000-hp. capacity, each with 50 per cent overload capacity, the speed being 250 r.p.m. The station will supply current both for the operation of the Bavarian railways and for general power supply. The Pelton-wheel units will supply the railway power, and were selected for this service because of the greater ease of regulation under the heavy fluctuations in current demand expected in railway work. The Francis units, on the other hand, will supply the general transmission network, where the fluctuations will not be violent. The Pelton wheels will operate single-phase generators, while the Francis units will drive 3-phase machines.

In addition to the Walchensee plant the Bavarian Government has under development four low-head plants on the Isar, near Munich, which will generate a total of 170,000 hp. They, likewise, will be connected into the Bavarian power net.

Power Network

This power net, which will be owned and operated by the government, will have 1,200 km. of main transmission line, operated at 110,000 volts. The main lines will extend from the Walchensee plant, which is in the Bavarian Alps (south of Munich), to the northern boundary of the state. A secondary network will operate at a pressure of 50,000 volts, while the local transmissions will be at 10,000 or 15,000. Into these networks all of the plants of Bavaria are to be connected, save those which, from motives of economy, will be dismantled. Where plants are not acquired by the state they will be compensated for the current they will deliver to the system. With the water power being developed at Walchensee and on the Isar and the economies resulting from the inter-connection of all large stations, it is expected that a large saving of coal will be effected, a very vital matter in view of the coal shortage with which Germany will have to contend for many years.

The design and construction of the transmission network is likewise under the direction of Dr. von Miller.

The work is an evidence of the spirit in which Germany is endeavoring to make the best of the severe conditions that have followed the close of the war.

Berlin, July 27.

Typhoid Castles in Sometown

In the first of a series of popular pamphlets entitled "Sometown," designed to promote the introduction of sewers in backward communities, the Clay Products Association, Chamber of Commerce Building, Philadelphia, discourses briefly about "typhoid castles along the back alleys." Thus:

"A good deal might be said about these typhoid castles, but you know just what sort they were. Everybody had one at the back of his lot. They made a picturesque architectural perspective along both sides of the alley as ornamental as a row of tin cans on a dump. They leaked rain and snow and bad smells, and if the holes in the ground under them filled up with water they leaked filth; but principally the leaked flies—flies that could come in and go out whenever they chose and carry their filthiness wherever a fly would naturally like to go—which seemed to be everywhere in Sometown."

Hydraulics of the Intake to a Pipe Drop

By George Henry Ellis

Great Falls, Mont.

The Pishkun pipe drop on the Sun River Project of the U. S. Reclamation Service has an intake, the hydraulic properties of which have been determined by current-meter measurement in the canal just above the intake. Here is located one of the measuring stations

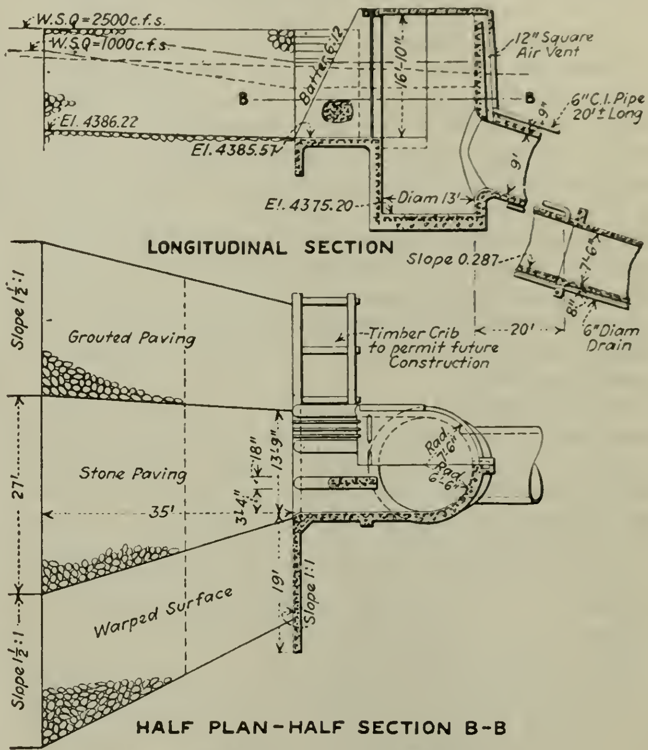


FIG. 1. INTAKE TO PISHKUN PIPE DROP

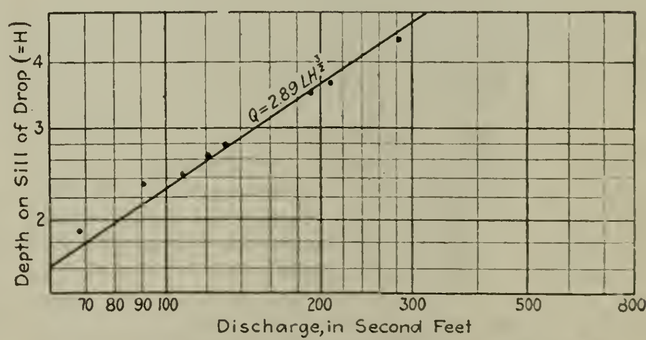


FIG. 2. DISCHARGE CURVE FROM GAGINGS 130 FT. ABOVE INTAKE

described in the *Engineering News-Record*, Jan. 8, p. 80. A drawing of the intake and a plotting of the results of nine ratings are given herewith.

It will be noticed that the paving above the intake has a fall of 0.65 ft., so that its upper end controls the water elevation at the measuring station when only a small quantity of water is running. At just what elevation this control passes from the paving to the intake is not known, but it would appear from Fig. 2 to be at a depth of about 2.4 ft. on the sill. It is probable that an exponent of 1.6 would fit the points better than that of 1.5 used, but the simple fraction is easier to use.

The 2 x 8 in. needles have not yet been installed, which leaves three clear openings of 3 ft. 4 in. each, so that L is taken as 10 ft.

Engineering Literature

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Useful Data Gathered by Public Officials Should Be Published

By Ruth Canavan
Librarian for Metcalf & Eddy, Boston, Mass.

Throughout the past decade there has been an increasing tendency on the part of states and municipalities to curtail the printing of departmental reports, either through failure to grant appropriations or by so restricting the length of such publications as to exclude all detailed data of value. Upon the outbreak of the war this tendency gave place to a definite policy of economy, justifiable under war conditions, but deplorable as a permanent practice. It has been advocated apparently upon three grounds: High cost of printing; dearth of assistants; belief that the reports were not of general usefulness.

As exemplifying the effect which this policy has had there may be quoted a portion of two letters received in 1918. The first extract is from a state board of health in the Middle West, which has been wont to publish its reports in detail: "We are sending you a copy of the annual report of . . . . for 1915. This is the last report that will be published in separate form as the . . . . General Assembly has stopped the publication of all state reports except such as are included in the volume known as . . . . This department has done fine work in the field of sanitation and its reports have been widely read, but the volume referred to is merely a compilation of statistics." The second letter from the head of the state board of health in New England contained this statement: "I regret to state that the Printing Commission have not yet published our reports for the years 1913, 1914, 1915 and 1916. A change in personnel occurred in this office on . . . . whereby Dr. X was replaced by Dr. Y." It was subsequently determined that "the reports between the years 1912 and 1917 will never be printed."

That the municipalities have also suffered is shown by a reply received from the city engineer of a southern municipality which for six years has operated a sewage-works of exceptional interest: ". . . . the city has never seen fit to publish any data on the sewage plant; much to my regret." And an official of an eastern city with a population of over 700,000 advises: "In any case, the reports issued by this city are not in detail and I think the information given would be of little use to you."

While this policy of economy may have been justified by the exigencies of the war period it has resulted in a deplorable dearth of printed data and in corresponding duplication of work. It is a short-sighted policy not only in that it deprives the engineering profession at large, and hence those places which its members are called upon to serve, of the results of investigations and operating experience, but also because it reacts upon the morale of employees of the city or state pursuing it.

An investigation to meet some specific need is made. The problem is solved and the data which enabled its solution, instead of being worked up for publication, are filed away in the form of computations and rough draft notes. The problem in all probability becomes a matter of record, but the basic information upon which its solution depended is buried in the archives. Possibly should the same situation arise anew, those immediately concerned in meeting it in the first instance might be able to unearth the original computations or notes, but changes in personnel occur and the original notes, assuming they could be found, might prove quite unintelligible to all except the one who wrote them. This leads to a repetition of the work and hence to duplication of expense; in fact, it may mean more than duplication, since an investigation carried on in 1918 would be obviously more costly, on account of advances in salaries, railroad fares, etc., than one made ten years previously. But it is interesting to note that the same finance committee which has refused to grant the appropriation necessary for printing the information, and thus making it a matter of permanent record, will unwittingly, in its general appropriation for departmental expenses, include sufficient funds to cover the cost of this unnecessary repetition of work.

There is also to be considered the demoralizing influence upon the work of the department employee, where the results of his investigations are never to get into print. He feels that he has lost all individuality. From the accumulated evidence he deduces his findings and dutifully makes his recommendations. But his conclusions, in all probability, are not as comprehensive or as carefully formulated as they would be were the report written with the knowledge that it was to be printed. While he personally may derive benefit from the results of his investigations, the state of the art does not feel the quickening influence of the local advance, nor are others elsewhere stimulated to carry this advance further.

This willingness to share the results of his experience and to do all he individually can toward the advancement of knowledge in his particular branch of the profession, is one of the finest traits of the engineer. It is a desire which should not be thwarted—for the sake of the individual, for the sake of the profession, for the sake of the country.

How then may this desire be fostered? There have been instances of an apparent lack of sympathy on the part of the chief of the department with the desire of his subordinates to work up and publish the results of their individual efforts. In this connection it must be remembered that the creditable work of the employee reflects credit upon the department, and hence upon its chief.

If appropriations for printing matter of scientific and practical value are refused, obviously the departments cannot issue such reports. They can, however, see to it that the results of investigations are worked up in sufficient detail and so filed and indexed as to make them of permanent value; they can give publicity, through the engineering press, to the fact that investigations along certain lines are in progress or have been consummated; and, above all they can encourage, or even require, that those in their employ prepare each

year for publication in the engineering periodicals or the society journals, the more significant of their findings. By so doing, city and state departments will not only stimulate the interest and endeavor of their employees but will render valuable service to the engineering profession and the public.

Gillette a Decade Ahead of His Time

Reviewed By Henry D. Hammond
District Engineer, The Lakewood Engineering Co., Cleveland, Ohio

EARTH WORK AND ITS COST: A Handbook of Earth Excavation—By Halbert Powers Gillette, Editor of *Engineering and Contracting*, M. Am. Soc. C. E., American Institute of Mining Engineers, etc. Third Edition. New York and London: McGraw-Hill Book Co., Inc. Flexible Cover; 5 x 7 in.; pp. 1346; illustrated. $6.

One is tempted to call this work by its proper name—a carelessly assembled collection of *almost* useless information—and let it go at that. But neither the subject, nor the book nor yet the author can be dismissed so lightly, if only for one reason. Gillette is a pioneer. He is attempting to publish something the material for which does not as yet exist—a complete treatise on the cost of many solutions to a large number of earth-handling problems. Yet, although pioneering is always tough on someone, it is most necessary, especially in the field of cost information, for the writer is not one who holds that the time will always be when accurate costs cannot be published and profitably used by others, to the great benefit of contracting. Indeed, it is a sign of the times to see works of this character appearing at all, regardless of the value of the works themselves. We have to begin somewhere.

But, in order that the pioneering effort listed above may perhaps be less dangerous to engineers and would-be contractors who may happen to read this notice, and in order to set a standard for future efforts in the same direction, it is proper, and in no way hostile or destructive, to mention some of the more glaring defects of this, the third edition of Mr. Gillette's earth-work handbook.

Although it is true, as stated by the author in the preface, that the value of cost information is not affected by age, so long as it is in terms of man-hours, and so long as the conditions are similar to work being done today, how much of the information in this work, ranging from ten to twenty years old, can pass this test? Very little, we fear. In fact, a great proportion of it can never be converted into man hours, the opportunity for that having been lost years ago when it was recorded and the job promptly forgotten. In instance after instance one or more quantities without which the equation is indeterminate are not given. Mr. Gillette set out to publish cost data, and when the best were not available, he took second-best, so to speak, to break the ice. In fact, very second-best. In one instance so much so that he omits the information altogether as being quite indeterminate, and apologizes for doing so. The only way in which such costs can be utilized by an engineer or other estimator is by taking here and there a bit of information which throws light on some unfamiliar condition, in a problem where the remaining factors are already determined. Of course, to say this much for the book is to accord it usefulness which justifies its publication. Then, too, it is almost the only available collection of data published within the last ten years.

The next most serious fault is the too great dependence upon Mr. Gillette's own paper, *Engineering and Contracting*, for quotations. A page count would perhaps reveal far more than half the book is quotations and extracts from that journal. In many instances new and blushing authors have been quoted without even removing the hair-moustache of the article—the well-known opening paragraph in which the writer tells the gaping world, "this is what you have been waiting for." Such editorial carelessness cannot be overlooked, even in Mr. Gillette.

The section of the work on steam shovels is taken almost whole from a report made years ago by Mr. Gillette's colleague, Richard T. Dana, to the Bucyrus Company, and contains at once the most practical data and some of the most doubtful-looking theory of the volume. This section will be found scant on the subject of revolving shovels as applied to modern highway work, but that was only to be expected. Such work is too new for a treatise which deals exclusively in pre-war costs, with occasional admonitions to the reader that "things have gone up one to two and a half times." The portion of the book dealing with grab buckets is deficient in information, not even distinguishing the wheel, arm and sheave types of bucket, and giving little discoverable information on the rate of handling loose material with these tools. In discussing hydraulic dredges, the largest and most efficient ever built—those used on the Toronto harbor improvement, which hold by wide margins all records for any type of excavating tool—are entirely overlooked, though other "record" data are included in the work. Other gaps might be mentioned, and will be noticed by experienced readers in each line.

In brief, then, the work needs the inclusion of real costs, which are very rare in published form, since contractors are loath to part with them; needs far better editing, with reduction of its information to man-hours instead of to dollars on an obsolete money scale, and needs to be more complete. All of which will come with time.

But it must be borne in mind that this will take time, and that the real reason why contractors do not publish their costs is a sound one. The root of this reason must be cured before real published costs are available. The trouble is that there are too many engineers and would-be contractors who are no more fitted to use the best of costs than a high-school graduate is competent to calculate the orbit of Halley's comet. This has been demonstrated so many times that it is patent to contractors. Costs, in the hands of such, are useless as Granville's *Calculus* is to a Hottentot. Worse, they are almost sure to prove destructive to some contractor. Fortunately, this class of engineer is being gradually eliminated, and the day will come when no one will be permitted to employ cost data in disposing of other people's money who cannot prove his competence to do so, just as no railroad would today commission a surveyor to design a Hell-Gate arch.

It is in anticipation of that day that the work cited is issued; and the writer of this notice, for one, hopes that, with all its necessary drawbacks, it may prove to do more good than harm, and that it may be the precursor of something more worth while to be published in the future.

Higher Mathematics for Engineers

REVIEWED BY CALEB MILLS SAVILLE
Manager and Chief Engineer, Water Department, Hartford, Conn.

MATHEMATICS FOR ENGINEERS, PART II—By W. N. Rose, B.Sc. Eng. (London). Late Lecturer in Engineering Mathematics at the University of London Goldsmiths' College, Teacher of Mathematics, Borough Polytechnic Institute. New York: E. P. Dutton & Co., Cloth; 6 x 9 in.; pp. 419; illustrated. $7.

The second volume of "Mathematics for Engineers," like the first, is intended to occupy a position midway between a theoretical treatise and a practical exposition of the uses of some of the high mathematics for the everyday problems of engineering work. The first volume (*Engineering News-Record*, May 15, 1919, p. 980), was confined to the more elementary mathematical processes of algebra and trigonometry, mensuration of solids, including conic sections, graphs and charts. The second volume, excepting a chapter on spherical trigonometry and another on mathematical probability, is devoted to the calculus, both differential and integral. The subject matter in both volumes is well presented and the practical method of handling the calculus in the second volume should be of especial value to those who, in student days, learned to apply this most useful tool by rule with little understanding of its possibilities and practical application. Prof. John Perry once said that the engineer should be taught to use calculus with the same ease that he does a chisel or a file. Few engineers do so handle it, but the expositions set forth in this book should go a long way toward an end so greatly to be desired in these days of conservation of time and energy.

The book is written from an English engineer's standpoint and many of the examples given are not of the type which would appeal most to American readers—as, for example, a problem to find the ratio of armament to displacement in a 21-knot battleship. However, the principles are plainly brought out and the only criticism is failure to hold attention by means of more familiar application. In Chap. 1 an excellent graphical exposition is given of the methods of calculus, and this should go a very long way in clearing up those doubts which persist in many minds of just how to translate problems in x, y and z into such shape as to solve practical problems, such as finding the head lost in friction when the horsepower transmitted by the main is a maximum. Such problems as this it is the purpose of the book to present in a manner that clearly shows not only their solution but also the practical application of the principles involved. The book comprises 13 chapters, all but two of which, as stated above, are devoted to the calculus in its various forms and methods. There are chapters on differentiation, including an introduction, functions, rules and applications; two chapters on integration, with a short table of integrals. Mean values, and polar co-ordinates have a chapter each. Simple differential equations and applications of the calculus receive quite complete treatment, and a short chapter is devoted to harmonic analysis. These, together with chapters on spherical triangles and mathematical probability complete the list.

Mathematical treatises, including those particularly designated for "Engineers," for the most part are of interest and value (1) to students in engineering shools. and (2) to designing engineers solving problems for construction work. The matter in the book under review, however, should be of practical use and benefit to a much larger class and is well worth inclusion among the reference books of the library of the practicing engineer to help him to solve some of his problems more easily and accurately than by approximate methods of arithmetic or the longer route of algebra.

British and American Viewpoints

REVIEWED BY R. FLEMING
American Bridge Co., New York City

STRUCTURAL STEEL WORK: Relating Principally to the Construction of Steel-Framed Buildings—By Ernest G. Beck, Wh. Ex., Assoc. M. Inst. C. E. New York and London: Longmans, Green & Co. Cloth; 6 x 9 in.; pp. 462; illustrated. $7.50.

The 13 chapters of this somewhat bulky volume are entitled: Materials, Stresses and Riveted Work; Elastic Lines and Deflections; Stanchions Axially Loaded; Stanchions Braced in Groups; Stanchions Laterally and Excentrically Loaded; The Design of Stanchions; Beams and Girders; Roof Trusses; Roof Trusses with Knee-Braces; Examples of Knee-Braced Roof Trusses; Roof Trusses with Knee-Ties; Multiple-Bay Knee-Braces; Design of Roof Framing. A few tables and an index complete an octavo book of nearly 500 pp.

The author is verbose and often gives pages to a topic which an American author would cover in a few lines, if he discussed it at all. For instance, the chapter of 25 pages on roof trusses with knee-ties is given to knee-braces made of flat bars and capable of acting only as ties.

A college professor of structural engineering would be interested in the novel presentation of the Section Modulus, Moment of Inertia and Radius of Gyration. He might also wish to examine critically the chapter on columns laterally and eccentrically loaded in which the author believes he has given the first published correct investigation of the probable distribution of the wind force between the two columns of a building bent.

An American manufacturer would protest vigorously if asked to follow some of the details shown. Angles are bent romorselessly. (See Fig. 99, 100, 101, 121.) It may be said that most British textbooks show angles bent in ways that would not be tolerated in American shops. In discussing a channel column laced with 2½ x ⅜-in. flats and ⅞-in. rivets (Fig. 42) the author says: "Some designers also use one rivet instead of two where the lacing bars meet on the channel flanges, lapping the bars instead of butting them. This the author strongly disapproves, on account of the extremely severe loading thrown upon the single rivet." This detail is not uncommon in Great Britain—it is shown also in Morley's classic "Theory of Structures."

Many of the methods of calculation throughout the book are not *workable* in actual practice. This, with its narrow scope, confirms the reviewer in his opinion that to an American engineer the book is of little value either for practical guidance or for reference.

In strong contrast to the reviewer's conclusion are the opinions expressed in the book reviews of British periodicals. The staid *Engineering* makes two or three trifling criticisms and ranks the book, "a very excellent piece of work." It also says: "This book will be found distinctly useful to those engaged in practical design" ". . . for sound good sense the author's treatment of his subject will be hard to beat." *The Surveyor* concludes its notice with: "It is a very practical an-

useful book, and with the great expansion of industrial workshops to which we are looking forward, it should prove of great value to designers of steelwork, whether as engineers, architects or students." *The Practical Engineer* says but little, but that little is not unfavorable. *The Technical Review* is somewhat discriminating and concludes with: "We can commend this work to the man who is not satisfied to use the ordinary tables and desires to understand how the formulæ in general use have been obtained. If he is equipped with adequate mathematical training, he will then find this work a very useful guide." *Mechanical World* concludes its review with: "The book is one which we can commend with confidence as a thoroughly sound treatise on the subject."

What are the reasons for the wide difference between British and American viewpoints regarding the design of steel structures? There are excellent British books on structural design but the majority of them have little to interest the American engineer. From the American standpoint questions may be asked: Why do some British writers prefer algebraic methods where graphic methods are simpler and more quickly performed? Is entering into minutiæ to the *n*th degree thoroughness or dilettanteism? Why is there such a clinging to precedent and reluctance to change, as evident in many details of construction being repeated for a generation? Why do not British periodicals record and illustrate failures? Or, are there no failures of steel structures in Great Britain? Why are British engineers, writers and manufacturers so slow to adopt things American? Equally suggestive questions can probably be asked from the British standpoint.

A full discussion and comparison of British and American literature on structural design cannot be made within the limits of a book review. An appraisal of their relative merits by a competent engineer with an experience in both countries would be welcome.

Publications Received

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be obtained without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or, in case of books or papers privately printed, then to the author or other persons indicated.]

CAPILLARY MOVEMENT OF SOIL MOISTURE—By Walter W. McLaughlin, Senior Irrigation Engineer. Washington, D. C.: United States Department of Agriculture. Paper; 6 x 9 in.; pp. 70; illustrated. 15c. from Superintendent of Documents.

CASING TROUBLES AND FISHING METHODS IN OIL WELLS—By Thomas Curtin. Washington, D. C.: Bureau of Mines. Paper; 6 x 9 in.; pp. 48; illustrated. 15c. from Superintendent of Documents.

CENTRAL ELECTRIC LIGHT AND POWER STATIONS: Summary of the Electrical Industries, 1917. Washington, D. C.: Bureau of the Census. Paper; 9 x 12 in.; pp. 184; illustrated.

ENGINEERS UNITE: High Spots in the Washington Organizing Conference of the Federated American Engineering Societies, June 3-4 as Reported and Interpreted by the Editors of the Technical Press. New York: McGraw-Hill Co., Inc. 8 x 12 in.; pp. 64.

THE FLOW OF WATER IN DRAIN TILE—By D. L. Yarnell, Senior Drainage Engineer, and Sherman M. Woodward, Professor of Mechanics and Hydraulics, State University of Iowa. Washington, D. C.: United States Department of Agriculture. Paper; 6 x 9 in.; pp. 49; illustrated. 25c. from Superintendent of Documents.

THE FLOW OF WATER IN DREDGED DRAINAGE DITCHES: The Results of Experiments to Determine the Roughness Coefficient, n, in Kutter's Formula—By C. E. Ramser, Senior Drainage Engineer. Washington, D. C.: United States Department of Agriculture. Paper; 6 x 9 in.; pp. 60; illustrated. 30c. from Superintendent of Documents.

GEODETIC SURVEY OF CANADA: Report of the Superintendent for the Fiscal Year Ending March 31, 1919. Ottawa, Can.: Geodetic Survey of Canada. Cloth; 7 x 10 in.; pp. 77; illustrated.

GRAVITY AND PRESSURE TANKS AND SUPPORTS. CONCRETE RESERVOIRS AND VALVE PITS. Boston, Mass.: National Fire Protection Association. Paper; 3 x 5 in.; pp. 96; illustrated.

HISTORY OF THE TWENTY-SIXTH ENGINEERS (Water Supply Regiment) IN THE WORLD WAR: September, 1917 to March, 1919. For Sale by H. J. Angell, Goulds Mfg. Co., 16 Murray St., New York, N. Y. Cloth; 6 x 9 in.; pp. 258; illustrated. $2.

Reprinted from the December, 1919, Journal of the New England Water Works Association. Besides the story of the regiment as a whole there are sketches of each of the six companies, of the headquarters and medical detachments, and of various officers. Halftone plates, maps, diagrams and cartoons add to the interest of the History.

HOUSE WIRING: A Treatise Describing and Illustrating Up-to-Date Methods of Installing Electric Light and Power Wiring, etc.—By Thomas W. Poppe, Electrical Engineer. New York: The Norman W. Henley Publishing Co. Paper; 4 x 6 in.; pp. 208; illustrated. $1.

AN IMPROVED FORM OF WEIR for Gaging in Open Channels: Results of a Research Supported by Engineering Foundation—By Clemens Herschel, Past President of American Society of Civil Engineers. Reprinted from *Mechanical Engineering*, the Journal of the American Society of Mechanical Engineers, February, 1920. New York: The Engineering Foundation, Engineering Societies Building. Paper; 7 x 10 in.; pp. 26; illustrated.

INDUSTRIAL CODE: Rules as Amended Relating to the Construction, Installation, Inspection and Maintenance of Steam Boilers. New York: Bureau of Industrial Code. Paper; 6 x 9 in.; pp. 148; illustrated.

LOCOMOTIVE DESIGN IN RELATION TO GRADIENTS AND CURVES—By R. K. Biernacki, C. I. E., I. S. O., Late Locomotive Superintendent, North-Western Railway and P. G. Royal-Dawson, M. I. C. E., Chief Engineer with the Railway Board. Simla, India: The Board. Paper; 8 x 13 in.; pp. 31; illustrated. 1 rupee, 4 annas.

There is little of practical value to the American engineer on this important subject, since it deals mainly with special types of articulated locomotives on narrow gage lines (24-in. to 42-in. gage) with steep grades and sharp curves.

MICHIGAN DEPARTMENT OF HEALTH: Report of the Commissioner for the Fiscal Year Ending June 30, 1919. Lansing, Mich.: The Department. Cloth; 6 x 9 in.; pp. 196; illustrated.

NOTE ON LOCOMOTIVE DESIGN: As It Affects the Bridge Engineer—By C. W. Anderson, M. Inst. C. E. Simla, India: Railway Board of India. Paper; 8 x 13 in.; pp. 5; illustrated. 6 annas.

NOTES ON CAST-IRON SLEEPERS—By A. Lines, Deputy Chief Engineer, Eastern Bengal Railway. Simla, India: The Author. Paper; 8 x 13 in.; pp. 15; illustrated. 6 annas.

Discusses the relative merits of half a dozen forms of cast-iron ties in use in India.

PUBLICATIONS OF THE UNITED STATES RECLAMATION SERVICE: Including Publications from Other Sources Relating to the Reclamation Service. Washington, D. C.: U. S. Reclamation Service. Paper; 6 x 9 in.; pp. 95.

SEWAGE EXPERIMENTAL INVESTIGATIONS AT WEST NEW BRIGHTON, STATEN ISLAND, N. Y.: Report by Warren R. Borst. Staten Island, N. Y.: Hon. Calvin D. Van Name, President of the Borough of Richmond. Paper; 7 x 10 in.; pp. 131; illustrated.

THE SHIPPING ACT AND MERCHANT MARINE ACT, 1920: Suits in Admiralty Act, Emergency Shipping Legislation and Other Laws, Proclamations and Executive Orders Relating to the Shipping Board and Emergency Fleet Corporation. Washington, D. C.: The Corporation. Paper; 6 x 9 in.; pp. 151.

STATISTICAL ABSTRACT OF THE UNITED STATES, 1919. Washington, D. C.: Department of Commerce. Cloth; 6 x 9 in.; pp. 864. 50c. from Superintendent of Documents.

STATISTICS OF RAILWAYS IN THE UNITED STATES: Report, 1917. Washington, D. C.: Interstate Commerce Commission. Cloth; 9 x 12 in.; pp. 533.

TIMBER DEPLETION AND THE ANSWER: A Summary of the Report on Timber Depletion and Related Subjects Prepared in Response to Senate Resolution 311. Washingon, D. C.: United States Department of Agriculture. Paper; 6 x 9 in.; pp. 16. 5c. from Superintendent of Documents.

TURBIDITY STANDARD OF WATER ANALYSIS—By P. V. Wells, Associate Physicist, Bureau of Standards. Washington, D. C.: Dept. of Commerce. Paper; 7 x 10 in.; pp. 28; illustrated. 10c. from Superintendent of Documents.

WATER SUPPLY AND SEWAGE DISPOSAL FOR COUNTRY HOMES—By E. J. McCaustland, Director of the Engineering Experiment Station, University of Missouri. Rolla, Mo.: The Station. Paper; 6 x 9 in.; pp. 36; illustrated.

Letters to the Editor

President A. P. Davis Urges Passage of Am. Soc. C. E. Amendments

Sir—The "Appeal" of Aug. 30, put out in an effort to defeat the pending amendments to the constitution of the American Society of Civil Engineers, makes a series of utterly unfounded charges:

A. Contrary to the statement of the "Appeal," the amendments criticized, with the exception of amendment F, do represent the mature views of the Committee on Development, a very representative body, and they represent the wishes of a large majority of the society as expressed in the votes on these questions in the questionnaire of last spring. They were not "railroaded" through the Portland convention, but, on the contrary, were debated at length, with no limit on the length or number of times any member should speak. The vote was not taken until debate voluntarily ceased, and the submission of the amendments was ordered by a vote of 73 to 13. All these amendments were considered and co-ordinated by a committee of the convention created for the purpose, and were passed substantially as reported by that committee, except for a few minor changes to improve the wording.

B. The "Appeal" charges that the amendments are vague and unco-ordinated and contain inconsistencies, but points out none of these alleged defects. If, after weeks of work on an effort to discredit them, the partisan author of the "Appeal" could find no basis for these charges, it is fair to assume none exists.

C. It is charged that the amendments tend toward the establishment of a political machine, which is exactly contrary to the fact. Their tendency is to increase the influence of the local sections and to decrease the power of the metropolitan machine.

D. Contrary to the statements of the "Appeal" they commit the society to no additional expense. The objections in paragraphs D and E of the "Appeal" absolutely cancel each other. Both cannot be valid.

Amendment F is designed to ameliorate the unfairness of the present representation on the Board of Direction. The number of members in District 1 entitles that district to about two and a half times the representation of each of the other districts, but instead of having two or three directors it has six, while each of the other districts has one. In addition to this, the present constitution requires one vice-president, the secretary, and the treasurer to reside in District 1, and each of these officers is ex-officio a member of the Board of Direction, thus giving that district virtually nine directors, whereas it is entitled at most to three. Amendment F corrects this by reducing the number of directors from District 1 to three, removing the requirement that a vice-president must be selected from that district and that the secretary be a member of the board. The treasurer, as now, remains a resident member of the board. This gives District 1 four members instead of nine, which is certainly liberal in view of its equitable title to less than three. The amendment contains only the necessary words to accomplish these purposes, and no inconsistencies, as any intelligent person may judge for himself by reading. A vote against amendment F is a vote to continue the unfair domination of a minority and an injustice to all the other districts.

The committee mentioned in the "Appeal" which was appointed in Portland and which the "Appeal" proposes to depend upon for "progressive" action was named entirely by one of the most extreme reactionaries and elected by the reactionaries who were in a small majority at the meeting of the directors in Portland. The progressive directors voted against it. This committee can be depended upon to bring in nothing of a progressive tendency. The defeat of these amendments means defeat of progress for an indefinite period. Al' real progressives should vote for all the amendments except D and E which relate to other matters. Votes already in can be withdrawn and changed.

It is hoped that no one will be intimidated by the threat to involve the society in protracted strife and litigation if these amendments be approved.

ARTHUR P. DAVIS,
President, American Society of Civil Engineers.
Riverton, Wyo., Sept. 7.

Plea for the "Annual Conference"

Sir—It is impossible to get together at either the annual meeting or the annual convention of the American Society of Civil Engineers an attendance representative of the membership as a whole. As a result the "mass-meeting government" provided by the present constitution, in the supreme authority given to the annual meeting and the annual convention, which would be ideal in a small society, is now totally inappropriate, for the "mass meeting" is never representative of any but the members in the immediate vicinity of the place where the meeting is held, or of a few devoted ones who make a commendable practice of attending all such meetings.

Whatever opinion one may hold as to the past government of the society, he must recognize the fact that that government, good, bad, or indifferent, has been a government by a small body of members, centered in and taking its inspiration from New York City. In saying this the writer attributes no ulterior motive to those who have guided the society's destinies, and believes that the result is the only one that could be expected under the present constitution. Somebody had to control the society's affairs and the men who were on the ground necessarily did it. If criticism were aroused it vented itself in a stray communication to the press, or in a swiftly smothered protest at the annual meeting, which, with one possible exception, has always been dominated by the New York membership, and has usually settled controversies by referring them to the board of direction.

Criticism at the annual conventions has fallen on deaf ears for the reason that few if any of those present were sufficiently informed upon society matters to be interested in the questions arising out of them.

This condition has discouraged many an energetic member who, realizing the impossibility of finding a place in the councils of the society without acquiescence in the dominant policies, has directed his interests elsewhere, and it has resulted that the board of direction, with its preponderant minority of New York members, has been, and under the present constitution will ever be, a non-representative body so far as the sentiment of the membership outside of New York is concerned.

The time has come when the society, if it is to be national in scope and spirit, can no longer be a local New York organization. The rumors of discontent which led first to the formation of local associations, then to the creation of the Committee on Development, and finally to the action at Portland, plainly indicate that a very considerable part of the membership outside of New York is dissatisfied with present conditions.

In order that the society may become truly national it must provide a *nationally representative body* to replace the *local mass-meetings* of the present constitution. If the membership of the society cannot attend the annual meeting and the annual convention, it can at least send accredited delegates to represent it, who by their association with the members at home can present their ideas and policies, and that is exactly what is contemplated in that portion of Amendment G applying to Article VIII of the Constitution which provides that:

"There shall be held during the Annual Convention a conference of representatives from the local sections to consider the welfare of the society and its members and to report thereon to the board of direction."

This plan, which contemplates an annual gathering of one hundred or more delegates from the several local associations, coincides with that adopted by the Federated American Engineering Societies, wherein a similar gather-

ing of society representatives constitutes the American Engineering Council, meeting annually and outlining the policies to be followed by the executive board.

Will the membership forget personal antagonisms and decide the question of the continuance of the old system or the adoption of the new after a careful study of the situation on its merits?

The society membership like the citizenship of the Nation may be divided into three classes:

1. A comparatively small group which takes an active interest in its affairs and is ever ready to assist in their direction or to oppose their misdirection.
2. A much larger group which consists of those who do not follow closely the business of the society, but rely upon the guidance of some "bell-wether," usually of the first group, to lead them when questions are submitted to a letter ballot.
3. By far the largest group, probably a majority of the membership, which is composed of those whose only interest in the society appears to be to wear its badge, to receive its publications, and to see their names in the list of members. This group appears to comprise at least 53 per cent of the membership as that number failed to reply to the last questionnaire.

Naturally the first group is divided between Progressives and Less-Progressives, and the second group follows the first in about the same relative proportions. The third group makes it possible for a few members to distribute new ballots in the last three or four days of a canvass and double the vote of any district. It constitutes in the society what corresponds to the "pocket boroughs" of British politics and the "floating vote" in our own, and is the greatest menace to the society's welfare.

Can it be persuaded to vote intelligently?

The amendment to the constitution designated "E" seems to the writer open to objection. This amendment provides, "No member of the nominating committee shall, during his term of office, be a candidate for any other office in the society."

The first objection to it is that if the amendments designated "F" and "G" are passed there will be no longer a "nominating committee" and hence the amendment is superfluous. The second objection to it is that if it be adopted and amendments "F" and "G" be rejected it will tend to prevent the most representative and best qualified members of the society from going on the "nominating committee" or else render them ineligible to membership on the Board of Direction. Therefore it is the writer's judgment that amendment "E" should be rejected.

In the interest of a more democratic or republican organization of the Society, which seems to be the expressed wish of a majority of the members, the writer endorses Amendments "A," "B," "C," "F" and "G."

Ann Arbor, Mich., Sept. 2. GARDNER S. WILLIAMS.

Computing Cross-Sections By Co-ordinates

Sir—The method of computing cross-sections as given by J. A. MacDonald in *Engineering News-Record*, July 22, 1920, p. 152, is by far the neatest and most direct method which has so far been proposed. I well remember the tedious days spent in calculating cross-section areas by the old method of trapezoids, and determined then to find some process more direct and simple with which to attain the same end. Taking up the subject of rectangular co-ordinates and applying it to railway cross-section areas, I came to the very same result that has been so clearly stated by Mr. MacDonald.

I do not know the custom on Canadian railroad surveys, but on American roads the cut or fill is usually ascertained on the center line first. This puts another term in the field notes, and indicates the center line at once, which is important, as the distances out, with one each side of the center, are added to obtain their difference or distance apart. If a sketch of each cross-section were drawn and placed before the computer it would be a guard against mistakes; but a sketch of every cross-section for 1,000 miles of road would be expensive in time and money. Without such a sketch, in going over page after page of field notes the mind grows weary and errors would most likely occur. If, however, the cut or fill for the center is interposed, the field notes will appear as follows:

$$\frac{-8}{22}\quad\frac{-6}{15}\quad\frac{-4}{12}\quad\frac{-5}{7}\quad\frac{-3}{0}\quad\frac{-2}{6}\quad\frac{-9}{12}\quad\frac{-6}{19}$$

The end terms for grade at edge of roadbed can be supplied mentally. The — 3 is not absolutely correct, but is taken to keep the fill in whole numbers. Although one more multiplication is necessary, yet only once do the distances out have to be added, while addition is performed twice otherwise.

The above idea is in no sense a criticism of Mr. MacDonald's method, but offered as a suggestion to guard against possible errors in computation.

It will be noticed that there are really two problems separated by the center line, but which are made one by adding together the distances out on each side of the center. As the center line is the origin of abscissae, it is more convenient to compute each way from the center.

When there is only one rod reading taken outside the edge of roadbed, it is often convenient to take one at the edge, as then the outside cut or fill multiplied by O cancels out; also it is sometimes convenient to know the distance above or below grade at this point. One of the situations where this method of calculating areas is most convenient is where there are both cut and fill in the same cross-section, taking care to follow the surface of the ground as it passes through the grade point.

The abscissae can be multiplied into the difference between the adjoining ordinates, but Mr. MacDonald's method is much neater and simpler, as a grade reading terminates a problem and calls attention to the fact so plainly that every chance for error is reduced to a minimum. This same method can also be used to find the contents in cubic yards directly without computing the cross-section areas at all, which is economy in both time and vexation of spirit. B. A. WAKEFIELD, C.E.

Webster, Mass., Aug. 14.

Engineers in Railroad Wage Award

Sir—I have noted the letters of W. H. Hobbs and Robert H. Baldwin published in the August 26th issue of your publication on pages 424 and 425, relative to "Engineers in Railroad Wage Award."

I have been in conference with various members of the U. S. Railroad Labor Board and I do not agree with the statement that "discrimination was used against the engineering profession."

No action has been initiated toward making an appeal to the Board in view of the adjustments for men in engineering positions that are now being made by the majority of the railroads throughout the United States, most of them after conferences with the sections of the American Association of Engineers on these roads. These increases average 20 per cent and in many cases are bringing satisfaction. Among the roads that have made this adjustment are the New York Central lines, Chicago and North Western, Illinois Central Railroad, Hocking Valley, Pennsylvania, and Southern Pacific. Other roads have indicated their intention of taking similar action, among them being the Chicago, Milwaukee and St. Paul, Santa Fe, Chicago, Rock Island and Pacific, and Pere Marquette.

The salary situation is being studied carefully, charts prepared and data compiled which will reveal to the public the surprisingly low salaries that are being paid to technical men as compared to men in other branches of railroad service, and this data is being presented to the railroad managements. Later on it is probable that some of it will be offered for publication in the columns of the technical press.

It must be remembered that by negotiations direct with the railroad managements, last year increases in salaries of railroad engineers were obtained by the American Association of Engineers amounting to over $5,000,000 annually. It is hoped, and indications now point to a satisfactory and

co-operative adjustment for present needs. The American Association of Engineers and its members desire to work loyally with the managements. Team work beats contention every time.

On the other hand patience ceases to be a virtue at a certain stage. Managements that fail to make proper adjustments in a reasonable time will have their case laid before the Wage Board. E. L. BRANDT,
Assistant Secretary, American Association of Engineers, in charge of the Railroad Department.

Chicago, Sept. 2.

Sir—"To be or not to be, that is the question" Walter J. Sykes raises in his letter on page 279 of your issue of Aug. 5 with regard to engineering departments of railroads. The Labor Board's decision on July 20 is a report covering twenty pages. The opening sentence of the report is as follows: "This decision is upon a controversy or dispute between the organizations of employees of carriers and the carriers named below." Mr. Sykes observes that no salary or wage awards were granted to the technical employees of the engineering departments, and he desires to know why some one of the 57 varieties of engineering societies did not plead the cause of the technical men before the Board. Mr. Sykes' observation is correct, and his question a perfectly fair one.

The Board does not even mention the technical men. It grants increased pay to those employees only whose organizations were parties to the controversy. There were some 18 organizations, parties to the dispute on the employees' side, and some 313 railroad companies, parties to the dispute on the employers' side. There are over ten thousand technical railroad engineering employees, but they were not parties to the dispute, and were not considered by the Board. The Board stayed within the law that created it, and if it had decided other cases than those of parties to the dispute, it would have gone outside its jurisdiction. This is the reason also why the Board refused to grant a hearing to the Switchmen's Association on strike.

Then the law is to blame? Perhaps. But the writer ventures to assert that not 1 per cent of the ten thousand technical railroad employees took any active interest in the law while it was being passed by Congress. This assertion is not meant for censure, because if an engineer were to keep himself informed with regard to the doings of Congress he would have no time left to do engineering. He has elected representatives to make his laws for him. He certainly should pay some attention to his selection. Our representatives should be pre-eminently men and women who serve the common good. If we have a bad law, look to the men who made it. To do this, all people in all walks of life must devote sufficient of their time to these important matters which vitally affect the common good, or suffer the consequences. If 90 per cent of the people act upon the principle that self interest is best promoted by promoting the common good, and 10 per cent ignore this principle—and in their shortsightedness act contrary to it while the former are too busily engaged in their daily occupations to prevent a large majority of our so-called representatives from being chosen from the group who ignore the common good—then all together everybody must suffer the consequences. The statutory law has been made and the personnel of the Board selected by which the 18 organizations of employees obtained an average increased rate of pay of about 22 per cent while the 313 organizations of employers an increased rate of charges of about 40 per cent. The show was all staged, and those who procured tickets got seats, the others stayed out. The technical men got no tickets.

As Mr. Sykes says, "Why was this?" Why didn't the organizations do something? The principal engineering societies are organized to promote scientific and technical knowledge. As such, they have no business going into other lines of endeavor. There are a few non-technical organizations of technical men who claim to be formed to promote economic welfare. There could very properly exist an organization of technicians consisting of several distinct departments--one a technical department of applied science, one a department of pure science or theory, etc., and one a department of economic welfare. There could be sub-departments, as civil, mechanical, electrical, etc. The writer does not know of such an organization in America today, although several may be aiming that way. The Federation of Engineering Societies recently formed may develop along these lines. It is the writer's understanding that at least two of the present organizations of technical men, whose announced purpose is economic welfare, did request a hearing before the Board and were refused, because they had not complied with the law, which requires that the organized employees must have first presented their grievances to their employers and have failed to come to an understanding, before the Board is entitled to hear the case; also they must not be on strike when coming before the Board.

Some engineers like to expatiate upon the saying that "technical men are neither capital nor labor but stand between these two groups in society as professional men." It is true that they are neither capital nor labor. Nobody is either one or the other of these things. Robinson Cruso made a boat. This simple sentence tells what capital and labor are, and neither of them was possible on that lonely island without Robinson Crusoe or some one else. The law doesn't require the Board to hear disputes between capital and labor. There are no such disputes. But it does require the Board to hear disputes between railroad employees (organized) and railroad employers (organized). Are the railroad technical men employers, employees, or professional men? An employee sells his services to an employer for salary or wages. A professional man sells his services to a client for a fee. Anyone knows that the vast majority of railroad technicians are employees. They must therefore form an employees' organization; present their requests for increased pay before their respective railroad companies, and be denied before they can under the law have their case decided by the Board. It is up to the railroad technical employees themselves. Will they meet the requirements of the law, or will they chase after some other hope?

Chicago, Sept. 3. C. A. COTHER.

Sir—I have read Walter J. Sykes' letter published on page 279 of the *Engineering News-Record* of Aug. 5, 1920.

The technical engineers on the railroads deserved to be neglected. Any group of men who, after the experience of the last six years, do not know that force is the one thing that counts in the case of large industrial corporations dealing with their employees, and who have not the intelligence to understand that "In union there is strength," ought to be neglected; especially when these technical engineers have had the example of the locomotive engineers before their eyes for so many years.

I have another charge to make against these technical engineers on the railroads; and elsewhere. Evidently they care very little for the present comfort and the future of their wives and children, those of them who have any, for otherwise they would go out and seek a decent living for them, as have the members of the Brotherhoods, the bricklayers, carpenters, plumbers, street cleaners, and others.

How much longer are the so-called intellectuals going to be contemptible mollycoddles, supplicating individually for the right for themselves and their families to live, instead of demanding it collectively, along with, and side by side of the coal heaver, the miner, the transport worker, and other more humble members of the army of production.

CHARLES A. MULLEN,
Consulting Paving Engineer.

Montreal, Sept. 4.

[The doctrine advanced by Mr. Mullen seems to have fairly wide acceptance, but that does not make it correct. Standards are being too widely abrogated the world over. If professional men cannot keep their heads, cannot be relied on to stick to high standards, we shall sink to a very low order. "In union there is strength," is sound doctrine, but it does not necessarily mean that force must be employed. The A. A. E. has got results and it has not used threats or force, nor has it allied itself with the coal heaver, no matter how excellent an individual he may be. EDITOR.]

NEWS OF THE WEEK

New York, September 16, 1920

Constitution Adopted for Minnesota Engineering Federation

The Minnesota Joint Engineering Board and representatives from the five local engineering societies and the state chapters of all engineering and architectural organizations met at the University of Minnesota, Sept. 10, and adopted the constitution for the proposed Minnesota Federation of Engineering and Architectural Societies. The constitution follows the lines laid down in the resolution published in *Engineering News-Record* of July 1. Any society in the state, possessing local autonomy, may become a member society upon ratifying the constitution.

The board of directors of the federation will have complete power to act on all matters of public policy in the state affecting the two professions, and no society may take action contrary to that followed by the board. An annual convention is provided for the purpose of reading and discussing technical papers. The federation will publish a monthly bulletin in the interest of the federation and the member societies and will employ a paid secretary-editor. Headquarters will be in St. Paul.

The meeting was marked by a spirit of co-operation and a lack of factional strife, due, no doubt, to the encouragement given by Herbert Hoover, president of the American Institute of Mining and Metallurgical Engineers, at the recent convention of that organization in the Twin Cities. He stated that if the engineers of the state perfected their proposed federation, the force that would have the greatest influence on public welfare would be created.

Contractors Seek Views of Presidential Candidates on Construction

Each of the presidential candidates is being pressed by the Associated General Contractors of America to express himself on the construction problem which faces the nation. General R. C. Marshall, Jr., general manager of the Associated General Contractors, classes the construction problem as second only to the production and distribution of food and fuel.

Some time ago General Marshall requested of the chairmen of the two national committees that the position of the party with reference to the construction problem be set forth by the presidential candidates. Apparently this request has not been complied with and General Marshall now has taken the matter up directly with the two candidates.

To Discuss Standard Sizes and Grades of Lumber

The National Lumber Manufacturers' Association, through its Engineering Bureau, will hold a joint conference of distributors and consumers of lumber, Sept. 28 and 29 at the Congress Hotel, Chicago, to discuss suitable standard sizes and grades. C. E. Paul, construction engineer of the Engineering Bureau, has conducted a comprehensive research on the subject in cooperation with the Forest Products Laboratory, Madison, Wis., and with lumber and technical organizations with a view to devising a complete scientific schedule of standards which will best serve the needs of wood users at the least inconvenience to the manufacturer. Mr. Paul's recommendations embodied in a "Table of Association and Recommended Standard Sizes" will be discussed. Copies of the table may be procured on request to the Engineering Bureau, McCormick Bldg., Chicago.

Addition to Letter of President Davis, Am. Soc. C. E.

From Arthur P. Davis, president of the American Society of Civil Engineers, has been received, by telegraph, the following paragraph which arrived too late to be added to his letter published on p. 570 of this issue.

"There is no merit in the objection recently raised that the reduction in the number of directors is inconsistent with the requirement of Article 3 that 25 votes are necessary to elect a member of the society. Amendment F specifically provides that all officers of the society at the time of the adoption of this amendment to the constitution shall continue to serve on the Board of Direction to the end of the terms of office for which they were elected. This provides abundant opportunity for the modification of Article 3, if necessary, before the reduced number of directors can become embarrassing. The adoption of Amendment F will affect only one of the recent nominees for director from District No. 1, and the procedure in that case is governed by the provisions of Article 7 Section 7. No embarrassment is involved."

Increase in Motor License Object of New Jersey Bill

A bill is to be introduced in the New Jersey Legislature designed to increase the revenue from motor vehicle licenses from $1,900,000 to about $3,500,000 yearly, so that the state can secure additional funds for the building and repairing of roads. The Trenton Chapter of the American Association of Engineers is urging the bill's passage.

New England Water-Works Men Hold Annual Meeting

Convention at Holyoke Well Attended —Long List of Technical Papers Presented and Discussed— Committee Reports

More than two score technical papers, several committee reports, exhibits and entertainments by the Water Works Manufacturers' Association, hospitality by the Holyoke water-works and other city officials and an attendance of three hundred or more were features of the thirty-ninth annual convention of the New England Water Works Association at Holyoke, Mass., Sept. 7 to 10. Abstracts of a number of the papers appear elsewhere in this issue and others will follow.

Committee on Standard Specifications for Cast Iron Pipe—Frank McInnes, Boston, chairman, reported that following the deadlock with the pipe manufacturers in 1917 little was done by the committee. Recently he and another member of the committee visited several pipe foundries in the south and found a willingness to co-operate with the committee. Several tests bearing on mooted questions are to be made by the manufacturers. Some possible changes in making pipe were noted in the report, including the use of an electric furnace to produce iron of greater tensile strength. The committee expects to maintain close touch with pipe makers on the one hand and on the other to learn from pipe users competent to judge what their opinions are as to the proposed changes in existing specifications, particularly as to uniform outside diameter of pipe.

Committee on Revenue from Fire Service—Through W. C. Hawley, Wilkinsburg, Pa., chairman, this committee submitted a final report recommending that there should be a charge for private fire protection based on the cost of the service—in other words, a capacity charge. One of the two representatives of the fire insurance companies agreed to the general conclusions of this report but it was understood that the other would submit a minority report. In view of this probability, the convention decided to continue the committee until the minority report can be presented at one of the winter meetings.

Committee on Rainfall and Run-Off Measurements — Robert E. Horton, Voorheesville, N. Y., submitted a final report giving many data supplementary to those on yields of smaller New England streams published in the 1914 report of an earlier committee. Each

record was accompanied by a statement of governing conditions. Some evaporation records were included in the report.

Other Committee Reports—A progress report on assessments for water main extensions was submited by Caleb M. Saville, chairman. A preliminary report by the committee on uniform accounting, Albert L. Sawyer, chairman, Haverhill, Mass., included an outline of a simple system of water-works accounts, based in part on a study of state utility commission forms and suggestions by the U. S. Census Bureau. The report will come up for discussion at one of the winter meetings of the association.

The committee on the use of bonds instead of certified checks to accompany contract bids recommended the passage of a resolution by the association favoring such a substitution, the difference between the lowest bid, if withdrawn, and the contract award finally made to be collected on the bond. The discussion on the recommendation showed a division of opinion as to the wisdom of the recommendation. One member stated that deposit of a check provides cash while a bond means a lawsuit if a contract awarded is not executed by the bidder. Objection was also made to the proposal to collect the difference between the bid withdrawn and the award finally made, it being held that this might prove unfair in some cases. Action on the recommendation was postponed to one of the winter meetings.

Massachusetts Typhoid Record—Under the title (chosen by the Program Committee) "Innocence or Repentance in Drinking Waters," Henry W. Clark, chemist, Massachusetts, State Department of Health, Boston, reviewed the decline of typhoid fever in Massachusetts during the last 35 years from 45 to 2.5 deaths per 100,000 population. This record has been made with comparatively little of either filtration or chlorination. Water supplies have been improved and safeguarded and untreated sewage has been excluded from streams used for public water supplies. Without knowledge of the contents of Mr. Clark's paper, a written discussion of it was sent in by George A. Johnson, New York City. Mr. Johnson took the Massachusetts State Board of Health to task for its conservatism as to filtration and chlorination. He urged that there is and can be no insurance against pollution of water supplies and that the record thus far shown is due more to the grace of God than to the activities of the state health authorities. Mr. Clark replied, in the words of Daniel Webster, "Massachusetts stands on its record." He also said that neither he nor the State Department of Health is opposed to filtration or chlorination where they are needed.

Studies of Color in Water—Extended studies of color in a large new storage reservoir and in feeders to the reservoir, all a part of the water supply of Hartford, Conn., were presented by Caleb M. Saville, chief engineer of the Hartford water-works.

In this paper various reports by experts, made before the reservoir was built, were summarized. The studies have borne out the opinion of the late F. P. Stearns that "entering water conditions" (the term used by Mr. Saville) in a reservoir as large as Nepaug, the one in question, exert little influence on color within ordinary limits and indicate that this reservoir, like others, will show considerable color improvement as time passes and the reservoir gets "conditioned."

Unaflow Pumping Engine—Continuing his earlier papers before the New England and the American waterworks asociations, D. A. Decrow, of the Worthington Pump & Machinery Corp., New York City, read a paper on "Further Tests of the Unaflow Pumping Engine," relating to a simple test unit at Buffalo, N. Y. High speeds and duties have been maintained, the latter running to and above 150,000,000 ft.-lb. per 1,000 lb. of steam, calculated from plunger displacement. A compound unit is now being built for installation elsewhere.

A New Type of Reinforced-Concrete Pipe—A proposed new type of reinforced concrete pipe was described by George C. Bartram, United Concrete Co., New York City. The pipe is modelled somewhat upon the old cement-mortar encased wrought-iron pipe used quite extensively in New England some years ago, but the steel cylinders of the new pipe are electrically welded longitudinally, then have longitudinal perforated strips welded on, inside and outside, these strips not only locking the wire or bar reinforcement to the steel cylinder, but also serving as spacers to the reinforcement. Sheet metal rings welded to the ends of the pipe lengths provide for contraction and expansion and help form bell and spigot joints. The ends of these rings are electrically welded, thus forming a continuous metal shell within the concrete. After this circumferential welding, the joints between two lengths of pipe are poured with concrete.

Trenching Machines — Satisfactory experiences with trenching machines were reported by several members, led by George W. Batchelder, water commissioner, Worcester, Mass. A. E. Martin, Springfield, reported the recent purchase of a gasoline power machine for $7,200, plus freight. Besides use for trenching, this machine has been used to remove a 16-in. pipe and to lower a 30-in. main.

In an address, Henry V. Macksey, president of the association, suggested an interchange of water-works equipment by small departments. It was voted to refer the matter to the executive committee of the assoociation, with the suggestion that it act as a clearing house of information on equipment available for rent.

Commerce Chamber Makes Appeal to Car Users

An appeal was made Sept. 9 by the Railroad Committee of the Chamber of Commerce of the United States in an open letter addressed to manufacturers and business men to join in making better use of existing railroad equipment as a means of providing immediate improvement in transportation service.

In part the statement of the committee says, "You can load and unload your cars promptly, if you will. As a rule the railroads allow you forty-eight hours free time to load your cars and forty-eight hours to unload them before any charge for demurrage. If you will use only one-half of this time, restrict your car order to today's program, avoid the duplication of car orders, and avoid the use of cars for storage purposes, you should be able to reduce the time that the average freight car spends in your hands from 37 per cent to 22 per cent of its total time, and thus add 360,000 cars to the available car supply."

Dexter Brackett Medal Awarded to Robert E. Horton

The Dexter Brackett Memorial Medal for 1919 was presented to Robert E. Horton, consulting engineer, Voorheesville, N. Y., on Sept. 8, at the annual convention of the New England Water Works Association at Holyoke, Mass., for his paper on the "Measurement of Rainfall and Snow." The medal is awarded annually to the author of the most meritorious paper, from the viewpoint of service, presented before the association during the previous year.

Road Materials Given Priority in Ohio

The Ohio State Highway Commission has secured from the Public Utilities Commission a ruling that road building materials will be given priority during the remainder of the year in order to speed up the road building program in the state. This order was secured when it was shown that road building projects in the state were being delayed by failure to receive supplies and materials. Open-top equipment under certain conditions will be furnished all contractors on state highway jobs and as a result much of the delayed highway work is going forward.

Minnesota Engineers To Back Licensing Bill

The committee of the Minnesota Joint Engineering Board on licensing of engineers and architects has prepared a bill for introduction into the Minnesota legislature this winter. The bill is similar to the model bill proposed by the committee of Engineering Council and has the backing of all engineering and architectural societies of the state.

New York Starts Pension System

Through an enabling act of the 1920 Legislature a pension system has been created, the support of which is to be shared equally between the City of New York and its employees. In the case of the administrative and technical forces it provides for optional retirement at the age of 60 and mandatory retirement at 70, with a pension allowance at the rate of one-seventieth of the average salary for the last ten years of service, for each year of service. It is thus made practicable for an employee to retire on a substantial annuity at a period in his life when he can really enjoy it.

The contributions to this fund, as explained by Arthur S. Tuttle, chairman of Engineering Council's committee on compensation of engineers, are graded according to class of service, age, and time of entrance into the city service, and range from about 4 upwards to a little over 7 per cent of the employee's salary. In case of withdrawal from the service for any cause, all contributions to this fund on the part of the employee are repaid, together with interest at the rate of 4 per cent. Incidental features of the plan include pensions for disability, life insurance to the extent of one-half a year's salary, and pensions to dependents in case of the employee being killed while in the performance of duty.

These latter benefits are paid for wholly by the city, which also assumes the burden of financing the operation of the fund for those now in the service up to Oct. 1, 1921, or such previous date as they may elect to avail themselves of it. Acceptance of the plan is optional on the part of present employees but is mandatory upon those who join the service after Oct. 1, 1920, when the system goes into effect.

Padding Road Estimates To Cover Bond Discounts Charged

Jesse E. Eschbach, chief examiner of the Indiana State Board of Accounts, issued a warning Aug. 26 to county surveyors and engineers against the padding of road estimates with an item to cover discount on bonds. Investigations recently disclosed that some engineers were including an extra item in their estimates to enable contractors to discount bonds which are not readily salable at 5 per cent, the legal rate of interest. Mr. Eschbach sent copies of the official forms for making estimates to the county officials and said that any attempt to include items not covered by the schedules will meet with prompt prosecution by the state.

S. N. Cragun, of the state board of tax commissioners, while hearing protests against road bond issues in southern Indiana recently, discovered several cases of alleged paddings of the engineers' estimates to cover bond discounts. He refused to approve the bond issues and called the matter to the attention of the State Board of Accounts.

Construction Under Way on Extensive Pit River Power Project

The Mt. Shasta Power Corporation, whose stock is owned by the Pacific Gas & Electric Co., has applied to the California Railroad Commission for a certificate declaring that public convenience and necessity require the development of the Pit River project in northern California. John A. Britton, general manager of the company, recently told the commission that his company has plans for hydroelectric power developments to cost a total of about $125,000,000, divided equally between power plants and distributing systems. The chain of developments in the Pit River region, a part of the general program, is to be carried out first. The work will involve seven plants, of which four are to be constructed now and the remainder as may be necessary.

Work started in July on two of the first four plants. These are known as Hat Creek No. 1 and No. 2 and they are to be finished by Jan. 1, 1921. These require no storage and only small diversion weirs will be used for diverting the flow. No. 1 will have 2,400 ft. of canal and 1,750 ft. of penstock developing 9,300 hp. on a 215-ft. head. No. 2, with a 4,750-ft. flume and a 400-ft. penstock, is to develop 12,300 hp. on a head of 195 ft.

The next two plants, Fall Creek No. 1 and No. 2, are just being started. They are to be completed in August, 1921. No. 1 requires 10,000 ft. of 14-ft. tunnel from which a short penstock will develop a 430-ft. head, giving 60,000 hp. No. 2 will take the tailrace water from No. 1 via a flume line to a point farther downstream when a drop of 100 ft. can be utilized to develop 18,000 hp. This makes a total of 99,000 hp. to be available by next fall from these four plants, all grouped closely together.

The three other plants, not to be constructed just yet, are all farther down on Pit River, and are to be known as Pit River Plants No. 1, No. 2 and No. 4 (No. 3 is an alternate plan not now being considered). No. 1 will have a 100-ft. dam and a tunnel line, developing 72,000 hp. on a 300-ft. head. No. 2 is to take tailrace water from No. 1 and after traversing a tunnel, develop 42,000 hp. on a 185-ft. head. No. 4 is to take the No. 2 tailrace water and after traversing a 7-mile tunnel, 20 ft. in diameter, develop a head of 932 ft. in a plant where the installed capacity is to be 232,000 hp. If present plans are carried out the latter plant would have turbines of record size. The units would be single runner vertical shaft type rated between 60,000 and 75,000 hp.

In all seven of these plants the water wheels are to be of the same type: vertical, single-runner units. The flow in the Pit basin is remarkably uniform, the seasonal variation on Hat Creek at No. 1, for example, does not exceed the range of 450 too 600 sec.-ft. At first the 60,000-volt transmission line of the California-Oregon Power Co. is to be used to deliver the power from these plants, but later on a two-circuit 220,000-volt line is to be built all the way to San Francisco.

Canadian Rate Decision Rendered

A decision authorizing an increase in freight rates in Canada of from 30 to 40 per cent was rendered at Ottawa, Sept. 9, by the Canadian Board of Railway Commisioners. Freight rates in Eastern Canada are increased 40 per cent, and in western Canada, 35 per cent, effective Sept. 13 and to continue in force until Dec. 31, after which time the increase in eastern Canada will be reduced from 40 to 35 per cent, and that in western Canada from 35 to 30 per cent. The flat percentage increase will not apply to all classes of low-grade tonnage, the increase on coal being an extra charge of from 10 to 20c. per ton.

Passenger rates were advanced 20 per cent until Dec. 31 when they will be reduced to 10 per cent for the ensuing six months, the present rates being restored July 1, 1921.

It has already been stated by Howard T. Kelly, speaking for the Railway Association of Canada, that it had been decided to grant wage increases on Canadian railroads that will meet the recent award of the Railroad Labor Board at Chicago.

Trustees of A. A. E. Investigating Purchase of Building

In accordance with action taken at the recent annual meeting of the American Association of Engineers at St. Louis, the trustees have been investigating and negotiating for the purchase of a building for the association. The City Hall Square Building of Chicago at a cost of about $1,000,000 has been considered. Purchase of a modern fireproof, twenty-story building to cost about $3,000,000 has also been investigated. Members of the association, except students, are asked to indicate an average subscription of $200 with a view to the purchase of a building of the $3,000,000 class.

Bureau of Pubiic Roads Begins California Road Survey

In response to the request of the California Highway Commission as noted in *Engineering News-Record*, July 15, p. 140, the U. S. Bureau of Public Roads nows has a staff of about twenty men at work in California under the direction of L. I. Hewes and T. W. Allen. In addition to the careful survey of the entire highway situation that these men will make, the California tained the firm of Howe & Peters, consulting highway engineers, who will also make a report covering the situation throughout the entire state. The Automobile Club of Southern California is participating in the investigation.

Serve Notice for New Idaho-Nevada Railway Route

Notice has been served upon the governors of Nevada and Idaho that a new line of railroad, to be known as the Idaho Central, will be constructed from Wells Nev. (on the line of the Central Pacific), to Rogerson, Idaho (on the Oregon Short Line), shortening the route between Nevada and California points and between Idaho, eastern Oregon, and Washington points approximately 400 miles. The proposed route is via Contact, Nev., covering a distance of 90 miles. The Interstate Commerce Commission has communicated with the Nevada and Idaho Public Service Commissions as to the issuance of certificates of public convenience. It is understood that the serving of notices on the governors and the action of the commission is to meet the requirements of the Transportation Act. The building of the line has been proposed from time to time for the past ten or fifteen years.

San Francisco May Buy Water-Works and Street Railways

City officials of San Francisco on Aug. 24 held a conference at which it was decided to submit to ballot at the November election two charter amendments which, if adopted, will give the city the right to purchase properties of the Spring Valley Water Co. and the United Railroads. The amendment relating to the Spring Valley Water Co. provides for an increase in the bonding capacity of the city by a sufficient amount to permit the purchase of the water system in case the vote is in favor of the plan. The amendment relating to the United Railroads would change the charter so as to give the Mayor and Board of Supervisors the right to negotiate for the purchase of the system on the installment plan.

California Power Administrator Orders 15 to 20% Cut

Users of electric power in northern and central California are facing an acute shortage, according to State Power Administrator H. G. Butler, and at a conference on Aug. 19 he ordered a 15 to 20 per cent cut in the electrical energy supplied to many industries. This order affects particularly those uses in which the energy is "lost for productive purposes," such as sign and street lighting, but also it was agreed that it is now necessary that the curtailment shall fall on all important consumers and the order has been sent out to gold dredgers, cement and mining companies and electric railways.

At the conference, call to which was telegraphed to all power companies in the state, Mr. Butler stated that the relief program was planned to protect the reduced power supply caused by the series of dry years "until further relief is secured from seasonal lessening of the load or from rains." For several weeks limitations have been placed on the hours for using electricity in irrigation pumping, and this general curtailment has been in prospect for some time. From now on the companies reselling energy are to file with the power administrator all new power applications for quantities above 2½ hp., the administrator to make a ruling in each case as to whether the use is for an essential industry. The power companies themselves have been doing this for some time.

Committee on Lincoln Highway Ideal Section Named

The Lincoln Highway Association has announced the personnel of the technical committee appointed to decide what specifications will rule the construction of an ideal pavement section to be built at some point along the Lincoln Highway during 1921. The committee will receive and digest the many replies received by the association from questionnaires sent to 4,600 highway engineers in the United States requesting views as to what each engineer considered an ideal section. From these data the committee will formulate its specifications.

Members of the committee represent not only Federal, state and county highway engineers, but each technical class interested in highway construction. The personnel of the committee is given herewith:

Thomas H. MacDonald, chief, U. S. Bureau of Public Roads; A. R. Taylor, state highway commissioner, Ohio; Col. J. M. Ritchie, Motor Transport Corps, U. S. A.; F. R. White, state highway engineer, Iowa; A. R. Hirst, state highway engineer, Wisconsin; W. G. Thompson, former state highway engineer, New Jersey; Col. W. D. Uhler, state highway engineer, Pennsylvania; Edward N. Hines, chairman, Wayne County Highway Commission, Detroit, Mich.; T. R. Agg, consulting engineer, professor of highway engineering, Iowa Sate College; Clifford Older, state highway engineer, Illinois; Arthur H. Blanchard, professor of highway engineering, University of Michigan; and Col. Sidney D. Waldon, director, Lincoln Highway Association.

Program of Maintenance Meeting at St. Louis

The Roadmasters and Maintenance of Way Association of America, at its annual meeting in St. Louis, Mo., Sept. 21-23, has planned for a number of special papers including the following: "Increasing the Efficiency of Maintenance-of-Way Forces," by F. G. Jonah, chief engineer, St. Louis-San Francisco Ry.; "Maintenance of Rail Joints," J. V. Neubert, engineer of maintenance of way, New York Central R.R., and "Where Are Our Ties to Come From?" by H. Von Schrenk, consulting engineer. Committee reports will include "Weights of Rail for Various Classes of Traffic," "Equation of Track Values," "Relative Economy of Treated and Untreated Ties," "Welding Frogs and Switches," and "Construction of Highway, Street and Farm Crossings."

Pennsylvania's Highway Program Slowed Up

Recent announcements made by the Pennsylvania State Highway Department indicate that inability of contractors to obtain shipments denied them because of embargoes, and the allocation of open-top cars to transportation of coal are seriously hampering Pennsylvania's road construction program. Pennsylvania has 267 highway contracts in force at the present time, involving the construction of 993.29 mi. of highways. To date this season 109.24 mi. have been completed, a mileage which Highway Commissioner Sadler believes could be more than doubled under reasonably favorable conditions.

Zoning Regulations for District of Columbia Are in Effect

Zoning regulations for the District of Columbia, as drafted by the Zoning Commission created by Congress, became effective Aug. 30. There are four use, four height and four area districts. Notwithstanding urgent solicitation to the contrary, the commission adhered to its tentative plan of limiting the height of future buildings in the downtown section to 110 ft. The regulations have been issued in pamphlet form by the Zoning Commission.

Lumber Interests To Protest Demurrage Penalty

Preparations have been made and financed by the American Wholesale Lumber Association to seek the elimination of the $10 a day per car penalty charge on lumber and forest products held more than 48 hours. The defense is mainly that the Interstate Commerce Commission has entered a discriminatory order imposed under the guise of its being merely and solely to combat the alleged abuse of the reconsigning privilege.

November Election May Remove Bar to California Road Work

Much of the contract work on the California state highway system is still at a standstill but an endeavor is being made to hold the engineering organization together, and the prospect is that after the November election work may be resumed. The court case brought against the commission by a former secretary, W. R. Ellis, and through which work has been held up, was decided in favor of the commission in the superior court of the state and, when brought on appeal to the appellate court, an opinion was handed down sustaining the decision of the lower court. The case is now before the supreme court of the state.

Inasmuch as the California law prescribes that highway bonds be sold at par and that they yield not more than 4½ per cent interest, the State Highway Commission had set about to use

Federal funds pledged the state for highway construction to make up the difference between the statute interest limit and the market value of the bonds. The commission took the view that it could so use Federal-aid funds inasmuch as the only stipulations made by the Federal Government for the use of Federal-aid funds were state participation in the construction of the roads and Federal approval of state project plans. Inasmuch as these conditions had been fulfilled the commission contended to act within its legal right, a position which was upheld in the court's opinion. Though difficulty has been experienced in the sale of bonds there was such a ready response when signers were sought for an initiative petition authorizing a higher interest rate that it is expected the measure will pass when it goes before the voters in November. By that time it is hoped that the court case will have been disposed of.

Lighthouses To Warn Motorists of Curves and Crossings

The State Highway Commission of Wyoming has under consideration plans for the installation of "baby lighthouses" at railway crossings and on the approaches to dangerous curves on the state's entire highway system. These lights "wink" at the rate of 45 times a minute, throwing a 9-in. ray which can be seen for a distance of 3 mi. They are similar to small lighthouses along the Atlantic and Pacific coasts and the Panama canal. The light standards are 8 ft. high, mounted on cement bases, and each is a complete unit. Red lights designate railroad crossings and dangerous curves are announced by yellow lights. The frequency of accidents on mountain roads in Wyoming and Colorado, especially to tourists not familiar with mountain roads, led the commission to open negotiation with the manufacturers. A few years ago the use of large mirrors on the curves was experimented with on one or two Colorado mountain roads but with only partial success.

U. S. Engineers in M. I. T.

With the opening of the fall term, the Corps of Engineers will have forty officers pursuing courses in the Massachusetts Institute of Technology. Twenty-five of these officers have been pursuing engineering studies at the summer school with a view to shortening the time that they will have to be away from their military duties. These men are being given this work in Boston to carry out the policy of bringing military engineers in contact with civilian thought and practice.

The work being done by these officers is under the frequent scrutiny of Major V. L. Peterson, who is stationed at the district engineer offices at Boston. Major Peterson organized and conducted a course for the three-year West Point men at Camp Humphreys.

Engineering Societies

Calendar

Annual Meetings

SOUTHWEST WATER WORKS ASSOCIATION, Waco, Tex.; New Orleans, La., Sept, 20-23.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA, Sterling, Ill.; St. Louis, Sept. 21-23.

AMERICAN ASSOCIATION OF PORT AUTHORITIES, Montreal; Chicago, Sept. 30-Oct. 2.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Valparaiso, Ind.; St. Louis, Oct. 10-15.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION, Chicago; Atlanta, Ga., Oct. 26-28.

The American Railway Bridge and Building Association has changed the dates of its annual convention at Atlanta, Ga., from Oct. 19-21 to Oct. 26-28.

The Western Society of Engineers will open its fall series of meetings with an address by Major John C. H. Lee, Corps of Engineers, U. S. A., on "The St. Lawrence-Great Lakes Waterway Project." On Sept. 16, James A. Peabody, signal engineer, Chicago & Northwestern Ry., will speak on "The Relation of the Engineer to Railroad Transportation." L. K. Sherman, until recently president of the U. S. Housing Commssion, now consulting engineer, Chicago, will speak, Sept. 20, on "Housing Developments."

The Smoke Prevention Association will hold its fourteenth annual convention Oct. 5-8 at the Sherman Hotel, Chicago. An exhibit of equipment for burning fuel smokelessly will be shown. Frank A. Chambers, deputy smoke inspector, City of Chicago, is in charge of local arrangements.

The Louisiana Engineering Society, at its meeting held in New Orleans, Sept. 13, was addressed by Dr. I. M. Cline, district forester, Weather Bureau, New Orleans, on "Relation of Change in Storm Tides on the Coast of the Gulf of Mexico to the Center and Movement of Hurricanes."

Personal Notes

WALTER P. COPP has been appointed professor of civil engineering at Dalhousie University, Halifax, N. S.

CHARLES D. SNEAD, senior highway bridge engineer at the Fort Worth office of the U. S. Bureau of Public Roads, has been appointed successor to J. L. Parker, of the Montgomery (Ala.) district, who has recently resigned.

W. H. ANDERSON, Sulphur Springs, Tex., has been appointed drainage engineer for the St. Louis Southwestern Ry., with office at Dallas. He held a similar position with the Missouri, Kansas & Texas Railway Co., at Waco, previous to Government control of the railroads.

JOHN T. EDWARDS has been appointed supervisor of maintenance in the road department of the New Jersey State Highway Commission.

LESTER C. WALKER, for the past ten years connected with the Idaho Irrigation Co., Ltd., Richfield, Idaho, and from May, 1919, until August of this year chief engineer of the company, is now in the employ of the U. S. Reclamation Service, on surveys for the American Falls Reservoir, with headquarters at American Falls, Idaho.

MORTIMER E. COOLEY, dean of the College of Engineering and Architecture, University of Michigan, and president of the American Society of Mechanical Engineers, has been made a member of the Postal Advisory Committee, which is to study, among other things, the feasibility of handling mail in cities in underground tubes or tunnels.

H. H. TEMPLE, chief engineer of the Pittsburgh & West Virginia Ry., at Pittsburgh, has been appointed general superintendent of that road and of the West Side Belt R.R., with the same headquarters. He succeeds J. E. Fairhead, resigned.

MAJOR JOHN W. STEWART, Corps of Engineers, U. S. A., has been retired for physical disability. His last assignment was the Vicksburg Engineering District.

CAPT. PENNELL C. PAINTER, who for a number of years has been associated with the different engineering departments of the City of Baltimore, more recently as assistant engineer of the Paving Commission, has accepted the position of city engineer of Washington, N. C., where he will take charge of the extensive street paving program and the extension of the sewerage and water system, planned to start next spring.

O. W. WHITECARVER, Georgetown, S. C., has been appointed assistant engineer in the office of the U. S. district engineer at Charleston, S. C., succeeding James P. Allen, resigned. Mr. Whitecarver has been assistant engineer at Georgetown for the last 20 years.

J. L. PARKER recently resigned as senior highway bridge engineer of the Montgomery, (Ala.) district, U. S. Bureau of Public Roads, to become special bridge engineer of the South Carolina State Highway Commission.

The Seaboard Air Line Ry. announces the following promotions and transfers: W. A. GREENLEAF, division engineer, at Savannah, Ga., transferred to the North Carolina division, at Hamlet, N. C. C. M. CANNON, division engineer of the East Carolina division, at Charleston, S. C., appointed division engineer of the Alabama division,

at Savannah, succeeding W. A. Greenleaf, promoted. W. J. GOODING, division engineer of the South Carolina division, at Jacksonville, appointed division engineer of the East Carolina division, at Charleston, succeeding C. M. Cannon, transferred. O. F. MCNAIRY appointed division engineer of the South Carolina division, at Jacksonville, succeeding W. J. Gooding, transferred.

JAMES P. ALLEN, who recently resigned as assistant engineer in the U. S. district engineer office at Charleston, S. C., will engage in a private engineering business. Associated with Mr. Allen will be W. S. Fitzsimons, recently second assistant engineer in the Charleston office.

G. C. PYLE has been appointed chief engineer of the Arkansas & Louisiana Missouri (formerly the Arkansas & Louisiana Midland) Ry., with headquarters at Huttig, Ark.

I. H. SCHRAM, recently division engineer on the Erie R.R., has been promoted to the position of terminal superintendent, with offices at Marion, Ohio.

J. Y. MCCLINTOCK, for more than 17 years in charge of highway work in Monroe County, N. Y., has become associated with George R. Newell, civil engineer, with offices in Rochester, N. Y. They are prepared to consider problems in engineering, including studies, surveys and reports, preparation of contracts and construction work.

Dr. ARTHUR M. BUSWELL, associate professor of engineering, Columbia University, has become director of the Illinois State Water Survey.

COLONEL J. P. JERVEY, Corps of Engineers, U. S. A., in charge of the Baltimore district, has submitted his application for retirement. He requests that his retirement become effective on Sept. 21, as he desires to assume the duties of city manager of Portsmouth, Va., the following day.

H. B. HOLMES has been appointed chief engineer of the Pittsburgh & West Virginia Ry. and the West Side Belt R.R., with headquarters at Pittsburgh, succeeding H. H. Temple, promoted.

ROBERT M. GATES, engineer in the New York office of the Lakewood Engineering Co., Cleveland, has been appointed managing engineer in charge of the Philadelphia district of the company, with headquarters in Philadelphia.

J. C. DAVIS, formerly connected with the University of Oklahoma, has been made testing engineer for the State Highway Department, with headquarters at Oklahoma City.

A. W. HARDY has been appointed resident engineer on the bridge now being built between Minco and Union City, Okla.

BUSINESS NOTES

AGNEW T. DICE, JR., railroad sales manager of the Reading Iron Co., Reading, Pa., in addition to discharging the duties of that position, has been placed in charge of the company's cut nail output.

THE JEFFREY MANUFACTURING CO., Columbus, Ohio, has opened a branch office in the Marine Trust Building, Buffalo, in charge of H. W. Scott, formerly of the home office of the company. Mr. Scott will be glad to render assistance to clients in that territory in the handling of problems covering elevating, conveying, crushing, pulverizing and portable loading machinery.

THE MESTA MACHINE CO., Pittsburgh, has opened an office in the Singer Building, New York, from which point all of its foreign business will be handled. The New York office will also be the sales office for the New York and Eastern states territory. M. M. Moore, export sales manager of the company, who has just returned from Europe, will be in charge of the new office.

OBITUARY

THOMAS M. SCHENK, district engineer, at Halifax, for the Public Works Department of Canada, died Sept. 4 at Montreal. He was 32 years of age.

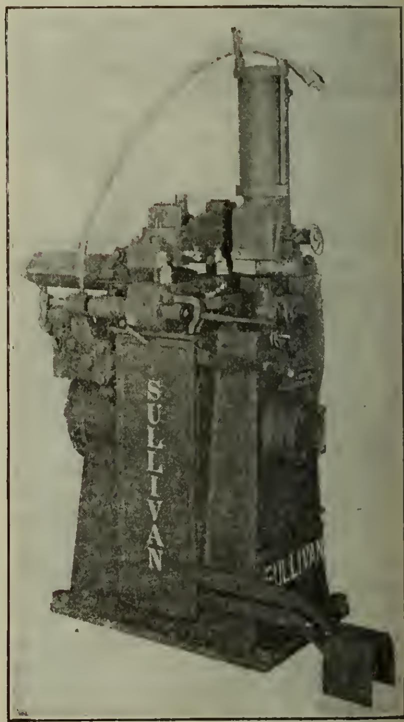
Sullivan Light Model Drill Sharpening Machine

The machine shown in the accompanying illustration is known as the Sullivan Class B Sharpener, and is designed for handling solid or hollow drill steel of any section up to $1\frac{1}{4}$ in. in diameter, and to make bits up to a maximum gage of $2\frac{1}{2}$ in. The Class B Sharpener weighs 1,500 lb.; is very compact, occupying a floor area of 4 ft. x $2\frac{1}{4}$ ft.; and stands 5 ft. high.

The essential features of the Class B Sharpener consist of a horizontal hammer cylinder and piston operating a dolly for upsetting, and a vertical cylinder and piston operating dies for swedging the drill bits or shanks. For upsetting bits or shanks the steel is clamped in steel dies mounted in the lower, or stationary, and upper, or movable, jaws of a yoke operated by a horizontal air cylinder situated in the base of the machine.

The clamping cylinder and piston are of the differential type, the clamping end being 10 in. in diameter and the releasing end 4 in. in diameter. The horizontal movement of the piston is communicated to the vertical action of the vise by the air power acting through a double toggle. The combined effort of the air power and toggle leverage is estimated as being more than 50,000 lb., all of which is applied to hold the steel firm in the vise.

In making or resharpening bits the steel is shifted from one hammer to the other, being alternately upset and swedged until of the proper gage and shape, and the wings, corners, and cutting edge properly drawn out to be uniform, and of the right thickness and angle. With a little practice perfect bits of the usual shape are made in one heat in a minute or less, on



LIGHT MODEL DRILL SHARPENER

either solid or hollow steel. Ordinary dull bits may be sharpened in from twenty to twenty-five seconds. In making shanks one heat is sufficient to forge those that require upsetting only, or swedging only, and two heats are necessary for shanks requiring both upsetting and swedging.

Civil Service Examinations United States

For the United States civil service examinations listed below apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the Civil Service Commission.

Junior Engineer and Deck Officer, $2,000 to $2,240 a year. Examinations Oct. 6-7, Dec. 8-9. Apply for Form 1312.

Rural Engineering Draftsman, $1,800 to $2,200 a year. Apply for Form 1312. Applications must be filed not later than Oct. 12.

Assistant Testing Engineer, $2,100 to $2,700 a year. Apply for Form 2118. Applications must be filed not later than Oct. 19.

A Consolidation of Engineering News and Engineering Record McGraw-Hill Company, Inc.—JAMES H. MCGRAW, *President*

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN *Editor*

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An Addition to the "Appeal"

A LETTER, signed by 82 of the 182 members whose names appeared on the "Appeal for a Progressive as Against a Radical Policy" for the American Society of Civil Engineers, is published in this issue. It pledges these members to work for two reforms which are the kernel of the progressive movement. The letter is an important clarification of the circular, which indicated that the signers favored changes, though only the one regarding the local sections was specified. The letter now pledges these men to work for two definite changes, and for a broadening of the technical life of the society. There were those who feared the "Appeal" was merely intended to postpone action with the hope of approving only ineffective and minor amendments in January. The letter dispels this fear. The signers give their word to their fellow members that if the pending amendments are rejected they will work for the two changes which are the essentials of the progressive movement.

A Fair Proposal

IN CASTING about for means of relief for the street railways the Federal Electric Railway Commission in its recent report proposed that the cost of street-railway extensions and of elevated railways and subways should be met by benefited property owners in the district served. The commission is justified in offering this plan for renewed consideration and is to be commended for pointing out the justice of the plan as a means of capturing some of the unearned increment of land values, due to electric-railway service, for the financing of the railways themselves. The committee does not go far enough in merely proposing that electric-railway extensions thus financed should not have their cost added to the capitalization on which dividends should be paid. In most cases, it seems certain, it would be necessary to make such extensions the property of the city. In fact, the city would probably have to make the extensions itself if their cost were to be assessed against all the property benefited. This would not preclude private operation under lease from the city. The data and opinions of the committee, as presented on p. 594, are well worth reading by all who are interested in the larger problems of both the street railways and the cities.

An Expert Opinion

AFTER the several reports of the Congressional committees which "investigated" war construction it is refreshing to read the analogous report of the Board of Review, which is abstracted on another page. The former are campaign documents, issued for political purposes; the latter is the unbiased judgment of technical men, two engineers and one public accountant. Though written before the Congressional fulminations, it constitutes a complete answer to such of them as tried to make out that the engineering and construction of the war was inefficient and ineffective, if not criminally inadequate. The board recognizes, as Congress did not, that hindsight is apt to be superior to foresight, and that the summer of 1917 demanded methods which would not have been tolerated in 1916 and which in the summer of 1920, with the war long over, can certainly be improved. The report confirms what the engineering profession has long known, that the war construction was a marvel of speed and effectiveness which contributed much toward the winning of the war.

Experience and a Works Department

IN ITS conclusions the Board of Review referred to in the preceding note very properly advocates a Federal Department of Public Works, but not under any specific name. It is, however, greatly impressed with the fact that the Construction Division of the Army, though under military control, managed to break for itself new paths of action through which it reached its ends unhampered by the time-worn restrictions of military personnel and methods. It therefore favors the retention of the methods and organization of this division for the Federal construction bureau, though it would divest it of all military character.

The problem of the Department of Public Works is not quite so simple as this would imply. The success of the Construction Division lay in its personnel. The drive of war led some of the clearest minds and highest executive talents in the engineering world to accept small salaried commissions or positions in which they worked under a pressure impossible to maintain in peace times. The methods evolved succeeded partly because they were taken directly from successful commercial and professional practice and partly because they had behind them enthusiastic men of superior experience.

To continue the success of such an organization, then, means more than merely to continue it as a government bureau, out of uniform. There must be maintained the quality, the initiative and the activity of a commercial or professional organization. In times of peace this ideal is probably impossible to attain, for any government organization suffers from the defects of its nature. A nearer approach to the ideal can be expected from a civilian rather than a military system because of a greater flexibility, a more ready infusion of new blood and a more democratic organization, but a constant fight will have to be made to avoid the dry rot and red tape of office, which threatens civilian as well as military government bureaus.

The prospects for a Department of Public Works are bright. Its organizers, when it comes, should not fail

to study the success of the Construction Division for pointers in their own problem. But they should not fall into the error of supposing that that division succeeded merely because it separated itself from military tradition.

Co-operation at Niagara

THERE is only one Niagara. Back in the wilds of the Southern continents there are falls as high and as voluminous, but nowhere else is the same combination of flow, head and power needs. Naturally, it has become the greatest center of hydro-electric development and the experimental ground on which the improvements in the art are being continually put to test. Every additional development of power there is, therefore of the greatest importance and it is a privilege to be able to lay before our readers explicit accounts of the latest one. They begin in this issue.

Niagara's problems are to some degree its own, but their solution has universal applicability as well as the greatest general interest to the hydro-electric expert. The technical details of this new plant need little comment beyond the descriptions which will appear, except perhaps to call attention to the efficiency and the size of the turbines—the largest yet built but to be surpassed in the new Canadian plant across the river—and to the ingenious fall increasers or head regainers devised for the draft tubes. The method of machinery design is distinctly novel. When started, the addition was a wartime plant with all the necessities for speed that that implies. The power company, therefore, took the radical step of calling in the competing machine manufacturers, stipulating to them only the power bases and demands and leaving them full direction of the details of design and construction. The results were more than satisfactory. The essential speed in construction was attained as well as a commendably high uniform performance. All interests concerned testify to a pleasantness often lacking in contract relations and a concentration of effort which sunk personal glory in the patriotic endeavor to put enough current on the wires to carry through the supreme manufacturing necessities of the war. The armistice came before the completion of the plant, but the work on it was one of the high engineering achievements of the war.

Some Possibilities of Cast Iron

A DISCUSSION of the relative merits of different types and designs of cast-iron ties, published by the railway department of the Government of India, suggests a thought as to the development of this material for special purposes. Owing to its normal characteristic of brittleness and consequent liability to fracture, cast iron is regarded ordinarily as unsuitable for structures or parts subject to shock. The fact is not always realized that brittleness is a property not necessarily inherent in cast iron, and that engineering and metallurgical skill can adapt the metal to surprisingly severe service.

A striking example of the application of this metal under conditions where it is subject to shock is the American cast-iron car wheel, which has been a successful and standard railway appliance for many years. Another example is the cast-iron tie, which, in various designs, is used extensively in India and to some extent in South America. Engineers in this country discuss the cast-iron car wheel and its improvement as an ordinary engineering problem. The publication noted above shows that engineers in India discuss the cast-iron tie and its improvement in the same way.

Yet the American engineer looks with distrust at the occasional proposal to make a tie of cast iron, because "it is so brittle." Foreign engineers, in general, regard the car wheel of cast iron with even greater distrust, because "it is so brittle." In both cases cast iron is regarded as a material universally possessing a certain objectionable characteristic. As a matter of fact, by careful grading and mixing of the pig iron and by special methods in manufacture, the American engineer is able to produce a cast-iron wheel that is strong and tough, to resist the incessant shocks to which it is subjected, and that has also a hard surface, to resist wear. In the same way, the engineers of Europe and India who manufacture and use cast-iron ties have developed a grade of metal that is equally well able to resist the shocks sustained in railway track. It must be remembered also, that this applies not only to the mass of metal in the body of the tie but also to lugs and projections that form part of the rail fastenings.

Cast-iron guns and mortars, which were used with success in the Civil War, were suggested—and perhaps used—during the European war, owing to the possibility of speedier manufacture, compared with the ordinary methods of constructing modern cannon. Speed of production was the vital necessity at that time. Erosion of the bore by gases is one of the main considerations in the life of these guns, fracture under the shocks of firing being preventable by the use of proper design, proper metal and proper methods.

No argument is intended for cast-iron ties on American railways, or for cast-iron cannon. The purpose is to indicate that by continued study of the metal and a wider knowledge of its properties old prejudices may be overcome and the metal made even more useful to the engineer than it is today.

Life of Dredge Pumps and Pipe Increased Fourfold

ATTENTION is challenged by the remarkable record of improvements in dredging equipment which have been made at the hydraulic fill dams for the Miami Conservancy District. As enumerated in the articles in this and preceding issues, these improvements fall into two groups. (1) Improvements in pump construction which increase output life and (2) improvements in planning pumping plants which reduce operating heads. Briefly, the life of different pump elements has been doubled and quadrupled and even multiplied by ten, pumping resistances have been reduced, and plant operations synchronized. These improvements are more than mere technical refinements.

A quadrupled output life of dredge pumps and pipe line, which, in general, is what has been effected at the Miami dams, has a significance beyond the fact that a tool of greater durability has been secured for the constructor. The opportunity for economies which come from continuity of operation has been extended. With prices and wages high and trained construction workmen difficult to secure and to retain, equipment

delays exact a heavy penalty. The nearly tenfold increase in the life of pump impellers, which has been effected at Miami is a notable gain in structural perfection, but economically it is a far greater accomplishment to have divided by ten the number of delays for replacing worn impellers.

In this task of obtaining dredge pumps of greater durability there is also a lesson in co-operation. It is a pertinent saying that development of construction machinery is a *post factum* procedure. This is strikingly illustrated by the experience being considered, but this experience is to a degree exceptional in the respect that the engineers have acted quickly after the fact. Both in pump construction and pipe fabrication, the improvements enumerated are the result of records and analyses by the engineers quickly placed before the manufacturers, and of prompt effort by the manufacturers, encouraged by the engineers, to satisfy the need.

After the fact, also, have come the developments recorded of sump design and pump layout and of operating control devices. These developments followed the disclosure of unexpected friction heads. Heads, ranging from 6 to 12 ft. in 100 ft., due to friction, explain many things which have been done at Miami and which otherwise appear without justification. In particular they explain the seeming incongruity of hauling materials by train a few thousand feet to be pumped another one or two thousand feet. Incidentally they portray how limited has been our quantitative knowledge of the friction heads developed in pumping mixtures of earth and water.

It was with a similar lack of quantative data in almost every respect that the hydraulicking operations on the Conservancy dams were inaugurated. From the beginning the work has been, perforce, a vast experimental laboratory in hydraulicking methods. This is the good fortune of the engineer. He will never again, to such an extent, be compelled to approach the problem of dredging pumps without recorded knowledge. He will have available equipment more nearly developed to his requirements. This perhaps is the greater gain.

It is the distinction of certain engineering operations that they have markedly extended the boundaries of service of construction equipment. The building of the Chicago Drainage canal in 1893-7 took the tipple incline, the cableway, the cantilever crane and the rock channeling machine from their field of service in mining and ore handling and placed them among the major tools for excavating earth and rock. Similarly the building of the Miami Conservancy dams has extended the boundaries of service of hydraulic dredging equipment.

The Oneness of the Economic World

EMPHASIS has been repeatedly placed in the last six years on the closeness with which the entire world is bound together economically. We had it demonstrated to us before our entry into the war, and, as pointed out in an article on Switzerland in this week's issue, the Swiss, though a neutral nation, experienced a rise in materials and wages and are suffering today from shortage of housing, as are all the belligerent countries.

Without inquiring into the conditions, one should, therefore, say with certainty that South America had experienced the same economic effects as have been felt in other countries. She is far away from Europe, but not so far but what the bonds draw her into the economic union.

As a matter of fact, one finds practically the same conditions in South America as elsewhere. Verne L. Havens, editor of *Ingenieria Internacional*, has just returned from a seven months' trip in which he visited Peru, Chile, Argentina, and Brazil. He found a shortage of labor, particularly of skilled men. Wages have risen about 50 per cent, the working hours have decreased about 20 per cent, while production is only about 75 per cent of what it was seven years ago. As a result of these conditions, costs of production have more than doubled.

Likewise, there is housing shortage—very serious in the large cities.

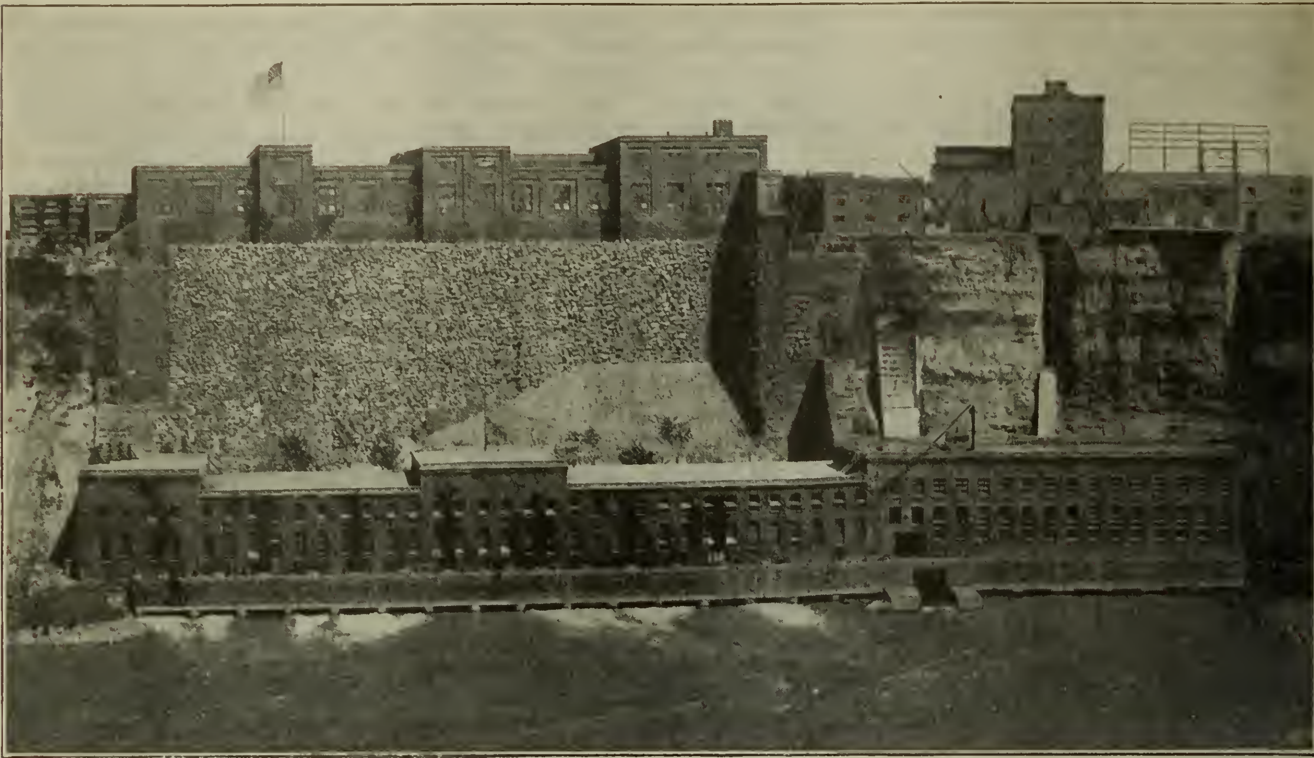
Everywhere, too, the attack on these problems for the purpose of solving them is the same—by a reawakening of the individual to his duty to render an honest day's work, and by the introduction of mechanical power to replace men wherever possible. In the application of both methods we in the United States have certain advantages, as compared with other countries, that in the one case should enable us to get back to normal more quickly than they, and in the other afford a large opportunity for export of American machinery.

In view of the unrest here and the lessened production per man, it seems hardly to accord with the truth to say that we have certain advantages with reference to the human element of the solution of the man-power shortage problem. Apparently we are no better off than other countries. However, America has always been an experiment station for proposals for bettering human relations in industry and the improvement of working conditions. True there is still much conservatism among employers even here, but far less than abroad. Our attitude toward the employee is more liberal than that in other countries, and we should accordingly go faster in the human part of the solution.

In the employment of labor-saving machinery, the field of application is necessarily larger in South America and in Europe than here. However, there is to be found there a good deal of inertia. They are not so accustomed to the application of machinery as we, and a lengthy educational process is needed. England is making rapid progress, however, evidenced by the fact that British manufacturers, for example, are imitating some of our types of construction plant never before manufactured, and seldom used, in England.

We have prided ourselves on an extensive use of machinery. The war, however, taught us that even we had a large field before us. The complexity of machines for doing even rough work is constantly increasing, and year by year intricate devices take the place of men in operations that a few years ago we thought were destined to be done by human power perhaps always. Despite, therefore, our already extensive use of machinery to replace human labor, and the great complexity to which such machinery has been developed, we can safely look for further progress, to the benefit of the public—always the ultimate beneficiary—and of those who have the ability to see the need and the resources and courage to make the necessary experimentation.

The oneness of the economic world, therefore, is emphasized not only by the widespread similarity of adverse conditions but also of the remedies proposed.



Developing An Additional 100,000 Horsepower at Niagara

Details of the Hydraulic and Structural Design and Description of Equipment of the Huge New Water-Power Plant on American Side of Falls

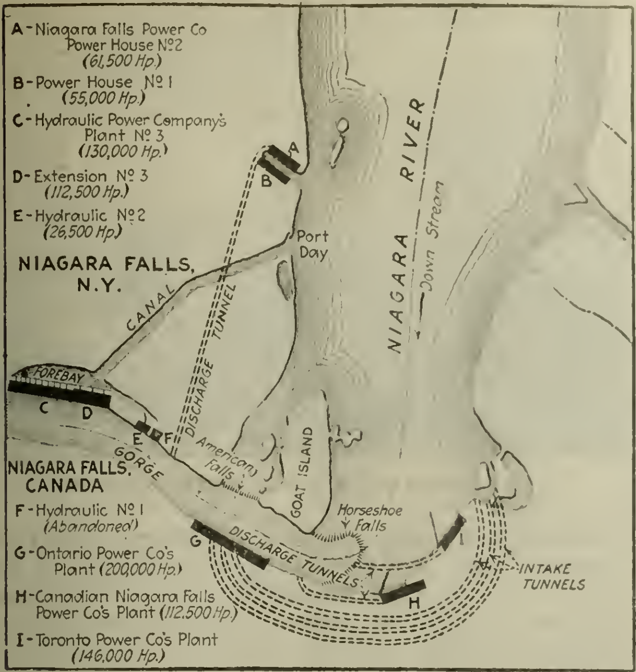
At the time of the United States' entry into the war, the Niagara Falls Power Co. was entitled to draw from the Niagara River not to exceed 8,600 sec.-ft. and the Hydraulic Power Co. was entitled to 6,500 sec-ft. Very soon thereafter the need for power for war industries became so great that the War Department issued additional permits to both companies sufficient to cover the maximum output of the apparatus then installed. After the merger of the two companies and the agreement of the consolidated company to proceed immediately with a new development, permit was issued for the entire amount of water available to the United States under the treaty, or 19,500 sec.-ft. The normal capacity of the existing plants was sufficient to use 15,100 sec.-ft., leaving a balance of 4,400 sec.-ft. for a new development. This has just been completed, as an extension of the plant of the Hydraulic Power Co. The three hydro-electric units, rated at 37,500 hp. each, but with a combined station output of 100,000 hp. are the largest ever built and the whole plant has many elements of novelty. The series of articles beginning here has been prepared in collaboration with the power company and takes up the various phases of the design and construction. Credit for the various articles is given specifically in some cases, but in addition the information has been secured from memoranda from John L. Harper, chief engineer, G. R. Shepard, assistant chief engineer, N. R. Gibson, hydraulic engineer and O. D. Dales, construction engineer of the company. In the two succeeding issues will be taken up the hydraulic design and the construction features. The development would have been completed some time ago in record time, but work was slowed down after the armistice.

How the Needs of War Developed Co-operation at Niagara

By John L. Harper
Vice President and Chief Engineer, Niagara Falls Power Co., Niagara Falls, N. Y.

The big electrochemical and electrometallurgical plants of the United States are at Niagara Falls, New York. When the war came, and shells and guns and ships and motor trucks and phosphorus and gas were found vital to the existence of the nation and its allies, our Government functioned through representatives whose minds appreciated values at Niagara other than in thundering vibrations and clouds of spray, wonderful as both may be in times of peace. In the presence of great dangers only the fundamentals count, and there was no hesitation on the part of the directors of the war in first restricting Niagara power to the manufacture of basic materials, and then demanding further development of power so that the production of these materials might be increased.

All parties interested in power development at Niagara Falls were asked to submit plans and propositions for a rush development of the remaining water available for diversion under the treaty with Great Britain. From these competitive plans, one of those presented by Hydraulic Power Co. of Niagara Falls was approved by the War Department as the one which would produce the largest amount of power in the shortest time, and at the same time be a proper and efficient power development after the stress of war had passed.



MAP OF NIAGARA FALLS DISTRICT, SHOWING LOCATION OF POWER PLANTS

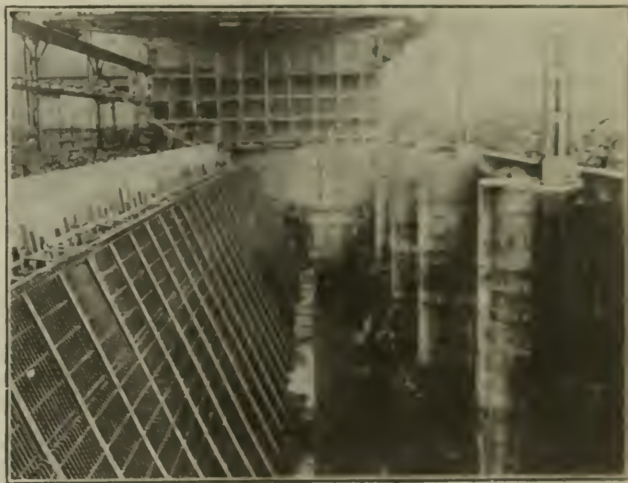
The plan so approved by the War Department required the use of all the water in respect to which the operating companies at Niagara Falls had proprietary rights. The consolidation of all the power companies was obviously the easiest way to unify these rights and upon suggestion of the War Department, such consolidation was undertaken. The Niagara Falls Power Co., Hydraulic Power Co. of Niagara Falls and Cliff Electrical Distributing Co. were consolidated under the name of The Niagara Falls Power Co., the control and management of the consolidated company resting in the former owners of the Hydraulic Power Co.

In the early part of May, 1918, authority was received from the Secretary of War with orders to proceed with the development in accordance with the approved plan under the supervision of an officer of the Corps of Engineers. The scope of the work carried out under this plan included the deepening of the intake from the Niagara River, the development and installation of improved ice deflecting booms, the deepening of the hydraulic canal through the City of Niagara Falls, N. Y., the construction of a new forebay, and three slope tunnels for taking the water from the forebay to the edge of the river in the middle basin, where the power plant was constructed as an extension to Station No. 3, of the Hydraulic Plant.

Three hydro-electric units were designed, to be equal in size, and to have a combined output at the highest efficiency of 100,000 hp. In view of the peculiar conditions that existed on account of the war, and in order to secure quick delivery, the contracts for the manufacture of the waterwheels and generators were distributed as follows: One complete hydro-electric unit to Allis Chalmers Manufacturing Co., two waterwheels to I. P. Morris Co., one generator to General Electric Co. and one generator to Westinghouse Electric & Manufacturing Co.

On account of the urgent need of this work by the War Department, A-1 priority orders were given by it to the builders for the obtaining of materials necessary for manufacture and construction, and sympathetic and effective assistance was rendered by all government departments in carrying out this work.

The contracts for the building of these waterwheels and generators were not placed on a basis of competitive prices, nor were specific guarantees of efficiencies exacted. As all of the power companies on the American side were to become one, it was deemed advisable to allow all of the larger manufacturers of this class of apparatus to show what they could do in the production of these new units, which were expected to be the last word in hydro-electric design. All of the manufacturing companies approached their tasks with enthusiasm and patriotic endeavor to produce the best, and now, when all three of these units are in operation, it is impossible to say that any better apparatus could have been constructed under the most minute specifications and inspection. All of these companies fully co-operated, not only with the War Department and the power company in meeting with dispatch the emergency requirements of rush production, but, at the same time, have given such careful and efficient attention to the whole design and manufacture that the resulting machinery is of the highest class known to



TRASH RACKS IN FOREBAY

the art, and, although the machines are of different manufacture, the builders have co-operated with each other in producing machines, the exteriors of which are similar, thus giving a uniform and pleasing appearance to the station.

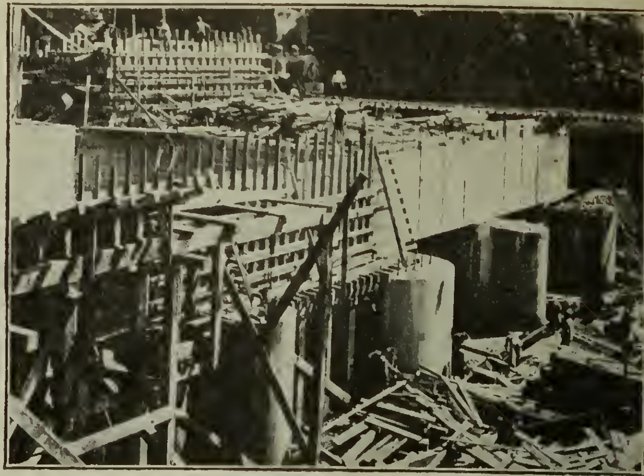
Although the official efficiency tests have not as yet been completed it is apparent, from preliminary tests, that the hydraulic efficiency will equal or slightly exceed 93 per cent, and that the efficiency from headwater to the switchboard will be over 90 per cent. The units have each demonstrated their ability to operate continuously at 40,000 hp., although the combined operating station output is considered as 100,000 hp.

These units are at present the largest hydro-electric units in the world, and it is a subject for pride in our American manufacturers that these four companies as well as those manufacturing valves, bearings, etc., have mutually taken this step in advance without failure in any particular.

The construction work was carried out in the face of unusual obstacles in procuring both labor and materials, yet in all cases the manufacturers of the prin-

cipal parts of the apparatus lived up to their agreements as to time of completion; and if the construction and installation had been pushed with the same vigor after the armistice was signed as it was before, it is probable that the first unit would have been put in operation in fourteen months after the word was given by the Secretary of War; but, under the reduced schedule as to progress, the first unit was put in operation nineteen months after authority was received to proceed.

The writer also wishes to express appreciation of the loyalty and efficiency of the engineering and construction staffs of the Niagara Falls Power Co., which was obliged to make the plans at the same time that the work was in progress, and whose ability and efficiency may be measured by the fact that in spending about $8,000,000 less than $1,000 was wasted in changes of plans.



FOUNDATION SLAB FOR TURBINE SETTING

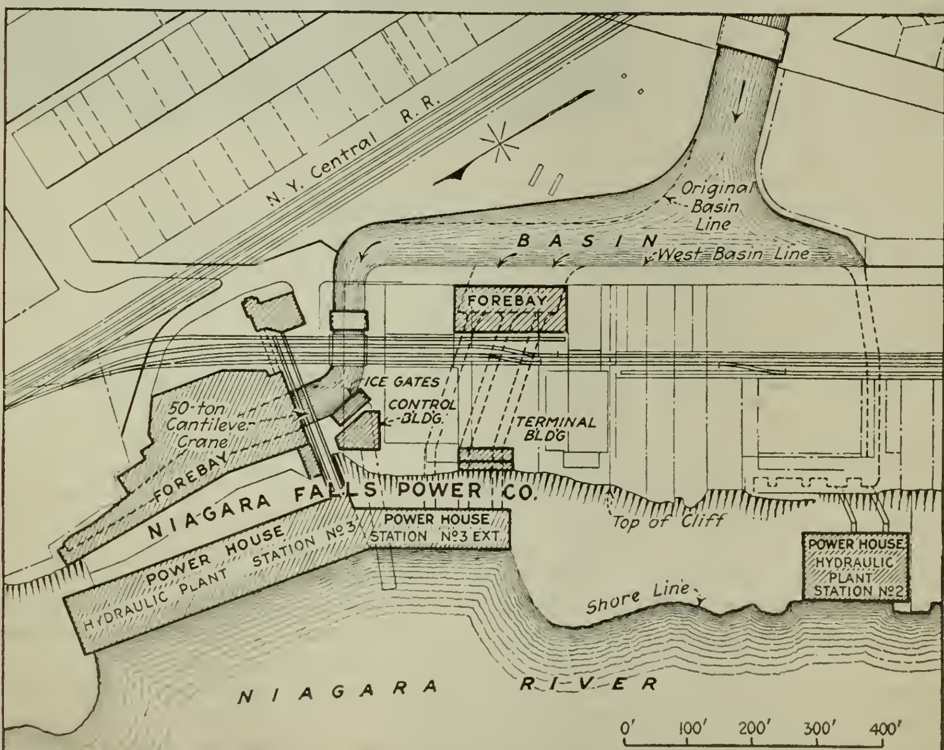
Structural and Equipment Features of New Niagara Plant

By O. D. Dales
Construction Engineer Niagara Falls Power Co.

Station No. 3 of the Hydraulic Power Co., is located below the falls at the lower end of the canal passing through the city. It takes water from the canal through thirteen steel penstocks built outside the cliff—though now concealed from view by a face wall—and delivers it under 210 ft. head to thirteen horizontal turbines of 10,000 hp. capacity each. The canal was started in 1852 but was not put into operation until 1872. It has been enlarged from time to time up until 1912 when Station No. 3 was completed at which time it was 100 ft. wide and around 15 ft. deep and had an average flow of about 9,000 sec.-ft.

The 1918-20 extension to Station No. 3 was built immediately upstream of the 1906 plant. It consists of three 15½-ft. penstocks taking directly from the canal through a new forebay and passing through the limestone rock at a general slope of 45 deg. to the power house alongside the old power house just above the lower river level. Here are installed three vertical turbines of 37,500 hp. each, connected to generators of a capacity of 32,500 kva. each, generating 12,000 volt, three-phase 25-cycle current when operating at 150 r.p.m. The recent operations comprised additional ice protection in the upper Niagara at the mouth of the canal, enlargement of the canal to pass the required 13,200 sec.-ft., construction of the forebay behind a cofferdam holding back the canal, driving the penstock tunnels through rock, construction of the power house and erection of the hydraulic and electric machinery.

The Niagara River, at the point where the company takes its water, is a broad stream, and the main channel is near the Canadian side. Between the main channel and the company's intakes there is a broad stretch of water intersected with submerged reefs and ridges, and having a depth of from 4 to 14 ft. at the main stage of the water elevation.



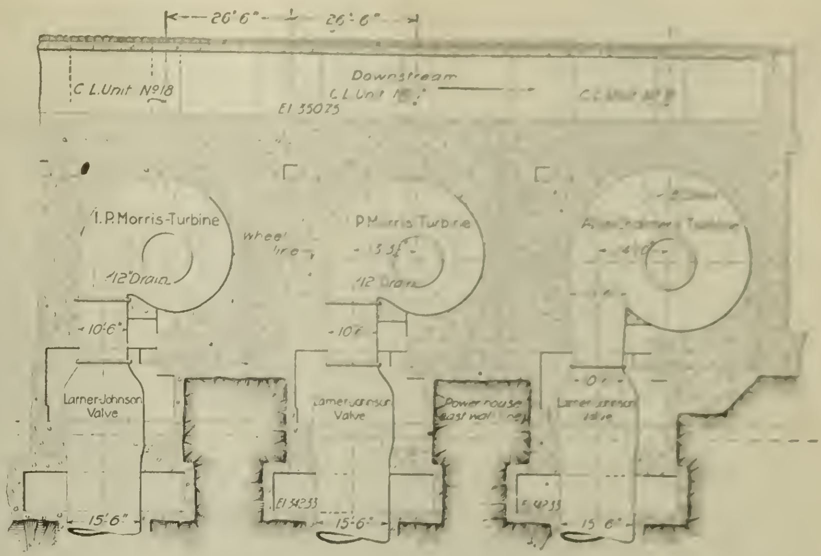
PLAN OF EXTENSION TO STATION NO. 3, NIAGARA FALLS POWER CO.

The engineering problem involved in the river work was to obtain the normal supply of water for the power plants during the winter period of low temperatures and severe ice conditions. The stream never freezes solidly over its entire width, and the outer line of the solid shore ice is located in approximately the same place from year to year. A deep channel about 200 ft. in width was run from the company's inlet outward to the edge of the ice line. Commencing at the intersection of this channel with the ice line, a series of piers consisting of steel sheetpile cylinders filled with concrete were built running upstream in the general direction of the ice line, but gradually working in toward the shore. Floating booms of

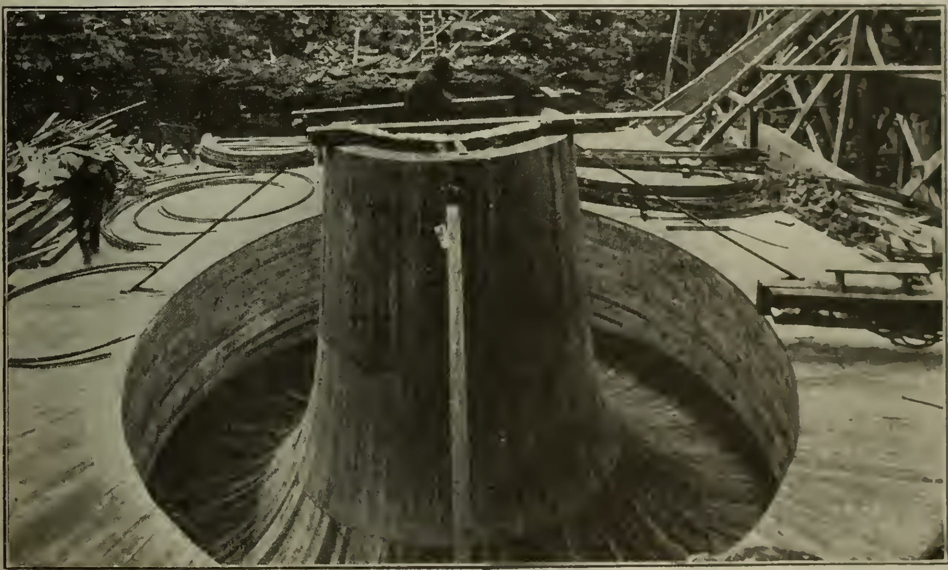
truss frames were placed from pier to pier. About half way between this row of piers and the shore, another row was placed, extending in the same direction and supporting floating booms in the same manner as the outer row.

This system has been in operation through one exceptionally severe winter and has proved entirely satisfactory. The booms have kept out the ice floating down the river, and what small amounts actually formed inside the booms, have been broken up from time to time in small quantities by the company's ice-breaking tugs and allowed to flow down the canal where it was disposed of through the spillway gates.

In order to get sufficient water through the canal to run the added equipment it was necessary to enlarge the cross section. The canal runs through the most thickly settled portion of the city, and it was impossible to acquire property rights to widen the canal, so that the only possible thing to do was to deepen it. The canal, prior to the enlargement, was 100 ft. in width and varied in depth, at the high water period of the year, from 15 to 22 ft. The new section is of the same width but has been deepened uniformly to 20 ft.



HORIZONTAL SECTION THROUGH TURBINE SETTINGS


DRAFT-TUBE FORMWORK FOR I. P. MORRIS UNIT

Forebay and Penstocks

The forebay is 154 ft. 7 in. long, 75 ft. wide, and 26 ft. 3 in. deep below normal water. It is entirely lined with concrete. Running out of the forebay are three penstocks, which are concrete lined tunnels of 15 ft. 6 in. diameter. The entrance to the penstocks is a bell-mouth 18 ft. 9 in. high by 28 ft. long.

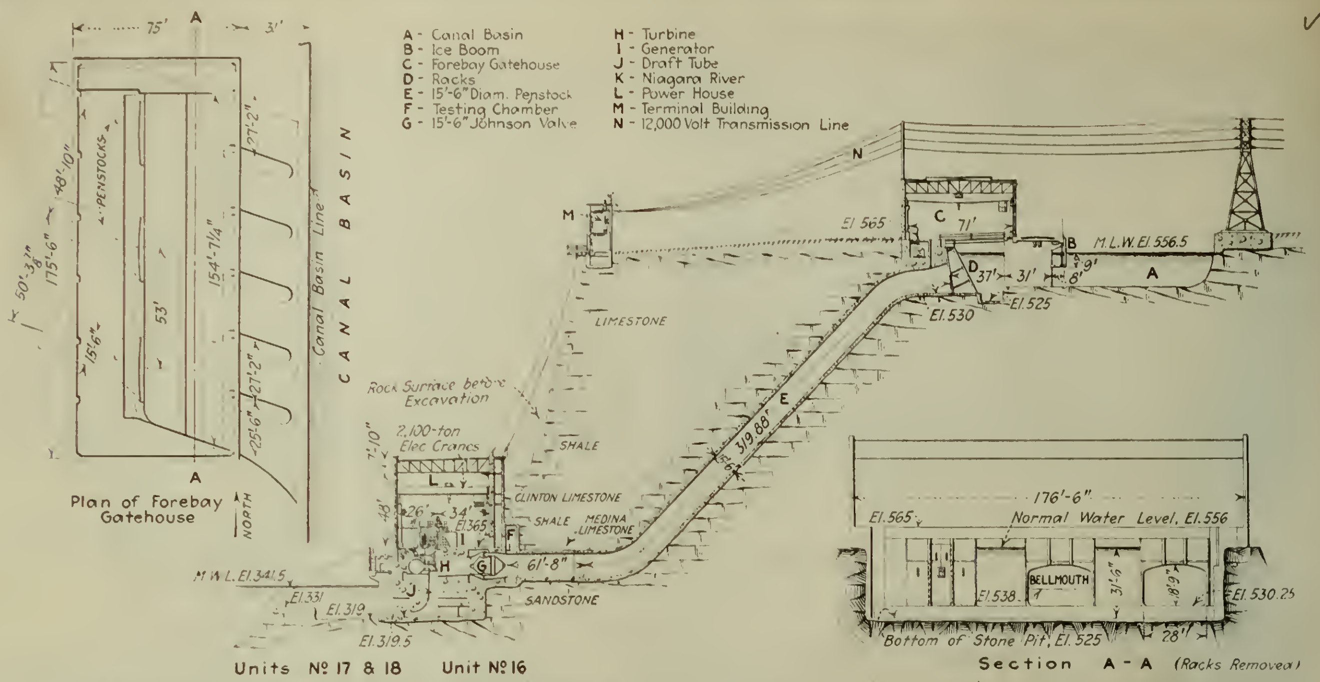
The penstock tunnels after leaving the bell-mouths turn downward at an angle of 45 deg. until they reach a plane at El. 353, which is on a line with the center of the waterwheels. They then run as horizontal tunnels out through the rock to the waterwheels in the power house. Of this horizontal part 76 ft. is composed of 1⅛-in- steel plate thoroughly riveted. The space between the steel lining and the rock is filled with concrete.

The valve for each unit was placed at the bottom of the penstock close to the turbine in order to save time when filling the penstock after the ordinary shut-down of a waterwheel. Stop gates were provided for the bell-mouth end as an extra precaution. These are merely large steel gates, three for each penstock, the center gate having a small by-pass wicket. These stop gates slide down in steel guides over the face of the bell-mouth. Steel lined grooves were placed in the face of the forebay wall to receive these stop gate guides.

Each of the three turbine casings is connected to its penstock through a Johnson hydraulically operated, electrically controlled valve. These valves, which are the largest in the world, were furnished by the Larner-Johnson Valve and Engineering Co. The outer valve housing is of cast steel and steel plate and is 17 ft. inside diameter through the body of the valve and tapers to 10 ft. 6 in. diameter at the outlet end. The entrance end to the valve housing is made of steel plate forming a flaring extension of the 15-ft. 6-in. penstock. The length of the valve is about 24 ft. Throughout the total length, approximately 24 ft., the area of the water passage is reduced without abrupt changes or sharp curves and the stream-line shape of the valve parts renders the hydraulic losses practically negligible.

Trash Racks and Stone Catcher

The trash racks which run the entire length of the forebay are composed of 4 x ½ in. flat steel bars spaced by cast-iron spreaders 4 in. centers. These racks are supported by a framework of steel designed with the assumption that the racks might become clogged and carry the entire hydrostatic pressure. The steel sup-



CROSS-SECTION OF NEW STATION WITH THREE 37,500 HP. TURBINES AND STATION RATING OF 100,000 HP.

ports are designed to carry the entire head with a working stress of 100 per cent greater than the usual working stress called for in the ordinary design.

In the bottom of the forebay and in front of the racks is a long groove running the entire length of the forebay, being 5 ft. deep. It is placed there to act as a stone catcher. As excavation will be carried on in the canal for some time after the completion of the station, loose rocks will be carried down the stream by the swift current and brought into the forebay. As the water in the forebay moves at a velocity of about 1½ ft. per sec. they will drop into this groove and not be carried down the penstock. When this stone catcher becomes filled the loose rocks will be removed by a grab bucket operated from the electric crane in the forebay house.

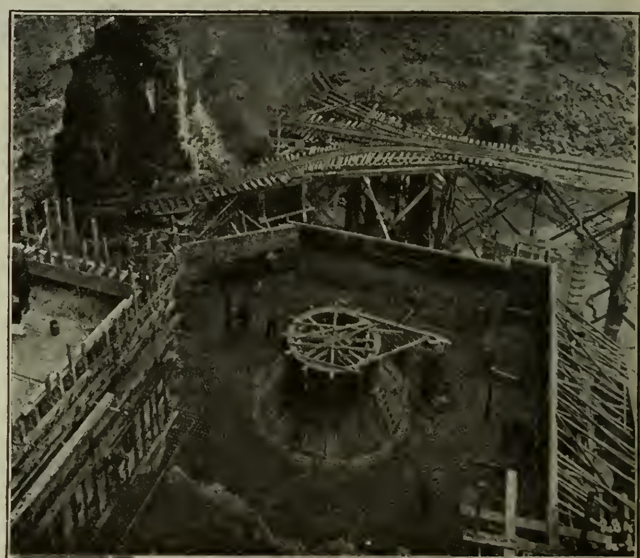
Ice Skimmer and Run

To prevent ice coming into the forebay an ice skimmer was built in front of the inlets. This consists of removable steel plate sections which extend 9 ft. below the water surface and are hung from the roadway slab above and braced laterally by steel framing to the concrete inlet piers. They will receive considerable pressure if large amounts of ice should be flowing in the basin. It was assumed that very little ice would be carried into the forebay as the velocity of the water in the basin is about 4.5 ft. per sec. and the water going through under the ice boom from the basin is 2 ft. per sec. This was very well proved by the experience of last winter.

By the construction of the ice boom system off Port Day in the Niagara River, it was believed that there would be very little trouble from ice in the forebay, but there will always be some ice form in the canal and there will always be the possibility that an ice boom might break and a large quantity come down the canal.

To take care of this a spillway and ice chute has been constructed. The old Station No. 3 had ice gates and an ice run running from the outside of the curve shown on the accompanying plan. This old ice run curved at a right angle and discharged into what had been the abandoned wheelpit of a large flour mill. This pit extended 70 ft. down from the top of the cliff, where the water and ice were discharged on the site of the new power house. It therefore became necessary to build a new ice run running directly from the old spillway gates to the river and passing under the new power house. Its location is shown also on the plan. It is a concrete lined chute 20 ft. wide and 15 ft. deep, inclined at an angle of 60 deg. with a horizontal with a parabolic curve at the top and bottom to connect the horizontal sections with the slope section.

The concrete lining of the chute was intended to be 18 in. thick, but it over ran this as part of the excavation was in shale which disintegrated after being exposed to the air. A concrete roof has been placed upon this chute and will later be covered with rubble stone masonry to look like the natural cliff. The horizontal part of the chute which passes underneath the power



REINFORCEMENT OF SETTING FOR ALLIS-CHALMERS UNIT

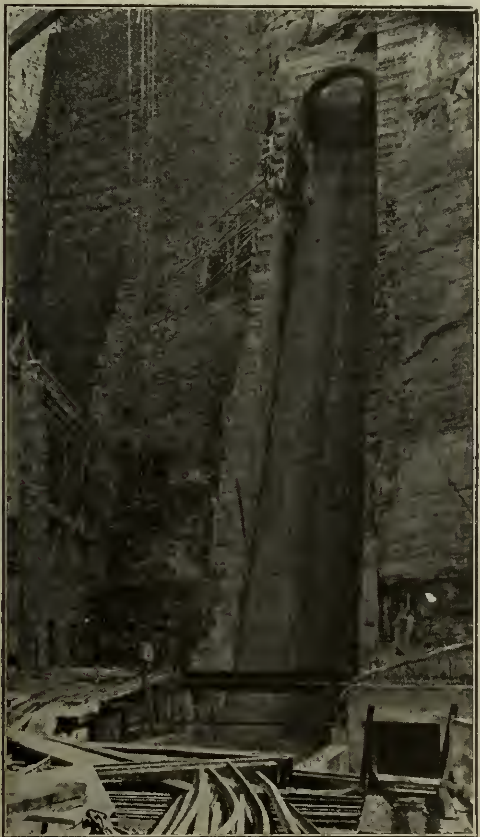
house is carried 60 ft. west of the power house so that the water, ice and débris will discharge into deep water of the river.

Details of Turbine Settings

By Louis S. Bernstein
Designing Engineer, Niagara Falls Power Co.

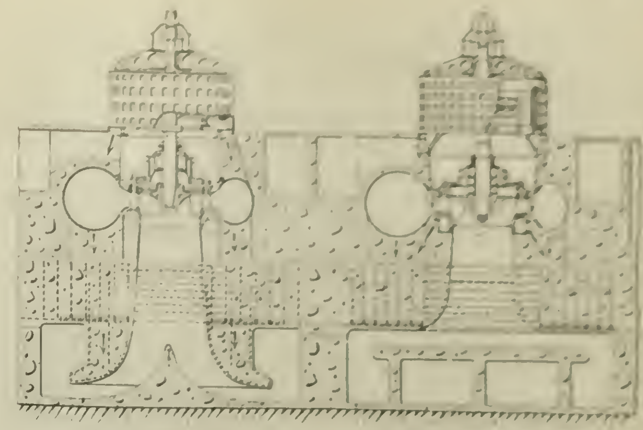
The hydraulic efficiency of the waterwheel unit was the governing feature of the design and for this reason and the fact that the size of the machines are larger and of different type than any in present use, radical departures were made as compared with the existing plants of the company. The fundamental features of the changes are as follows: (1) The vertical shaft type unit was adopted. (2) The usual bent tube type of draft tube was abandoned for the more efficient types known as the "hydraucone" and the "center cone," respectively.

In plants where the combination of a moderate discharge and the bent-tube type of draft tube exists, the



ICE CHUTE BEFORE COVERING

problem of supporting the turbine and generator is comparatively simple, as the loading is usually small and the natural arch of the bent tube acts as the support on one side, and the concrete mass foundation as the support on the other side. It can readily be seen that as the unit becomes larger and both the clear span of the tailrace and the load to be supported becomes greater, if the arch type of construction is not available, the problem of supporting the unit becomes more complicated; in special cases, where the turbine and generator are of extreme size and weight, special provision must be made to take care of the vibration of the machine as well as the superimposed loads.



VERTICAL SECTION THROUGH TWO TURBINE SETTINGS

There are two types of units, one being installed by the Allis-Chalmers Co., and the turbine of the other by the I. P. Morris Co. The draft tube of the Allis-Chalmers' unit is known as the "hydraucone," while that of the I. P. Morris is known as the "center cone." In each case the clearness in the tailrace and the other hydraulic features of the draft tube were determined by the makers of the respective turbines and the hydraulic engineer of the power company. Details of the machines and their appurtenances will appear in a later article.

The draft tube of the Allis-Chalmers' unit consists of a horizontal reinforced-concrete plate supported by three reinforced-concrete walls, the entire structure being centered in the tailrace directly under the discharge of the turbine. The draft tube of the I. P. Morris Co. unit consists of heavy flared reinforced-concrete wings suspended from the foundation slab of the unit and a center cone extending up between and centering these wings. The foundations for the units outside of the draft tube are practically the same. A cross section through both units is shown in an accompanying drawing.

Condition of Turbine Loading

In the Allis-Chalmers' unit the generator is supported by a heavy cast-iron frame called the "pit liner," having a top diameter of 22 ft. 4 in., a diameter at the bottom of 17 ft. 2 in. and a height of 9 ft. 4 in. This is carried by the speed ring which is a circular steel casting that acts as a stationary guide for the water entering the runner The speed ring in turn is supported by another circular casting called the "discharge ring." This casting rests on the foundation slab, and the concrete inside of this casting is cut out and formed to the shape of the draft tube. The diameter of the opening at the top of the foundation slab is 10 ft. The opening gradually increases in size through the slab and becomes tangent at the bottom. The diameter at the point of tangency is 24 ft. 4 in.

In the I. P. Morris unit the generator is supported by massive concrete piers which rest directly on the heavy cast-iron wheel case. The load is transferred from the wheel case to the foundation slab and the distribution is more favorable than in the other unit. The flared wings of the draft tube are attached to the bottom of the main foundation slab with three rings of reinforcing bars. The opening in the main slab is similar to that of the Allis-Chalmers' unit.

The actual weight of one complete unit consisting of one generator and turbine is in excess of 1,000 tons. The entire weight from power house floor to the top of the tailrace on the neat inside line of the foundation piers is 5,500 tons per unit. It was assumed that this entire load was carried by the main foundation slab. The amount of arch action was impossible to determine owing to the nature of the load concentration of the machine in the vicinity of the opening for the draft tube.

The main foundation slab is 11 ft. thick. It has a clear span of 45 ft. The reinforcing consists of eight bands of steel bars, each band containing twenty-five 1¼-in. square bars. In addition to this there are about 450 vertical 1-in. square bars, spaced about 2 ft. centers over the entire area acting like stirrups. It was thought advisable to tie this large mass of concrete together since there is about 1,000 yd. of concrete in each slab, and for construction reasons it was decided to pour this slab in two sections. In addition to these vertical bars, limestone plums were placed so that about one-half of the stones projected above the neat line of the first pour to act as an additional horizontal tie. The entire surface was picked, roughened and thoroughly cleaned before the final pour was made.

In the design of the main foundation slab each band was considered acting as a beam and assumed to carry one-eighth of the total load inside the neat line of the foundation piers, the load being considered as uniformly distributed. Based upon this assumption the unit stress in the reinforcing steel is 15,000 lb. per square inch and in the concrete 450 lb. per square inch. The unit shear on the neat line of the foundation piers is 45 lb. per square inch.

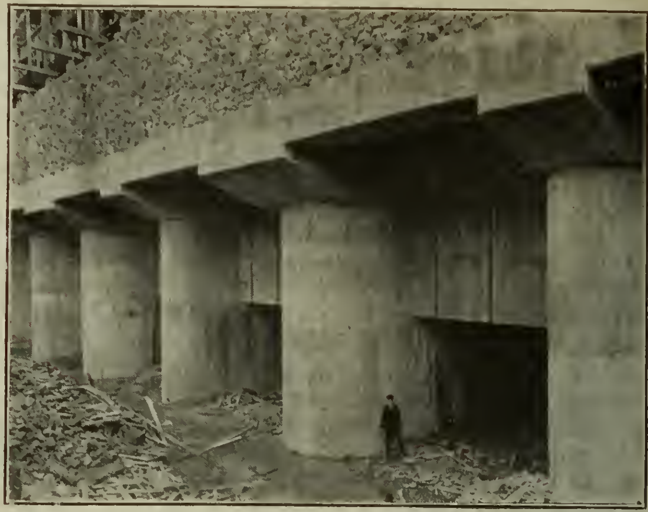
The foundation slab is carried by the main power house piers, which are spaced 53 ft. centers, and one smaller center pier. The main piers are 13 ft. thick at the river face of the power house and gradually taper down until they are 8 ft. thick at the center line of the unit. These piers are joined together from this point by a concrete wall 4 ft. thick, against the bedrock, having a radius of 22 ft. 6 in. to the inside face. This makes a horse-shoe shaped tailrace, semi-circular at the rear end and slightly contracting until it reaches the river face of the power house. The piers are rounded off to a radius of half their thickness at the river face of the foundation.

Superstructure of Power House

The power house, which is located in the gorge, is a building 60 ft. wide inside with a 6-ft. space between the back wall and the cliff, this space being used for cable and hot air passages. It extends 225 ft. upstream from old Station No. 3. The floor of the power house is at El. 365, which is 7 ft. above the highest known water level and is 23 ft. 6 in. above mean water level. The roof is 80 ft. above mean water level.

The operating gallery is 20 ft. wide and extends along the entire west side of the building and is 13 ft. 3 in. above the power house floor, being on a level with the walks leading to the top of the generators and around the Kingsbury bearings.

The east wall of the power house is of concrete and the west wall which faces the river is of rough rubble masonry, being the same as all masonry walls used in the construction of Station No. 3. This type of masonry is used as it harmonizes the best with the existing cliffs.



TAIL RACE EXIT OF EXTENSION TO PLANT NO. 3

The weight of the rotating parts of one unit is about 200 tons. Two 100-ton cranes and a lifting beam constituted the crane equipment for the installation of the new plant. The total moving load transverse to the building consists of the live crane load, the weight of the lifting beam and the crane trucks, making a total load of 260 tons. The moving load in the longitudinal direction of the building consists of the weight of the crane bridge in addition to the transverse loading, making a total load of 340 tons. The coefficient of sliding friction between the wheel and the truck was assumed as 0.2. This gave a transverse force of 104,000 lb. and a longitudinal force of 136,000 lb. applied at the top of the crane girder to be taken care of in addition to the regular maximum wheel loading of 76,000 lb.

In the design of the steelwork it was assumed that an equal portion of the lateral load would be taken by the top flange of each set of crane girders. The top flange of the crane girders was proportioned for the combined stresses due to the vertical and lateral forces, the span length in each case being the distance between the column centers.

The columns and trusses were designed as a portal fixed at the base. The lateral reaction from the crane girder was assumed to be taken by both the crane column and the truss column. The amount taken by each of these members was determined by the lateral deflection in these members for their particular condition of loading.

The longitudinal force from the crane was assumed to be taken by the crane column, knee braces and the crane girder. In determining the final sections the allowable unit stress in all members that were increased by the lateral or longitudinal forces due to the action of the crane were made 25 per cent greater than the allowable unit stress in the members not affected by this loading.

To Start Illinois Waterway

As the first step in the construction by the State of Illinois of the waterway to connect the Chicago drainage canal with the Illinois River, the State Department of Public Works has invited proposals for the Marseilles lock in the Illinois River. This waterway will be the closing link in a navigable route between the Great Lakes and the Mississippi River, as noted in *Engineering News-Record* of Feb. 26, 1920, p. 433.

Experience With Automatic Crest Gates of Wissota Dam in Flood

A SUDDEN rise in the Chippewa River during the last week in March, causing considerable damage to dams above Eau Claire, Wis., was due to melting snow and to heavy rains falling on a territory covered with snow and ice. As a rule the ice on ponds and rivers is rotten before the floods come and is washed out. This flood appears to have started with an ice jam which carried away the old timber Dietz dam on the Thornapple River, in Sawyer County. It increased rapidly, carried out several Tainter gates at the Cornell dam and the walk and flashboards of the Dells dam, just above Eau Claire.

At the Wissota dam, three miles above Chippewa Falls, Wis., the pond had been lowered about 8 ft. below normal early in March to obtain additional power, but it was filled during the first stages of the flood and as the peak was approached the water rose nearly 3 ft. above its normal level. A head of 60 ft. is carried by this dam, flood water being passed over the spillway by 13 Stauwerke automatic gates 60 ft. long (see *Engineering Record* of Jan. 29, 1916, p. 137). These gates are designed to hold the water at El. 898, but a level higher than El. 900 was reached, as shown by the accompanying table.

WATER ELEVATIONS AT WISOTA DAM DURING FLOOD OF MARCH, 1920 (Readings at 6 p. m.)

Date March	Pond Level	Tail Level	Date March	Pond Level	Tail Level
20	890.7	837.4	26	899.5	850.
21	892.2	837.3	27	900.4	852.0
22	893.5	839.0	28	900.1	852.6
23	895.4	840.5	29	899.2	851.1
24	899.5	841.5	30	899.9	849.3
25	898.7	848.0			

Normal elevation, 898.
Maximum elevation at crest of flood, 900.5.

An automatic recording gage station is maintained at Chippewa Falls, three miles below the dam, by the Railroad Commission of Wisconsin and the U. S. Geological Survey. According to a report by the Railroad Commission the record shows that the gates did not release any large volume of water until the pond elevation had reached 900, or two feet above normal. They then operated to lower the pond about 1 ft., but as the flood increased they held back the water until the pond elevation was 900.5 at the time the crest passed. The following is quoted from the report:

After the Stauwerke gates had been operating for about a year at Wissota, a test was made by order of the Railroad Commission to determine their operating qualities. It was found that the gates did not drop to waste the water until it had reached a point several inches above the normal level. Also that after they had dropped sufficiently to waste the water they did not return to position until the water had gone down several inches below normal. The conclusion at that time was that while their operation was satisfactory with respect to safety to the public, which was the only question involved in that investigation, the indications were that they lacked sensitiveness. There was a range of perhaps a foot or more between the level at which they would drop and the level at which they would rise to position. This insensitiveness is somewhat unfortunate from an operating point of view as a great deal of valuable water is wasted.

The Stauwerke automatic gate does not lend itself so readily to flood control as do ordinary Tainter gates. There is no means of draining the pond in anticipation of the arrival of a large volume of water, even when it is known that a flood of large proportions is approaching. In the flood above described, approximately 80,000 cu.ft. per sec. were passing down the river and these gates could have handled a larger quantity of water, but had it been possible to waste water faster in the earlier stages, perhaps a smaller maximum would have resulted at Eau Claire.

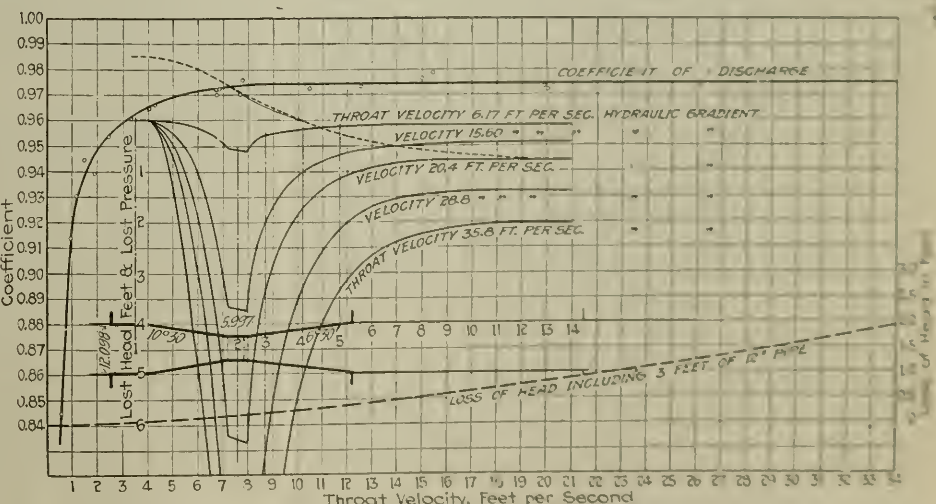
Test Curves of Special Venturi Meter Agree with Theory

By W. S. Pardoe
Assistant Professor of Civil Engineering, University of Pennsylvania, Philadelphia

THE accompanying curves of the test of a 12 x 6-in special Venturi Meter show, in the coefficient of discharge curve, a very substantial agreement with the computed curve for this sized meter shown in an article by the writer in *Engineering-News-Record*, Sept. 25, 1919, p. 606.

On the same curve sheet are plotted a number of hydraulic gradients for various velocities obtained from piezometric reading at piezometers 1 to 14. The form of these curves is well illustrated and also the fact that the recovery of pressure continues after the downstream end of the discharge cone for a length of three diameters. This meter is special in that the downstream half angle is 6 deg. 30 min. instead of 2 deg. 30 min. as is usually the case.

The loss-of-head curve at the bottom of the sheet shows that if three diameters of straight pipe be included with the meter the loss of head is closely given by the expression $h_l = 0.0017\ V_t^2$, which is very nearly the same as for meters of this size with the downstream half angle 2 deg. 30 min. The economy in the length of the meter is very evident as shown by these curves of actual test.



CURVES FROM TEST OF SPECIAL VENTURI METER MADE AT UNIVERSITY OF PENNSYLVANIA

Board of Review Justifies War Construction Methods

Two Engineers and One Accountant Appointed by Assistant Secretary of War After a Long Investigation Make Some Recommendations for Future Emergencies

IN THE summer of 1918, Benedict Crowell, Assistant Secretary of War, asked three civilians, two of them engineers and one an accountant, and all men of the highest prominence in their respective professions, to "review the construction work rendered necessary by the war emergency and done by or under any subdivision of the War Department." The investigation was to be made "particularly to cover the methods, procedure and results of the Construction Division of the Army." The Board first met Sept. 11, 1918, and immediately started work. It rendered a preliminary report just after the armistice and a final report Aug. 31, 1919. This final report has just been issued by the Government as a printed book of 381 pp., which constitutes one of the most important contributions to the history of the engineering of the war, as well as an interesting comment by experts on a subject on which unexpert and partisan congressmen have been unusually verbose in this presidential year.

The board was composed of Francis Blossom, of the firm of Sanderson & Porter, Engineers, chairman; Charles A. Morse, chief engineer of the Rock Island Ry. and assistant director of operation, engineering and maintenance, United States Railway Administration, and W. Sanders Davies, public accountant, and president of the American Institute of Accountants. Thomas H. Pierson was assistant to the Board and in charge of the Washington office.

The report is long and involved. The board had full authority to require all available information from any of the agencies of the War Department and it apparently did so. Its conclusions are given in repetitive detail, with successive abstracts of the main deductions. They all reduce to a comprehensive endorsement of the War Department's policy and practice and especially of the cost-plus contract as used by the Construction Division. There are some recommendations for the future which differ from the practice of the past, but they are the results of experience and in the eyes of the board could not necessarily have been foreseen. The board is strong in condemnation of the lack of preparedness of the country which forced the terrific scramble of the summer of 1917, but on the whole agrees that the construction work on this side of the ocean—it did not look into the work of the A. E. F.—was remarkably well done.

As a byproduct of its investigation, the Board comes out strongly for a Department of Public Works—though not under any specific name—which will include even the construction work of the army. It also commends the decision to vest the construction work in the Cantonment, later the Construction Division, and not to give it over to the Corps of Engineers.

Abstract of the conclusions of the report are given below:

The Board of Review found little evidence of dishonesty in War Department construction work. It believes that the greatest losses to the Government were not due to dishonesty, but were caused by the use of inadequate methods and men who were unfit or incompetent for construction tasks put upon them. The giving of important positions to men who were untrained in the work they had to direct was costly and jeopardized the success of the war program. It may have been thought that such men would be less apt to use their positions to overdue their work or to profit by contracts placed with their former associates, overlooking the fact that incompetency of officials invites dishonesty, because of their inferior capacity to direct or stop it. Whatever the reason, vacillation and inaction were assured while such men were learning their tasks. No method more costly or more likely to cripple the work of the Army could be adopted, as the extra costs of a prolonging of the war by delays due to inefficiency of this kind could easily run into hundreds of millions of dollars and thousands of lives.

Political influence was not a disturbing factor in war emergency construction work, and there is a good ground for belief that it would not prove detrimental to the peacetime operations of a consolidated construction bureau handling all ordinary Government work.

As to the plan: It would have been impossible for the Government to build the cantonments and camps on time by purchasing materials and employing its own labor forces. Results proved that the Government had all and more than it could do to expand its own staff bureaus to meet war demands without simultaneously attempting to create and operate a large number of construction organizations.

Engineering—The method generally adopted of making only the typical plans in Washington was the only one under which the field work could have been done within the available time. The standards adopted were from the best engineering practice and could be applied to construction work without waste of time or money on non-essential details. In many cases decisions had to be made without precedent. This necessitated knowledge, judgment, and experience. Energy and boldness were shown by the engineers in quickly conceiving the plans and in accomplishing their prompt execution.

Construction—The placing of competent men in charge of each project and giving them broad general instructions and full authority over the work, the selecting of experienced contractors, and the giving to superintendents and contractors the assistance of expert advisory engineers and town planners was in line with the general policy for emergency construction work approved by the Government.

Many difficulties were met in organizing administration and construction forces of the necessary size. There were no contracting organizations of sufficient size to undertake the work that was planned, and, as those used were organized under the stress of war-time conditions, it was difficult to obtain efficiency. This organizing entailed some lost motion, but, considering the work as a whole, the efficiency was apparently no lower than might reasonably have been expected from the prevailing conditions.

Material—The methods adopted for locating and purchasing, or otherwise acquiring, all the needed materials proved effective. The procurement of some of these materials in quantity, through the medium of representatives of groups of manufacturers in Washington, was advantageous from the standpoint of speed. It distributed orders according to the existing facilities for filling them and prevented confusion and congestion in the material markets, which would have delayed deliveries. It is believed that the prices obtained by this substitution of co-operation for competition were as low as could otherwise have been obtained.

Quality of Construction—The board has studied cantonment plans and specifications and inspected the type and quality of construction used in a number of these projects. Its conclusions thereon are as follows:

All facilities that were important and reasonably warranted were furnished.

The general health, comfort, and convenience, and the

physical, mental, and social welfare of the troops were provided for as fully as was practicable.

The barracks were of modern housing type, reasonably well provided with ventilation, window screens, heat, and electric light.

An adequate supply of pure water was furnished for drinking and bathing, with modern plumbing and sewerage systems.

The kitchen, bakery, and steam laundry equipment were first class.

Facilities furnished for reading, recreation, amusement, and comfort included libraries, theaters, and post exchanges.

The civic improvements equaled, in character, those of many suburban cities and included walks, paved roads, street lighting, and fire protection. In some cantonments the buildings were painted. This added to the life and decidedly improved the appearance of the structures.

Speed of Construction—This board shares the generally expressed opinion that the cantonments and camps were built with remarkable speed.

The designs were as economical as the requirements and as due provision for the health and reasonable comfort of the troops permitted.

Delays occurred due to lack of competent workmen and mechanics. Some loss of time was caused by lack of proper supervision of labor. Most of the delays were due to unavoidable causes and emergency conditions, and all were so overcome that the construction was ready as and when needed.

In reviewing war results obtained and difficulties overcome by the industrial home army or the overseas combatant army, the essential test is believed to be the degree of success achieved and not the size of the organization or of its pay roll. In order to have the necessary workmen for this construction on hand when needed it was impossible to avoid having and paying for labor surplus when progress was slowed up by lack of materials or other causes. The board believes that, in a review of the cantonment and camp work done in 1917, for the tests of speed, quality, and cost must be substituted speed and quality.

The reported total cost of the 16 National Army cantonments and camps as of December 31, 1918, was somewhat under $200,000,000 and the average daily cost of the war to the United States was about $30,000,000. If the completion of these cantonments and camps in time to receive the army in September, 1917, and to house it during the extreme winter of 1917-18 shortened the war by only one week their total cost was saved. If it shortened the war by one or two days the total excess cost paid for speed were saved. These figures include no allowance for any saving of soldiers' lives.

The board is of the opinion that, had construction not been pushed at maximum speed, cold weather would have interfered with and caused much delay in this housing work, which, with the difficulty of training troops in severe winter weather, would have greatly delayed the mobilization, training, and embarkation of American troops for France, with results that might have seriously influenced the issue of the war.

The work of this organization was greatly aided by the good teamwork and spirit of co-operation which was built up within it by its leaders. Special mention is due of the broad vision, knowledge of character, and good judgment shown by these men in the selection and placing of their subordinates.

The conclusion of the Board of Review is that the value of the method and results used on cantonment and camp construction can not be measured in dollars or in unit costs but must largely be gaged by the usual test of army work, success or failure. In this case all evidence obtained indicates that they achieved a degree of success much beyond that anticipated.

The Construction Division of the army earned the respect and confidence of substantially all of those with and for whom it worked, especially as to its grasp of actual and probable requirements and its speed of execution. The plan of organization, methods and procedure, taken as a whole, and measured by results accomplished, seem to average higher than those of any other War Department bureau with which the board has dealt, and it can suggest no improvements therein except for certain minor changes, largely in accounting procedure, which could be made to advantage if the division were given additional authority or a military position higher than its divisional status. Its present plan of operations provides properly for centralization of advisory and directing functions, decentralization of supervisory and executive functions, and expansion to meet construction requirements of almost any character.

Its personnel showed unusual ability, energy, and courage in grappling with the big problems of design, administration, and construction which were thrown upon them and demonstrated capacity and competency to handle such work satisfactorily. The standards and methods adopted in the selection of its personnel and the character of men chosen reflect credit upon the the chief of the division and his advisers. They showed discrimination in the choice of officers, took special pains to put the right man in the right place, where he could work at maximum efficiency, and, in order to eliminate guesswork and selection based on impressions, endeavored to choose only men who had made good and to put them on a class of work with which they were familiar.

The division was itself responsible for creating its present plans of organization and operation. It developed a high order of teamwork by the use of picked men having experience, enthusiasm, and self-confidence, who seem to have been singularly free from pessimism and jealousies, handled work more by mutual suggestion and patriotic self-subordination than through orders and the exercise of authority, and realized their responsibility for promptly supplying the structures and plant facilities essential to the production work of other war bureaus. These men showed zeal, ability, and results of the highest order and were tireless in their efforts to create such a non-combatant army of workers as would ensure the quick construction of all facilities required to maintain an uninterrupted flow of supplies to the Expeditionary Forces.

The Board of Review is of the belief that this work was done at a cost which was greatly increased by national unpreparedness, but which could not have been lessened by placing the work with any other military or civilian bureau.

The Board of Review is of the opinion that the Construction Division should not be disbanded after the accomplishment of its specific war work, but should be utilized to co-ordinate and handle army construction and related work in peace times and that the Government can further its interests in no more effective way than by continuing and extending the consolidation of its construction work.

The board is convinced that the functions of design, construction, and procurement of materials should, together with authority, responsibility, and accountability, be placed with one division, corps, or department; that it should perform all non-technical War Department and Government construction work; and that such division or agency should, when necessary, co-operate with other Government agencies in the clearance and allocation of projects and of the material and labor therefor.

The fees paid to supervising engineers, except on a few projects, and the salaries paid to their assistants were very small in comparison with the responsibilities involved and the fees commonly paid for similar services on private work.

The Board of Review is of the opinion that the correctness of the decision to place this work (other bureau and corps construction) with the Construction Division and to have it act under the Secretary of War and co-operate with the War Industries Board has been proven by the successful results of such method, particularly in obtaining the speed essential to meeting army needs.

The Board of Review * * * finds that the Secretary of War acted wisely in disapproving the recommended transfer of the Construction Division to the Engineer Corps

under war conditions and is further of the opinion that the transfer should not be made under peace conditions and that the Construction Division should be entirely separated from the Quartermaster Corps.

It is the belief of the Board of Review that the Cantonment Division was better equipped than the Engineer Corps by professional and commercial acquaintance, training, and experience to deal quickly and effectively with the contracting, industrial, and labor interests which had to be relied upon to execute this work; also that the use, on the cantonment and camp construction, and on the later construction work of the War Department, of commissioned civilian engineers and constructors rather than the regular army organization, and the use of other civilian engineers who worked as Government advisers and employees and contractors, released for overseas combat service the limited number of army officers who had military training and allowed the work to be done by the men best qualified to handle it.

Cost-Plus Contract for Emergency Work

The Board of Review has made special inquiry of many contractors, constructing, and administrative officers, field auditors, advisory and supervising engineers, and other competent judges respecting the methods and procedure used and results secured on construction done under the Contract for Emergency Work. The following statement summarizes the more important opinion so obtained.

1. The contract permitted starting work promptly and pushing it rapidly. This prevented loss of time, which meant loss of money and lives and possibly of the war. The speed attained under the contract was responsible for getting troops to France in time to turn the tide which many believed had to be turned in 1918, if at all.

2. The contract could be used without change, irrespective of the size or character of the project.

3. Delay was not necessarily entailed by the frequent lack of definiteness as to general requirements or as to total structures and facilities to be provided.

4. Work could be shut down or rushed to completion at the discretion of the Government.

5. Prices of materials and labor and the quality of the work could be fixed and controlled by the Government, and disputes were avoided as to these and were largely eliminated as to overhead costs and extras.

6. The contract was unaffected by wide variations constantly occurring in the available supplies of material and labor.

7. Loss of time through the creation of new construction organizations was avoided by the selection and utilization of such existing contracting concerns as were best qualified to execute the work.

8. The contractors, subcontractors, superintendents, engineers, and Government representatives on the various projects were all working with a common interest and to the same end—to finish the work in the least time and at the lowest practicable cost under the conditions prevailing.

The board concurs in the foregoing opinions and conclusions:

The schedule of fees provided in the standard contract seems, in the opinion of practically all who were interviewed, to be generally considered as adequate and fair to all parties. The Board of Review shares this view and, had the war continued, would have suggested no material changes therein. The board has also considered the question as to whether contractors should be selected according to their willingness to do the work for less than these fees. Many such contractors could have been found. The board is convinced that such a plan, if adopted, would have proved disastrous to the execution of the war program and that an effort to save on the fee of a competent contractor by selecting another because of his willingness to work for a smaller fee would have been as false economy as to attempt to hire legal, medical, or other professional service on such a basis. Savings in fees so effected would have been wasted several times over in other ways and would also have entailed fatal delays.

The board finds that the standard contract secured maximum speed, coupled with proper quality, at a less relative cost than could have been done by any other method available and that it operated with smoothness and flexibility and prevented delays from misunderstanding and friction between the Government and its many contractors. As a rule its critics do not seem to have grasped the underlying facts and conditions nor always to have understood the nature of the contract and the reasons for its adoption. No form of war emergency construction contract could eliminate waste, extravagance, or inefficiency which, under war conditions, could only be minimized through the use of experienced Government representatives on the work of administration and supervision, and competent contractors on the work of execution.

The board finds that the use of this form of contract, as finally developed, was well justified and contributed to the success of the emergency construction program; that by its use speed was attained in war construction projects; and that it is probable that such work could not have been performed in the time available without it or its equivalent.

The board finds that the cost plus with sliding scale and fixed maximum fee contract can not be judged alone by the cost of work done thereunder as it was designed primarily to, and did, secure speed; that unit labor costs thereunder were high, as in all war work, but that the causes did not lie in the contract itself, but rather in the conditions surrounding its application, which were principally high wage scales; overtime; use of any labor obtainable to push work; inefficiency for floating labor; labor shortage; lack of experienced foremen and superintendents; and poor management by some contractors.

The Board of Review is, however, of the opinion that in the matter of fees the standard contract could have been simplified by the use of a block system of fees based on the payment of a fixed amount for the first block of the cost and of suitable additional amounts for each additional block; and that under such a block system of fees a concern proven satisfactory on emergency construction could probably have been kept at work continuously throughout the war period for a lesser total fee than by subdividing the same work among several contracts executed with him or others.

The board is also of the opinion that Government interests would have been helped in some cases by the insertion of a clause in the standard contract requiring that the duly appointed representative of the general contractor or subcontractor who, under the contract, was to be kept at the site, be one of the chief executives of the corporation or a member of the firm. Much work had to proceed on general plans while details were being developed and this involved decisions respecting locations, roads, transportation, handling of materials, etc., which required that the contractor's resident executive be a man of large caliber. The insertion of the provision mentioned would have enabled the Government to compel a negligent contractor to give the work the needed quality of supervision. In some instances the contractor tendered his organization and invited the constructing officer to use it. This attitude threw responsibility and duties upon the latter which the contractor alone should have carried.

Suggested Contract Improvements

The Board of Review has condensed some of its views and conclusions into the following suggestions for improvements:

Have all Government agencies use types of standard construction contracts so far as possible.

Adopt the standard form of Contract for Emergency Work when conditions make it advisable that Government construction be done on a cost-plus basis, as this form of cost-plus contract created by the General Munitions Board and used by the Construction Division of the army was of great value in accomplishing the war emergency work.

Create by a qualified board or committee corresponding standard forms of lump-sum and unit-price construction contracts for ordinary peace-time use.

Prohibit the use of multiplicity of construction contract forms varying widely and unnecessarily in type, form, and compensation of which many instances may be found among Ordnance contracts.

By adopting contract standards such as those above mentioned, the Government will be better protected and will save time and money and the contractors will receive fair and uniform treatment and the amount which the Government has to pay for its construction will not depend upon the experience of its Government representative who is charged with the negotiation or be controlled by patents or by the special trade or professional knowledge of the contractor. Any compensation properly due him for these features should be specific and not be used as a basis of bargaining as to the fee to be paid for the construction of the needed plant facilities.

Consolidation of Government Construction

With respect to these and related matters the board is of the opinion:

That as, under peace conditions, and to a large extent under war conditions also, nearly all construction and the engineering incidental thereto is of a civil character, the principal exception in each instance being that which relates to artillery and combat work, civilian engineers and experts must constitute the main reliance of the country for the construction work of both peace and war.

That as time does not permit including thorough and varied training in practical commercial work in the education of army engineer officers they will be outclassed by civilian engineers on most construction work, but should, nevertheless, be given as much of such training as possible because they will otherwise become a clog instead of a help to those whom they may be called upon to direct but whose work and problems they can not properly understand without it.

That, so far as practicable, the directing and executive engineers on most Government construction should be drawn from civilian life, be unhampered in their work by differences of military rank and stand on peace and not a military or war basis as to classification and relationships.

That, if the organization handling the nation's connational construction and engineering work that civilians can do, because, in another war, its engineers will again be unable to handle such home work in addition to their military work and that the practical training given to army engineers in peace time should be provided by detailing them to work on construction on a parity with civilians, as any plan which gives them the special status of military rank on construction work will prove unsatisfactory because army rank tends to insulate them from the most educational features of the work.

That, if the organization handling the nation's construction in times of peace were directed by the War Department, it would in time of war be disrupted by the calling of its chiefs into active service at the very time it was most urgently needed for war-emergency work.

The board is impressed with the benefits which were secured by consolidating the construction work of various War Department bureaus and believes that much other Government construction could be merged to advantage and that national preparedness for peace or war would be effectively promoted by creating a Federal construction bureau with an essential civilian organization and personnel to administer and supervise all Government construction except that of a technical military character. Such a bureau could handle more expeditiously and economically than the War Department many construction problems which, in the past, have been loaded on to the latter, which can not be made an efficient peace-time administrative-construction bureau because its functions are essentially military and its operations are hampered by complications of military organization and rank inseparable from army activities. The projects of such a construction bureau would afford better opportunities for the practical education of army officers, and cost the Government much less than the present plan of placing much of such work under the War Department. All of the principal national engineering societies advocate the formation of a construction bureau of the character above described.

To handle properly a large volume of Government construction work control must be exercised through centralized supervision. This should fix the general standards and policies and be decentralized as to the design and execution of individual projects, so permitting the proper adaptation of general plans to local conditions by those in direct charge of each piece of work.

The War Department alone should not be relied upon and made responsible for the success of the army in war. In peace times its status is necessarily one of inaction and such an organization, normally inert, can not of itself expand speedily to the full proportions necessary for meeting all army needs in a war emergency and assure the country of protection. In time of war the War Department is expanded under great strain from a relatively small to the largest Government department. At such times other departments, particularly those having to do with internal affairs, are contracted and many of their activities practically suspended. As the Government has to utilize civilians to perform its construction work during war it is desirable to relieve the War Department from dangerous strain in war by having a peace-time construction organization which, being unhampered by military regulations, could work at maximum efficiency and in war could handle emergency construction speedily and effectively. A sufficient amount and variety of work to keep its personnel well trained would be provided under such a plan without enlarging the normal and proper scope of Federal activities.

Observation indicates that satisfactory results in the war emergency construction have been accomplished largely by, and in degree proportionate to, the freeing of experienced constructors from control by Army officers. This leads to the conclusion that neither Military Academy training nor Army experience can of itself insure fitness or ability to handle construction work.

After full consideration the Board of Review finds that Government construction work for public use should not be done by the War Department and that the execution of some of the construction now assigned by law to that department should be transferred to a civilian construction bureau.

Officers' Reserve Corps

The Board of Review is of the opinion that the Officers' Reserve Corps members engaged on the emergency-construction work of the War Department could have rendered better service if the time available for their training had permitted giving them more instruction in Army-organization methods, relations and discipline, as many civilians, especially the older ones, entering the Army do not seem to grasp the need of conforming to its requirements. There also seems to be considerable room for improvement on the part of the officers of the Reserve Corps and those of the Regular Army, who represent respectively the civilian and military branches of engineering, in developing adaptability to the other's viewpoint.

Locating a Railroad by Airplane

According to a recent "news letter" of the Air Service, United States Army, locating a railroad by airplane has been carried out by the Third Aero Squadron, Camp Stotsenburg, Philippine Islands and one long flight has enabled a railroad engineer to determine which one of three general routes will be used for the new road. It is stated that many months and thousands of dollars have been saved in the work. Instead of three parties of locating engineers being sent out to make the survey, only one will now be necessary. The new line is projected by the Manila Railroad Co. as an extension of its line from Cabanatuan through parts of the provinces of Nueva Ecija and Nueva Vizcaya to Bayombong. The first trip was made with the chief engineer of the railroad, passing over Mount Arayet and then following the Pampanga River until the railroad line was picked up at Gapan. The river was followed from Cabanatuan on to Pantabangan and over Mt. Pangloriahan, thence to Bayombong.

Extending Benefits Assessments to Street Railways

Electric Railway Commission Urges That Property Benefited Stand Part of Cost of Street Railway and Subway Extensions

BASING their argument upon the well-known theory and practice of assessments for benefits as an equitable means of financing streets and sewer improvements and pleading that landowners as well as street-car riders should bear part of cost of the electric railways service, the Federal Electric Railway Commission, in its recent report, urges that wherever practicable some or all of the cost of street railway extensions, subways and elevated railways be assessed upon the owners of the property benefited. By way of illustration it summarizes estimates made by the City Club of New York in 1906, showing that a subway extension costing $7,375,000 increased the value of the property in the district benefited by $49,200,000, or nearly seven times. Commenting on these figures and then elaborating its argument the commission says:

Is it not in accordance with the laws of economic justice, then, that the landowners, as such, should share the benefit of increased land values with the public? Instead of the cost, $7,375,000, of the Manhattan extension being borne by the owners of land in the newly served territory, it was capitalized and translated into an annual charge of $350,000 or more, a burden which had to be borne out of the car fares and which today helps to intensify the financial predicament in which the company finds itself. If the public pays out of its fares for the cost of maintaining and operating the line which will bring the outlying land owners such enrichment, should the latter not share with the public out of that enrichment, depending upon the degree in which he is benefited, by paying for or by helping to pay for the initial cost of construction of the line? That such a solution is just is rather significantly shown by the fact that in a number of cities land owners in outlying districts have offered spontaneously to contribute large sums to the company to assist it in constructing certain extensions.

The present predicament of the street railway companies is in many places partly due to overbuilding, a fault traceable to political or business pressures exerted by speculators in suburban lands who had little or no financial responsibility in connection with the street railway extensions which they caused to be built for their immediate benefit. This action of the suburban land owners of certain cities, on the other hand, is a significant expression of enlightened self-interest and a sound, constructive recognition of a fundamental principle of justice. The establishment of that principle by law, whether by changes in city ordinances, state statutes or state constitution, should, in our opinion, not be delayed. This thought is especially recommended to the attention of a number of communities which are now facing the necessity of extensions or rapid transit improvement.

Three points in this connection should be briefly touched upon: (1) The amount of the assessment on any owner would probably have to become fixed by an appraisal some time after the construction of the improvement, and the owner should be given the option of paying his assessment in installments over a course of years. Consequently, the actual first financing of the extension might have to be by the city. (2) It will doubtless be urged by some that such a system for building extensions would lead to municipal ownership. On the contrary, it seems to us that, if properly administered, it could, by reducing the acuteness of the fare question, serve with much force to offset the pressure for municipal ownership. (3) As to the problems incident to allowing a private company, for a nominal rent and in return for undertakings as to repair and maintenance, to take over or use public property, similar problems incident to similar arrangements have already been ably and effectively handled in Boston and a number of other cities under state or municipal regulation in connection with subways and other structures.

The Commission then takes up some of the broader aspects of the subject, including the relations of the street railway and rapid transit to city planning the housing problem and social welfare and concludes by urging that the plan, notwithstanding legal obstacles, be given a trial:

If objection to the employment of such principles in constructing extensions be made upon the ground that public officers and land owners along the line of the proposed extension are thus given the power to vote such extension, let it be remembered that the problem of extensions is not only a serious financial problem, but is also esesntially and finally a long-range social problem. The development of a city's street railways should be guided primarily not by the fortuitous financial experiences of a small group of bankers or real estate operators. It should be guided by the foresight and vision of those who are officially responsible for planning the city's growth and life, in terms of its water supply, its light, its streets, its sewers, its schools, its parks, its playgrounds, its civic centers, its night amusements, its community life, its libraries, its hospitals. It should be guided by those whose public duty it is to be interested in the health and happiness of the average city toiler and his family of growing children.

The call for municipal ownership today does not all emanate from dissatisfaction with the service in a narrow sense as riding facilities. It is largely an expression of feeling on the part of many that the street railway, instead of helping to make conditions bearable, is contributing to making them unbearable; that it is not, with the functions and powers which it exercises, accomplishing what it might accomplish to reduce the abnormalities of city life. While areas within the city remain undeveloped and unserved by adequate transportation, toiling thousands find themselves dragged out miles further—not to green lawns and spaces, but to a repetition of the same ugly congestion that they knew in the city. The time will come when employers and educators will be forced to take cognizance of the impairment in working efficiency caused by such inconveniences as are suffered by the traveling public today. The time is approaching when cities will find it necessary to extend their street railways, not on the basis of new property values or the earnings of any single line of rails, but on the basis primarily of what will be most consistent with the public health and public economy.

These motives are strongly at work underneath our situation today. The public's control over stock issues, service, routes, extensions, etc., is needed today not only in order that as part of a plan for restoring the credit of the street railways the community's interest may be protected by the guarantee of efficient management, but also because the city of today is taking a more conscious, constructive interest in the city of tomorrow. That interest can be recognized and cared for under private operation if the public authorities have the suggested control. If such control does not come into effective existence, then one of the strongest forces making for municipal ownership will continue to exert an increasing influence.

Your commission trusts that this principle of paying wholly or in part for the construction of extensions out of special taxation of benefited property will be seriously studied and adopted, where possible. It seems fundamentally sound. While its adoption presents legal difficulties, as has the adoption of many another newly recognized industrial-economic relation, it holds great promise for reducing the financial problems incident to public transportation.

The entire body of conclusions and recommendations of the commission's report, with editorial comment, appeared in this journal, Sept. 2, pp. 480 and 436.

Monolithic Brick Pavement Fails From Expansion

Heat Causes Brick Slab To Separate From Concrete Base and Finally To Rupture With Violence

By M. W. Watson
State Highway Engineer, Topeka, Kan.

Doubt as to the suitability of monolithic brick pavement for Kansas is raised by the behavior of the first rural road of this type constructed in that state. Explosions of the brick surface have called for a number of repairs to a road only a year old. Showing generally a good joint bond, the brick top bulged up from the concrete base and finally the surface was broken and forcibly dislodged. Improved methods of construction may be able to eliminate the danger, but until their efficacy is demonstrated it is thought that the adoption of monolithic brick for Kansas highways may well proceed with caution.

Between the cantonment at Fort Riley and Junction City there was a pre-war waterbound macadam road 30 ft. wide which soon succumbed under a war-time traffic of 8,000 vehicles a day. It was thought that a 20-ft. monolithic brick pavement, properly constructed, would withstand this traffic and in the autumn of 1918 its construction was begun. The work was designated Federal-Aid Project 12. Delay in procuring materials greatly prolonged the construction, but the urgency of the improvement made it necessary to proceed even at low temperatures and, therefore, the contractor was frequently obliged to protect the pavement from freezing.

Large trees border both sides of the road and its surface is constantly shaded. The grade is practically level. Ample drainage is provided for surface water but it was not practicable to elevate the road entirely above flood overflow. The cross-section, Fig. 1, shows

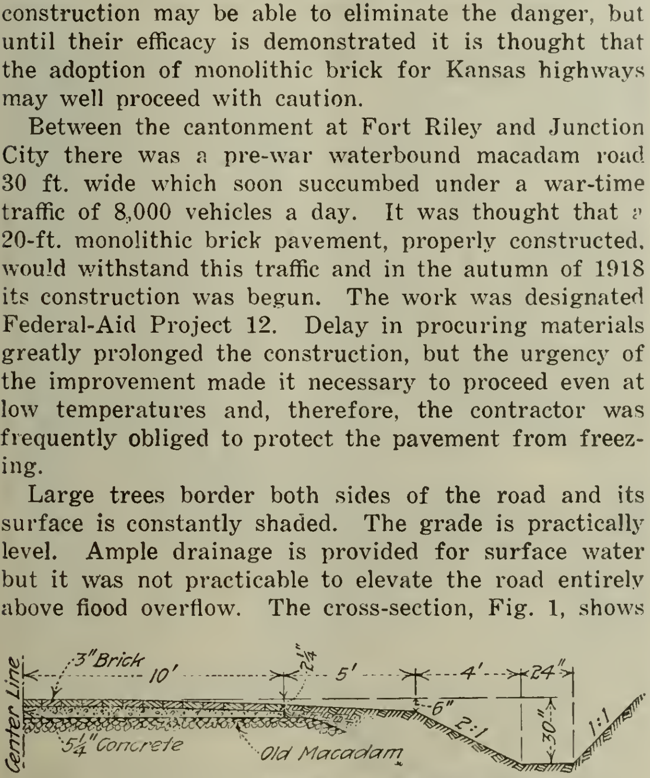


FIG. 1. SECTION OF PAVEMENT FRACTURED BY HEAT

the design. The old macadam was carefully reshaped and rerolled to form a substantial and uniform sub-base. Having this rigid sub-base, the slab was designed only slightly thicker than is general practice for concrete pavement.

A 1:3:5 concrete was used for the base. The stone, which was graded from ¼ in. to 1½ in., had a French coefficient of wear of three and a toughness of approximately five. Mortar briquettes made with sand pumped from the adjacent Republican River, showed 4.4 per cent greater strength than briquettes made of the same cement and standard Ottawa sand. Vertical fiber brick 3 x 4 x 8½ in. were laid with the rough wire cut surfaces at top and bottom. To give grout space, the brick had grooves on one side aggregating about 30 per cent of the surface area. Lug bricks were not then made by local plants.

Steel forms and a multiple steel templet were employed for placing the base concrete and the 1 : 3 dry mortar cushion. The brick were laid directly on the mortar bed and after culling were rolled with a light hand roller. Occasional bricks, lifted after rolling, showed that the dry mortar had become sufficiently damp to adhere to their bottoms. A grout mixing machine was employed and great care was taken to make certain that the grout penetrated to the bottoms of the joints.

Service observations of the pavement are for the year 1919. As far as can be seen the effect of traffic has been slight; the surplus grout is not worn away. Transverse cracks have developed about every 60 ft. and approximately 400 ft. from one end there is a longitudinal crack about 250 ft. long. None of these cracks show signs of wear.

Construction was completed late in December, 1918, and in the early spring of 1919, when the temperature reached a fairly high level, an explosion occurred at

FIG. 2. SHATTERED PAVEMENT AFTER FAILURE

about midlength of the project. For a space of about 12 ft. the bricks separated from the base and were scattered promiscuously. During the summer of 1919, four additional explosions occurred in the total length of 1.12 miles. Examinations showed that the grout had penetrated the full depth of the joints. In one instance, when the writer examined the road a short time before the explosion, it was found that the brick slab had lifted from the base for a span of 15 ft. A truck in passing over this bulge caused a variation in height of about 2 in.

The view, Fig. 2, shows a damaged section of pavement after failure. Brick taken up when failure had occurred, as is indicated by Fig. 3, disclosed very little adhesion to the base but the grout joints remained intact in several rows. The bricks were not shattered nor crushed, but were sometimes broken in the middle. In two cases the base remained intact, indicating a complete separation and a probable greater stress in the surface than in the base. The failures occurred at different points along the road; some at construction joints and some between construction joints; some in the shade and some in the sun.

It is evident that a monolithic brick pavement should not be built at low temperature, without expansion joints, as the materials become fixed in place when contracted and the resultant expansion on raising the temperature is fatal. The use of expansion joints at frequent intervals might serve as a preventive, but their use in monolithic brick is hardly practicable and if used the true monolithic character of the pavement is somewhat abridged.

To repair the breaks the base was cleaned of all surplus material and the sand cement cushion was removed.

FIG. 3. JOINTS INTACT BUT SLAB BOND POOR

Where a failure in the base occurred, the base was replaced. A row of bricks was laid along each edge, set in mortar and grouted, to form a header, with ample room for expansion at the end. A new sand-cement cushion was placed between the headers and clean bricks were laid to fill the gap. These bricks were bituminous filled on the assumption that they would serve as an expansion joint in the event that too great stress again came at the same point.

A study of the action of this pavement leads to a number of conclusions as to the probable action of monolithic brick pavements under similar conditions.

The climatic conditions of Kansas are extreme but compare favorably with a number of the middle western states. The low temperature sometimes reaches 20 deg. F., the high temperature 110 deg. F. in the shade and at least 140 deg. F. on the pavement in the sun. A pavement may be subjected to stresses of extreme violence by sudden changes of temperature when a variation of 40 deg. F. in a few hours is not uncommon. Sufficient experiments have not been made to show just what thickness of slab will withstand the thrusts brought about by changes of temperature. It is apparent that a 3-in. slab of brick, which at points fails to adhere to the concrete base, is not of sufficient thickness, and there is no guarantee attached to monolithic brick work that will insure this adhesion. The use of the tamping template and the omission of the sand-cement cushion may solve the problem, but until it has been satisfactorily demonstrated that a slab of this character will remain in place, the conservative engineer will seriously question the advisability of building a large mileage and will turn to the older and safer methods.

Sand-Lime Brick Production

The sand-lime brick produced in the United States in 1919, according to an estimate made by the United States Geological Survey, Department of the Interior, amounted to 145,000,000 brick, valued at $1,725,000, an increase of 47,000,000 brick and of $841,000 over 1918. The maximum output of sand-lime brick—227,344,000 brick—was made in 1916, but the maximum value was that of 1919.

Flood Protection Project for Council Bluffs

Flashy Hill Stream Overflows Channel Crossing Flat Lands of City—Propose 2½-Mile Diversion for $897,300

AN OPEN channel diverting Indian Creek from its present channel through the city and discharging into the Missouri River near the upper end of Council Bluffs, Iowa, is the method of protection against the floods in this creek which has been recommended in a report to the city authorities by Alvord & Burdick, consulting engineers, Chicago. The city has a population of about 38,000, which is estimated to increase to 100,000 by 1950.

At present the creek flows south through the entire length of the city, as shown by the map, Fig. 1, and

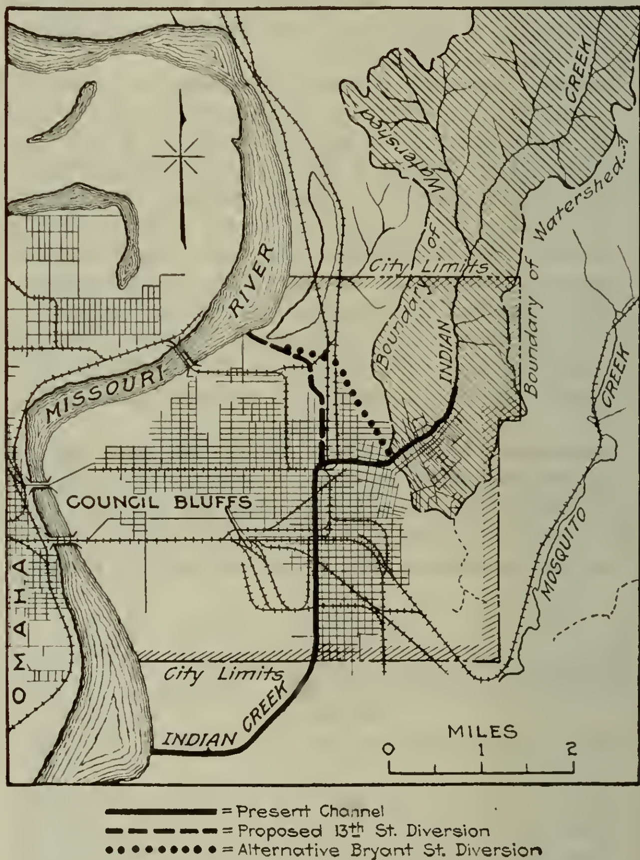


FIG. 1. INDIAN CREEK FLOOD RELIEF PLANS FOR COUNCIL BLUFFS, IOWA

its floods have been a continual source of trouble in an area of about 480 acres comprising business, railway and residence sections. This area has been flooded about a dozen times in the past twenty years. Not only has material loss been sustained by the municipality and the property owners, but the flood hazard has tended to reduce property values and to retard the development of the city. City expenditures for replacing bridges, clearing the channel and removing deposit from streets and alleys after floods have aggregated $412,000 in 36 years or about $11,475 per year. Damage to dwellings, industries and railways is estimated at $22,000 per year, or a total expenditure of $33,475 per year due to floods in Indian Creek.

Although the city lies mainly on the flats or flood

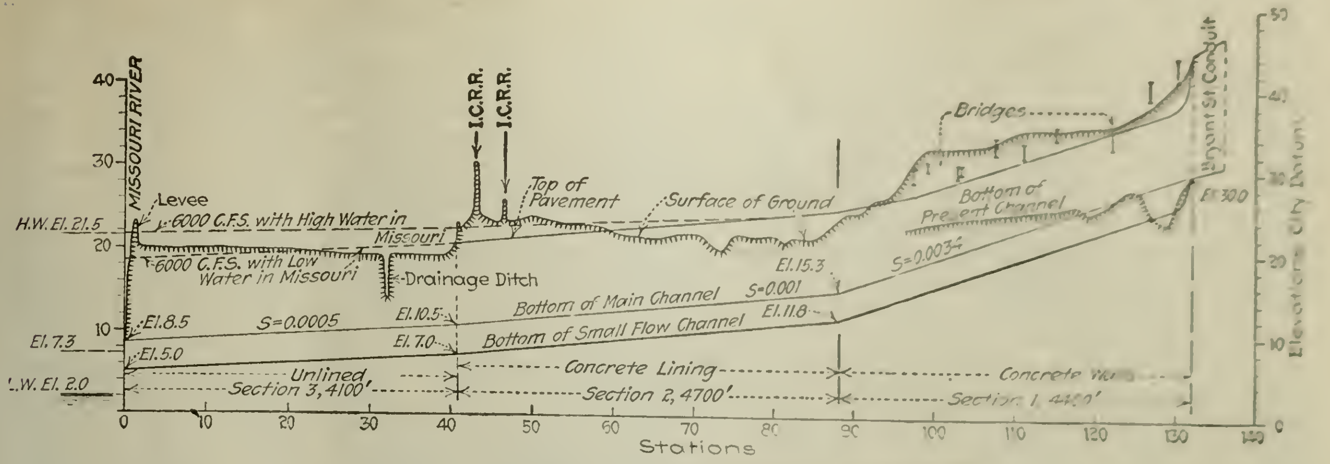


FIG. 2. PROFILE OF CREEK DIVERSION CHANNEL

plain of the Missouri River and has 66 per cent of its area within 10 ft. of the extreme high water level, the heart of the business and residence districts is on higher ground and lies in the path of Indian Creek below Bryant St., at which point it emerges from the hills. Above Bryant St. the creek has a drainage area of 11 square miles and a fall of 270 ft. in 7 miles; but thence to its present discharge at the river it has a fall of only 30 ft. in 5 miles and the slope and cross-sections are insufficient to carry off the floods which originate in the hills. In the flat land the creek does not receive much surface drainage, as its bed is but little below the general level of the ground and its channel lies between artificial banks 10 to 20 ft. high. Below Bryant St. the present channel is crossed by 23 highway bridges and 19 railway bridges.

It is estimated that the greatest floods have reached a rate of 3,500 sec.-ft. and that the channel has a capacity of 5,000 sec.-ft. in the hilly ground above Bryant St. but only 1,200 sec.-ft. in the flat part of the city. In planning protection works it is considered necessary to provide for a maximum flood rate of 6,000 sec.-ft. in view of the future development on the lower part of the Indian Creek drainage area. At present, about 85 per cent of the drainage area is in its natural state or under cultivation, but the report points out that the rate of runoff from a residential district with paved streets and sidewalks will be two or three times as great as that from the present unimproved lands.

Three main projects are discussed in detail in the report. A diversion channel 11,500 ft. long from Bryant St. to the river; the enlargement of the present channel through the city for a distance of 26,550 ft., and a diversion channel 13,200 ft. long from 13th St. to the river. The estimates of cost are $2,046,400, $1,421,000 and $897,300, respectively. A covered conduit would be required for a considerable part of the first plan, ranging from a single channel 15½ ft. deep and 16 ft. wide, to four channels 13 ft. wide and from 9 to 13 ft. deep. Although an open channel would be practicable for the second plan, it would have to be confined between vertical concrete walls for some distance, owing to the high cost of land.

An open channel with sloping sides, partly lined with concrete, can be built on the third route, except that for about 4,000 ft. at the upper end there would be vertical retaining walls. The profile of this recommended channel is shown in Fig. 2. The typical cross-sections, shown in Fig. 3, provide for a wide storm water channel with a central ditch for dry weather flow. The fall per mile is 18 ft. and 8.2 ft. in the two concrete-lined sections and 2.7 ft. in the unlined section, with respective velocities of 19, 12 and 5½ ft. per second. This is equal to the first in point of efficiency and is recommended on account of its much lower cost, which is due to the small number of bridges and the avoidance of expensive

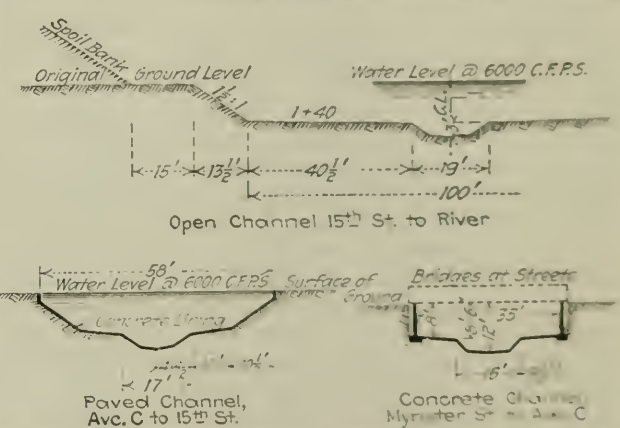


FIG. 3. SECTIONS OF LINED AND UNLINED CHANNELS

land. In view of the damage and expense due to the recurring floods it is considered that the cost is well justified by the adequate flood relief which it will insure.

In all these projects the velocities will be sufficient to prevent material deposit of sediment in the lined channels through the more valuable land. For the unlined portions of the channels it is considered more economical to remove the sediment periodically than to incur the higher charge of interest on the cost of lining. In the hilly country above Bryant St. the creek causes trouble by washing the banks and will overflow at some future time when the city has been developed to its present northern limits. It is proposed, therefore, to improve and line the channel with concrete from Bryant St. up to the city limits, at a cost of $277,000. This would be an addition to any of the three projects for improvement below Bryant St.

Relief from the floods in Indian Creek has been under consideration for more than forty years and numerous plans have been proposed, including tunnels westward to the Missouri River and eastward to Mosquito Creek

The method of controlling floods by a detention reservoir with dam is not applicable in this case, owing to the large extent of the drainage area which lies within the city limits and below the site for a dam

Floods in Indian Creek are caused generally by short sharp storms rather than by long and steady rains, the creek overflowing in from 30 minutes to 4 hours after the beginning of rain. For this reason, statistics of 24-hour rainfall are not of much value in studying the flood conditions, but of greater value are the records from tipping gages at places subject to similar rainfall conditions. From a study of such records it is estimated that for storms of 1¾ hours, which is about the period of concentration on this drainage area, the maximum rainfall would be 2.3 in. per hour About once in five years there might be a fall of 1.15 in. per hour and a fall of 1.75 in. per hour for 1¾ hours might occur once in fifty years.

Ten Years' Building and Housing Activity in New York

TEN YEARS' statistics of building activity in the several boroughs of New York City have just been prepared at the request of the authorities concerned with governmental study of the housing problem. They show that 1920 is equal in building activity to the most active year in the preceding decade, and because of the high price level exceeds all others in the total cost of construction involved. But this total includes an abnormally low amount of dwelling construction. In particular the amount of apartment house construction is exceedingly low. This phenomenon is known to be in evidence throughout the country, but it has not yet been set forth in such explicit form as in the New York tables reproduced herewith. These tables cover separately the Boroughs of Manhattan (old city of New York), Brooklyn (old City of Brooklyn, containing large areas as yet only partly built up), Bronx (the rapidly growing residential district in the northeastern part of the city), and Richmond (Staten Island, largely open country with separate villages). The different characteristics of the areas affect the tabulated data in obvious manner. Differences in the form of the statistics compiled make comparisons of the several tables inexact.

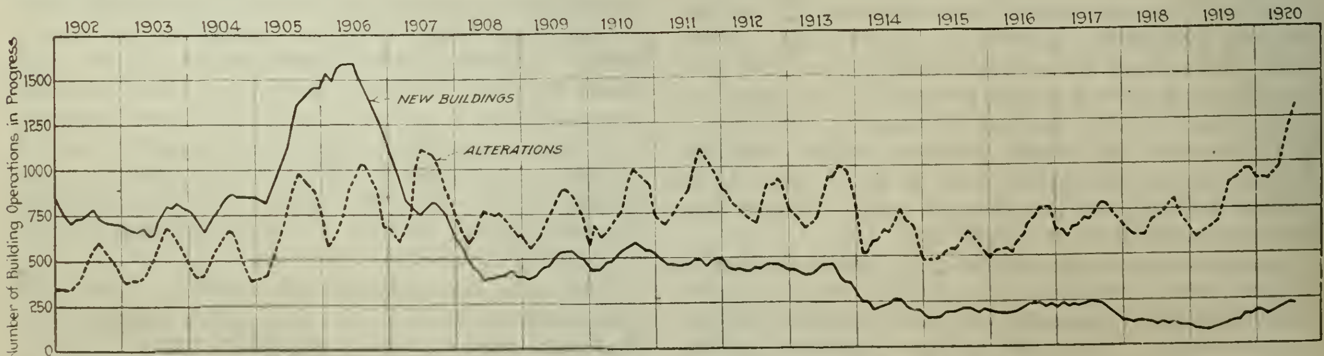
In all cases, it should be noted, the 1920 figures are given for six months only, and the probable figures for the year are a little less than double those for the first half (in Manhattan building operations for the first six months tend to run about 57 per cent of those for the year, according to R. P. Miller, superintendent of buildings).

In the general building field the most significant figures are those of Manhattan. It will be seen from the fourth column of the table that the value represented in building operations showed a declining tendency after 1912, very sharply accentuated after 1916. In 1919, however, operations reached a figure very close to the average of the preceding nine years. With prices increased somewhat since 1919, the figures for the current year promise to show at least 70 per cent increase over the preceding year. The following columns of the table (which form part of the totals given in the first group of columns) indicate prominently not only the relative insignificance of housing construction in this borough but also the present depression of apartment house construction. This is commonly interpreted as being a result of the recent agitation over rent problems within the past year.

In Brooklyn, while the value of 1920 building will not exceed that of 1919, it is far ahead of the figures for prior years, both in total value and in number of buildings. The figures are on a slightly different basis from those in Manhattan, as they refer to permits issued, instead of applications filed. House building is a far more important part of building in Brooklyn than in Manhattan, but it will be seen that the expenditure on housing for 1920 will be very far below that for 1919, and not far above the average for the previous ten years. Activity has concentrated in one-family and two-family dwellings, and fallen off in apartments.

The Borough of the Bronx shows the same phenomena in even more pronounced fashion. The expenditure on apartment house construction for 1920 will be less than one-fifth that of other years in the decade, while one-family and two-family house construction will be about normal, as will also the total expenditure on building work. In Richmond, where new housing is confined to the construction of one-family dwellings at present, activity has somewhat increased. But in considering the Richmond figures it is necessary to take note of the very low cost per dwelling ($2,800), and the slight increase of this figure from the 1915 figure of about $2,000; it appears that dwelling house activity has been kept up largely by turning to cheaper and smaller construction, since building costs are not far from three times those prevailing in 1915.

Besides giving a picture of building activity and of the present status of housing provision in New York City, the tables contain much miscellaneous information concealed in their figures. Thus, in Manhattan the average cost of tenements (includes all multi-family dwellings except hotels) in 1919 was in the neighborhood of $7,500 per apartment, while in the Bronx the average



BUILDING AND ALTERATION WORK—BOROUGH OF MANHATTAN

TEN-YEAR BUILDING ACTIVITY—IN FOUR BOROUGHS OF NEW YORK CITY

MANHATTAN
(Applications Filed)

	Total New Buildings			Dwellings		Tenements			Other Residence Buildings	
Year	No. of Applications	No. of Buildings	Estimated Cost	No. of	Estimated Cost	No. of Building	(Apts.)	Estimated Cost	No.	Estimated Cost
1910	778	838	$96,703,029	43	$1,906,300	208	(7,600)	$36,923,000	7	[illegible]
1911	771	840	98,537,275	39	2,263,500	194	(7,933)	29,178,000	[illegible]	[illegible]
1912	691	757	116,325,135	28	1,532,000	182	(6,379)	30,452,000	12	[illegible]
1913	508	577	73,970,685	32	2,761,000	158	(6,337)	22,267,200	[illegible]	[illegible]
1914	375	411	45,471,165	21	1,682,000	133	(5,141)	18,916,000	[illegible]	[illegible]
1915	418	489	64,652,869	25	792,500	193	(6,436)	24,960,500	[illegible]	[illegible]
1916	510	564	114,690,145	38	3,065,700	183	(7,721)	37,841,500	27	[illegible]
1917	279	321	29,068,525	5	420,000	23	(838)	2,661,000	6	[illegible]
1918	178	182	8,507,000	4	215,000	9	(395)	1,780,000	1	[illegible]
1919	368	379	72,283,061	19	1,904,500	44	(1,801)	13,576,000	14	[illegible]
1920 (6 mos.)	234	434	67,382,458	10	555,000	15	( )	7,925,000	2	[illegible]

BROOKLYN
(Permits Approved)

	Total New Buildings			Single-Family Bldgs.		Two-Family Dwellings		Tenements	
Year	No. of Permits	No. of Buildings	Estimated Cost	No.	Estimated Cost	No.	Estimated Cost	No.	Estimated Cost
1910	2,871	5,770	$34,813,720	(Incl. in next column)		4,046	$17,206,930	563	$7,123,[illegible]
1911	2,634	5,288	32,598,240	(Incl. in next column)		3,720	14,624,495	549	[illegible]
1912	2,595	5,105	36,472,377	2,021	$7,249,790	1,215	5,387,725	763	[illegible]
1913	2,250	3,616	30,719,101	1,227	4,344,925	857	3,833,820	533	[illegible]
1914	2,375	4,379	38,269,185	1,683	5,285,750	1,119	4,754,850	715	[illegible]
1915	2,750	5,121	40,300,600	1,580	5,436,065	1,575	7,555,620	[illegible]	[illegible]
1916	2,578	4,946	35,397,480	1,802	6,217,745	1,619	8,041,800	605	[illegible]
1917	1,658	2,696	27,613,290	1,060	3,558,000	536	2,804,250	[illegible]	[illegible]
1918	1,789	2,815	17,858,425	732	3,029,232	430	2,429,200	25	[illegible]
1919	6,348	12,889	68,137,966	4,301	22,433,825	2,221	18,267,050	295	7,811,000
1920	2,571	4,506	34,478,465	1,600	9,113,125	621	7,114,100	26	2,291,[illegible]

NOTE—Total cost of Plans and Specifications filed during the years 1918 and 1919 and the first six months of 1920:
1918.................... $23,775,950 1919 .... $99,813,643 First six months 1920 $5[illegible],624,7[illegible]

RICHMOND
(Permits Approved)

	Total New Buildings			Single-Family Dwellings		Two-Family Dwellings		Tenements			Other Residence Buildings	
Year	No. of Permits	No. of Bldgs.	Estimated Cost	No.	Estimated Cost	No.	Estimated Cost	No. of Bldgs.	(Apts.)	Estimated Cost	No.	Estimated Cost
1910	724	841	$3,363,868	441	$1,059,558	178	$509,512	2	(8)	$15,000	2	$15,500
1911	778	911	2,513,324	501	1,129,106	151	488,754	1	(4)	6,000		
1912	812	1,007	3,412,103	627	1,862,128	95	297,641	..	( )		1	1,000
1913	893	1,013	3,377,109	620	1,549,198	77	251,262		( )		3	15,500
1914	1,009	1,160	2,272,898	695	1,275,320	68	240,029		( )		3	60,4[illegible]
1915	1,212	1,381	2,630,192	695	1,409,910	112	329,276	3	(15)	28,000 not built	5	33,724
1916	1,205	1,378	4,563,716	701	1,486,431	109	407,717	1	(4)	12,000 not built	4	40,7[illegible]
1917	937	1,171	3,717,263	590	1,120,310	48	201,618	2	(110)	340,000 not built	1	9,000
1918	669	891	2,085,293	460	1,039,674	33	192,167	1	(37)	95,000 not built	1	40,000
1919	1,757	2,135	4,295,399	1,313	3,232,175	23	106,216		(.)	....		
1920 (6 mos.)	979	1,176	2,580,117	746	2,079,410	.	....		..	....		

BRONX
(Permits Approved)

	Total New Buildings			Single-Family Dwellings								
Year	No. of Permits	No. of Bldgs.	Estimated Cost	No.	Estimated Cost	No. of 2-Family Dwellings	Estimated Cost of 2-Family Dwellings	No. of Tenements	No. of Apartments	Estimated Cost of Tenements	Other Residence Buildings	Estimated Cost of Other Residence Buildings
1910	1,313	2,026	$44,034,405	347	$2,337,300	273	$1,274,600	971	20,391	$34,941,000	6	$[illegible]
1911	940	1,357	22,837,060	296	1,831,950	264	1,160,200	372	8,184	14,500,000	4	[illegible]
1912	929	1,310	34,644,400	157	975,750	187	779,200	607	12,222	25,192,500	[illegible]	[illegible]
1913	662	846	20,072,489	99	502,722	129	655,062	330	7,371	14,943,851	1	[illegible]
1914	580	735	16,347,382	116	516,200	93	413,850	269	6,2[illegible]	12,206,000	[illegible]	[illegible]
1915	701	962	28,119,100	150	642,000	67	286,700	489	11,9[illegible]	22,822,000	2	[illegible]
1916	542	650	16,725,582	67	306,500	68	312,000	224	5,200	12,012,000		
1917	359	640	8,545,475	90	488,500	64	347,000	59	1,685	3,770,000		
1918	171	206	3,991,900	30	156,000	12	62,400	22	752	1,675,000		
1919	632	1,084	21,006,865	350	2,367,000	128	865,000	95	3,311	9,654,000		
1920 (6 mos.)	403	630	11,752,180	216	1,749,600	116	939,000	16	632	2,485,000		

apartment cost less than $3,000 in the same year. Single-family dwellings in the Bronx increased in cost from about $4,300 apiece in 1915 to $8,100 in 1920; in Brooklyn from $3,450 to about $5,700; and in Richmond, lowest of all, from $2,030 to $2,800. Efforts to economize in construction costs may be seen in the fact that Brooklyn building costs increased from 1915 to 1920 in the ratio 1.66 for single-family dwellings, in the ratio 2.38 for two-family dwellings, and in the ratio 4.30 for apartment houses.

Additional to the building activity shown by the tables, there is a large amount of building alteration work constantly in progress. What an important factor in the building situation of New York this alteration work constitutes, and how it varies with relation to the variation in new building, is well shown by the accompanying diagram for Manhattan, covering the period of 18½ years from the beginning of 1902. The diagram shows that since the phenomenal peak in new building construction in 1906, following shortly after the completion of the first subway, building steadily decreased, reaching its lowest point in the early months of 1919, since which time a marked and well maintained improvement has gone on. During the same period of improvement, alteration work has increased by more than 50 per cent, and is now at a height largely exceeding that ever before reached in the history of the borough.

The figures on this chart are not comparable with those in the tables, as they represent number of operations instead of costs and actual building in progress at the specified time.

Hydraulic Fill at the Miami Conservancy Dams—III

Discharge Pipe Life Increased by Using High Carbon Steel—Friction Heads of 10 to 12 Ft. Developed in Pumping Heavy Glacial Drift

By C. S. Hill
Associate Editor, *Engineering News-Record*

EXCEPT at Germantown, all hydraulic fill embankments are of large area and comparatively little height. This has complicated embankment construction (1) by requiring construction in sections and (2) by necessitating many rearrangements of pipe line.

Friction Heads.—When the pumping plants for the five flood protection dams were planned there were few available data on friction head. For glacial drift it appeared that 4 ft. in 100 ft. would be a fair allowance for a velocity of 12 ft. a second in the 15-in. discharge pipe. At none of the operations has the head been less, generally, than this figure and never has it been as little except when pumping clay and fine glacial till, as in 1919, for the Taylorsville dam. At Lockington, another sluicing operation, the average friction head has been 6 ft. in 100 ft. Fair ranges at Huffman are 8 to 10 ft., and at Germantown 6 to 8 ft. The highest heads have been averaged at Englewood. Here a heavy gravel and sand, and high velocities, have given 10 to 100-ft. heads.

These high friction heads place a heavy penalty on the length of pump discharge and in a large measure explain the reason for the decision to haul the material from borrow to pit to sump and, at Englewood, to build a succession of sumps to allow the pumps to be shifted to higher and higher locations on the slope of the dam. Comparison of the figures indicates generally smaller heads at Taylorsville and Lockington than at the three other dams. Differences in the character of the material pumped probably account for these differences in head. It is interesting, however, to speculate whether in excavating by monitors and in sluicing there is not a presorting and pre-mingling of the solids which does not prevail when the material is mechanically excavated and delivered to hog-boxes whence it is washed directly into the sump, and whether this previous working over by flow does not put the mixture of solids and water into a condition in which it is more easily pumped.

Discharge Pipe Service.—About four complete replacements of discharge pipe line for each operation were estimated necessary, when the work was first planned. This estimate was based on the use of ordinary riveted steel dredge pipe. Fortunately this replacement expense, except for some of the pipe installed for the first operations, has been made unnecessary by

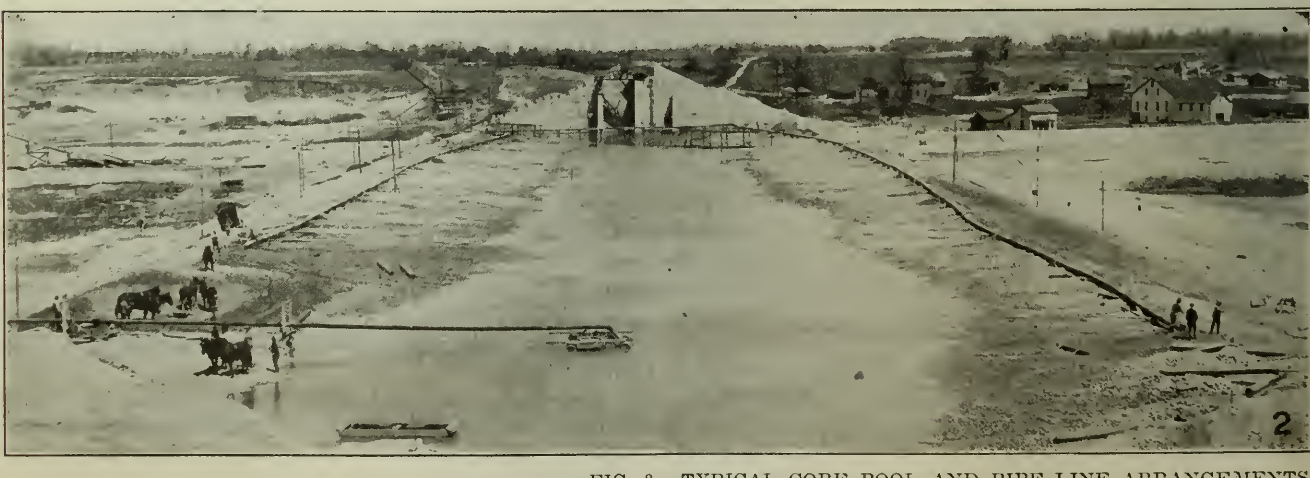


FIG. 8. TYPICAL CORE POOL AND PIPE LINE ARRANGEMENTS
(1) Sluicing Directly to Embankment at Huffman. (2) Core Pool Siphoned Off for Clay Blanket at Lockington.

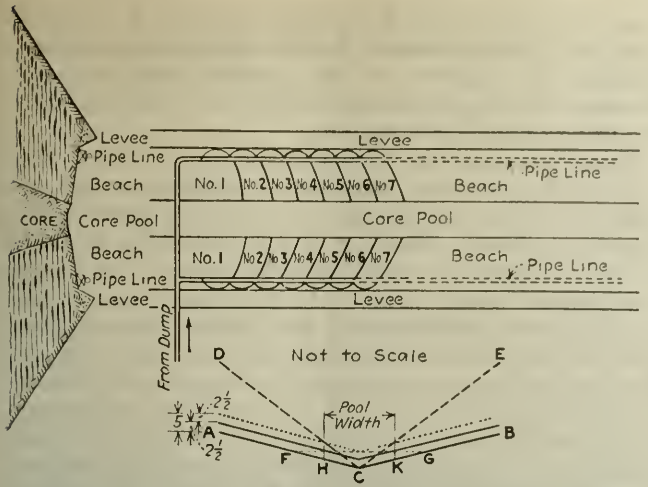


FIG. 7 DIAGRAM OF EMBANKMENT BUILDING PROCESS

the production of an alloy steel pipe of extraordinary wearing qualities. Less than 100,000 cu.yd. of material pumped ended the life of the ordinary 0.1 to 0.2 carbon steel dredge pipe and the new pipe has shown itself good for 400,000 cu.yd. It is a longitudinally welded pipe, of No. 8 gage steel plate, 15 in. inside diameter, and weighs about 29 lb. a lineal foot. The steel contains from 0.50 to 0.60 carbon and about 0.75 manganese, which are about the limits for a metal which can be bent and welded without difficulty.

As made up the pipe is in 16-ft. lengths, (two 8-ft. lengths welded together) with stovepipe joints, which are held together by loops of wire drawn taut around projecting ears on the shell near the end of each length. To insure an even wear around the circumference, the pipes are turned 120 deg. for each run. By numbering one end of each length 1, 2 and 3, at 120 deg. apart, the turning is done without error, and the lower third of the pipe, which sustains the maximum wear, is different for every lift of the fill.

Hydraulic Fill Procedure.—At the Miami dams the procedure of building the hydraulic fill is in general that universally employed. On the outer edges of the fill levees are thrown up, as shown by the diagram Fig. 7, defining the slope of the embankment. The pipe lines from the pump are parallel to and just inside the levees. Beginning at the end nearest the pump, filling is started with a short pipe line until a strip, as No. 1, is filled to pipe level down the beach from levee to core pool. Then a 16-ft. section of pipe so added to the line and strip No. 2 is filled. These processes are repeated until the end of the embankment is reached when the pipe is unjointed section by section and another lift is started and completed by repeating the whole operation. When one pump is employed the two beaches are brought up alternately; with two pumps both beaches are raised at the same time. The views Fig. 8 of the fills at four of the dams, with the diagram, make the general procedure quite clear.

Levee and Beach Construction.—Two methods of levee construction have been principally employed. That most used is construction by dragline excavators. A small caterpillar-traction machine, as shown by Fig. 9, with a 40 or 50-ft. boom and a 1½-cu. yd. bucket, travels along the beach inside the levee line, and, borrowing

AT FOUR OF THE MIAMI CONSERVANCY DISTRICT DAMS

(3) Full Length Embankment Fill at Germantown. (4) Cross-Dam and Stone Toe-Buttress at Taylorsville

FIG. 9. CATERPILLAR DRAG LINE BUILDS CORE POOL LEVEE

material from the beach, builds up an embankment to generally twice the height of the lift being employed for making the hydraulic fill. By making the levee twice the height of the lift, dragline travel is reduced and time saved. With the dragline very little trimming by hand of the permanent outside slope is necessary and generally manual labor is reduced as compared with the second method of levee construction.

This second method used largely at Taylorsville and incidentally at some of the other dams is hydraulic fill using window pipe. At Taylorsville a combination of conditions favored the window pipe method. The beach runs flat and was built up in 2½-ft. lifts. Only one run of discharge pipe was used and the frequent changes of pipe required by the low lift called for a pipe shifting gang of six men. Between pipe shifts this gang was not busy. With a six-length window pipe discharge the men could build the levees by hand, the windows delivering the material in heaps close to the levee into which raking and shoveling was easy. The window pipe were fashioned from the ordinary discharge pipe by cutting 4 x 6-in. square holes in the bottom; three to each 16-ft. length. At Taylorsville six lengths of window pipe were employed which furnished for the levee builders 18

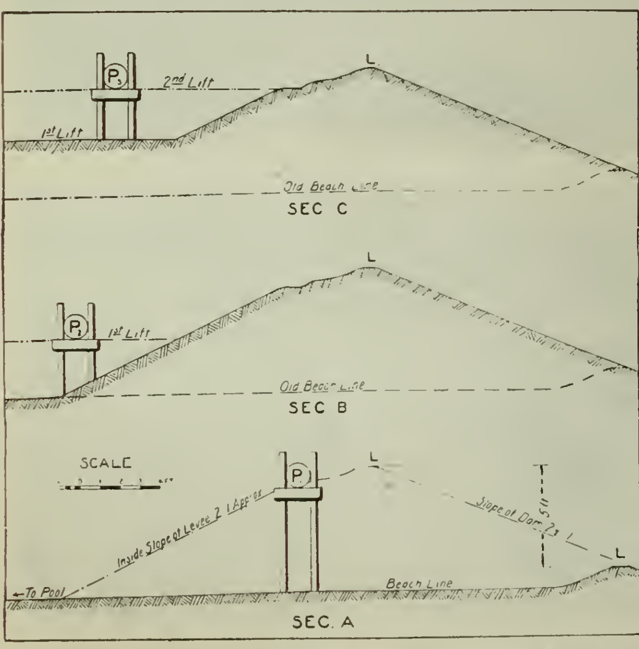


FIG. 10. LEVEE CONSTRUCTION WITH WINDOW PIPE

piles of material about 5 ft. apart and about 4 ft. inside the line of the levee crest. Only the finer materials drop through the windows so the process described was further aided by the unusual proportion of fine material in the Taylorsville borrow pit.

Beach construction ordinarily is in 4-ft. lifts, the Taylorsville operation being an exception as will be explained later. Considering a 4-ft. lift the procedure is about as follows: Starting at the end of the fill, two lengths of pipe are laid on timber bents 4 ft. above the previous beach grade. As pumping proceeds the coarse material builds up in a cone at the discharge end. The finer particles are carried down the beach toward the core pool and are distributed by size along the route until only those which are very fine enter the still water of the pool and settle to form the core. When the coarse stone has built up to the height of the pipe another length is added by laying it on the built-up fill with a timber bent supporting the outer end. Pumping is then

FIG. 11. FILL GUIDED BY WINDOW PIPE AND BAFFLE BOARDS

resumed until the time arrives for another pipe length to be added. In this way the 4-ft. lift is carried the full length of the embankment.

The successive stages of building levee and beach with window pipe at Taylorsville are best understood from the diagrams of Fig. 10. Section A shows the pipe location for a run along the beach to build the 5-ft. levee indicated by the broken line. With the levee completed the pipe line is dismantled and located in the new position shown by Section B to make a run for the first beach lift of 2½ ft. This first lift is followed by a second 2½-ft. lift as shown by Section C to complete the beach to levee level. A new levee is then built and the beach filling operations are repeated.

Beach Slope and Core Width.— The rule in placing hydraulic fill is to keep the core width, at any elevation, about equal to the height from this elevation to the top of the dam. This rule gives a core width at the bottom of about one-eighth the dam width and never exceeding one-fifth the dam width. Co-ordination of beach slope and height of lift is the means for maintaining the rule.

Normally the angle of the beach slope depends upon the composition of the material being pumped. If fine material predominates the slope is flat as in the 1919 fill at Taylorsville and if coarse material predominates,

as generally is the case at the other dams, the slope is steeper. To keep the core pool width constant the lift for each run of fill must be less if the beach is flat than it need be if the beach is steep, as indicated graphically by the diagram in Fig. 7. To raise the fill 5 ft. in one lift, having the flat bench slopes *ACB*, would spread out the pool surface to *FG*, but by using two lifts of 2½ ft. the pool width is kept reasonably close to *HK*, the normal width. If the beach slopes are steeper as *DCE*, one lift of 5 ft. can be made and the pool width maintained normal. It is this reasoning which determines the use of the 2½-ft. lift at Taylorsville and the 4-ft. lift, generally, at the other dams.

As the top of the dam is approached and the width of the fill decreases, the problem of core pool control requires more attention. To keep the core width down, the narrowing beaches have to be built up faster, that is with steeper slopes than when they were comparatively wide. If the borrow pit conditions make it practicable to select coarse or fine materials, alternate pumping of the two meets the requirements. Another method is to hold a greater than normal proportion of the sand and smaller pebbles high up the beach by using a window pipe discharge. Baffle board control of the beach streams is also employed to shift the deposition areas as shown by Fig. 11.

FIG. 12. WELL DEFINED EDGE OF CORE POOL

Analyses indicate the core solids to consist of about 75 to 85 per cent clay and silt and 15 to 25 per cent of very fine sand. Normally the plane separating the core fill from the beach fill is remarkably well defined as is indicated by the view Fig. 12 showing a portion of the beach margin disclosed by lowering the pool at Englewood. Ordinarily the overflow from the core pool is wasted outside the dam area. Possibly 2 per cent or more of the particles of core material fineness are carried away by the overflow. Conservation of these solids at Lockington has been accomplished by siphoning the pool overflow down the upstream slope of the dam into a dyked area where a clay blanket was required on a portion of the old stream bed. At another location to reduce the work of pumping sluicing water to the sump, the pool overflow is taken to the sump. Generally there is an element of danger in this procedure which requires to be watched; a gradual accumulation of floating solids in the circulating water complicates the task of beach and core control.

All work is being performed by the construction department of the Miami Conservancy District, Arthur E. Morgan, chief engineer, Chas. H. Paul, assistant chief engineer, and C. H. Locher, construction manager. Much credit for the success of the hydraulicking operations is due to the division engineers at the dams. All of them have given careful thought and study to the problems encountered and have made valuable suggestions for improvements in design. They are: Arthur L. Pauls, Germantown; H. S. R. McCurdy, Englewood; Barton M. Jones, Lockington; O. N. Floyd, Taylorsville and C. C. Chambers, Huffman. G. L. Albert, hydraulic engineer, has given special attention to the hydraulic fill installations and operations at all of the dams and S. M. Woodward, consulting engineer, has offered valuable advice and suggestions.

Government May Study Tunnel Problems

THAT there is a country-wide demand for a study by the government of tunnel construction is the belief of George S. Rice, chief mining engineer of the Bureau of Mines, who recently returned to Washington from a trip through the West. Several of the cities which he visited have vehicular tunnel projects under consideration. He also looked into the proposal to drive the six-mile Moffat tunnel in Colorado. Before the Moffat railroad is extended to Salt Lake City, it is proposed to drive a double tunnel to prevent the almost prohibitive grades which otherwise would be necessary. The Bureau of Mines has been conducting research on mine gases for many years. A year ago, the bureau was solicited by several eastern cities, interested in vehicular tunnel construction, to co-operate in a study of the effect of the exhaust gases from automobiles in long tunnels. Congress declined to allow any appropriation for this work, but it is believed that the appropriation failed from the desire to eliminate all new items from the appropriation bills. It is believed that the next Congress will be more generous, especially in view of the widespread demand for authoritative data, not only in the matter of gases in tunnels but in the whole matter of ventilation during construction and subsequently. Due to fire hazard this phase of tunnel construction should be the subject of government study, in the opinion of many since the government is in a better position to gather the necessary data than is any other agency.

American Personnel for Merchant Marine

Six out of ten men now entering the merchant marine service under the U. S. Shipping Board are American citizens, recent advice from the office of the board states. In 1917 only one in ten of enlistments below the grade of officer on American ships had American citizenship. The board claims that "it is important that as fast as possible all foreigners should be replaced by Americans."

Concrete Trusses and Cantilever Girders in Theatre

Roof Cost Reduced by Substituting Concrete for Steel—Balcony Has Heavy Girders and Long Cantilevers

ROOF trusses, long balcony girders and long cantilevers, all of reinforced concrete, are important structural features in the new Euclid Theatre at Cleveland, Ohio. This building has capacity for 2,000 seats, including the main floor and the balcony. The roof is supported by four concrete trusses 82 ft. 3 in. long over all and 10 ft. deep between centers of chords.

The use of these concrete trusses was due to conditions of the steel market. Steel trusses were included in the original design, but when the engineers were ready to place the contract they found it impossible to secure delivery within the time required. In order to avoid the necessity of canceling the entire project it was decided to design trusses of concrete. On completion of the work, it was found that this construction had effected a saving of $4,000.

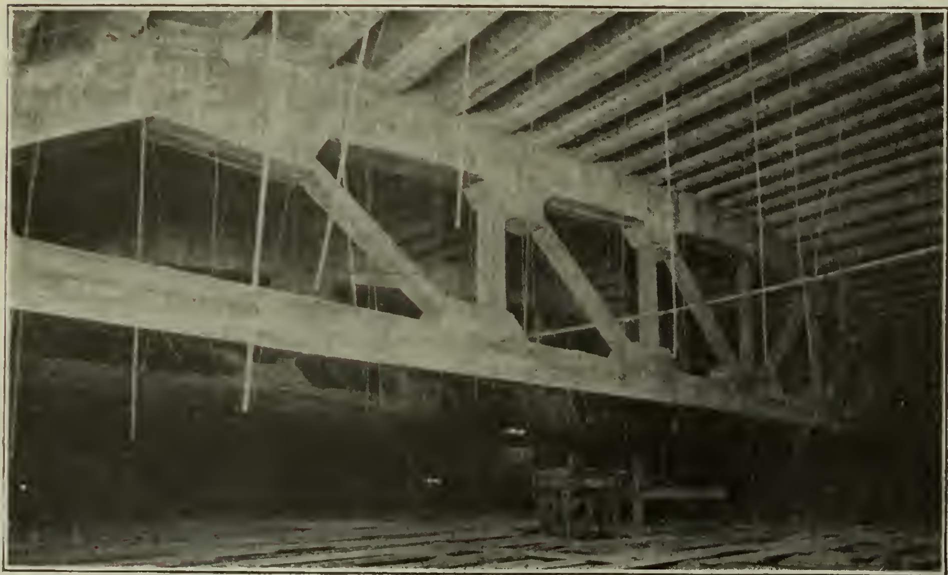


FIG. 1. CONCRETE TRUSS OF 82 FT. SPAN FOR THEATER

A view of one of these trusses, with the concrete purlins and roof slab is shown in Fig. 1. Details of the truss design, with dimensions, reinforcement and stresses, are given in Fig. 2. A concrete mix of 1:2:4 was used, the coarse aggregate being blue limestone not exceeding ¾-in. in size. Tension in the reinforcing steel is taken at 16,000 lb. per square inch and compression in the concrete is taken at 650 lb. The trusses are designed for an assumed dead load of 90 lb. per square foot from the trusses, purlins, roof slab and suspended ceiling. The design includes also a live load of 35 lb. per square foot for snow.

At each end the truss is T-shaped in plan, in order to give ample area on a brick pier, these piers being built into the walls. Dowels anchor one end of the truss to the pier. The trusses are spaced 20 ft. c. to c., and carry pre-cast concrete purlins of 12-in. I-beam section which are anchored at the ends by dowels embedded in the concrete of the top chords. Upon the purlins is a monolithic concrete roof slab 2 in. thick, covered with a weather coating of bituminous material and gravel. Hanger rods in the bottom chords carry a suspended ceiling of expanded metal and plaster about 3 in. below the trusses.

As each truss weighs about 32 tons, the forms had to be carried by a heavy falsework structure about 50 ft. high, resting on footings at the floor level and thoroughly braced. Wood forms were used and were left in place for about sixty days before removal. Concrete was mixed fairly wet and was placed by means of a tower with elevator bucket and chute. For each truss, the pouring was continued without interruption until its completion.

An unusual element of the interior arrangement, which had an influence on the structural design, was the placing of the stage and balcony across diagonally

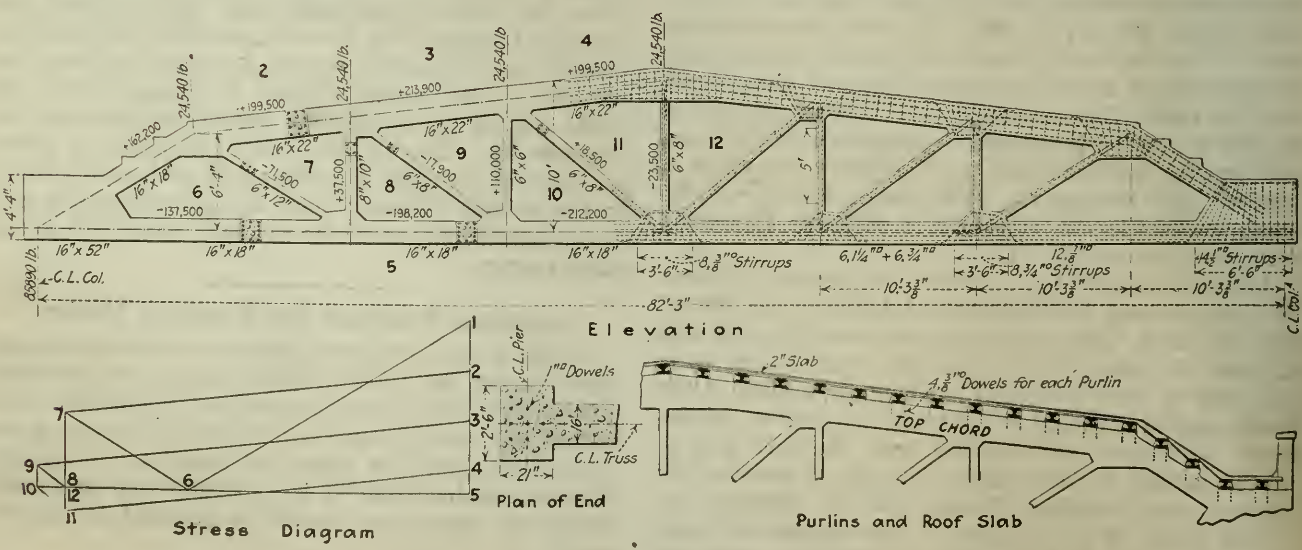
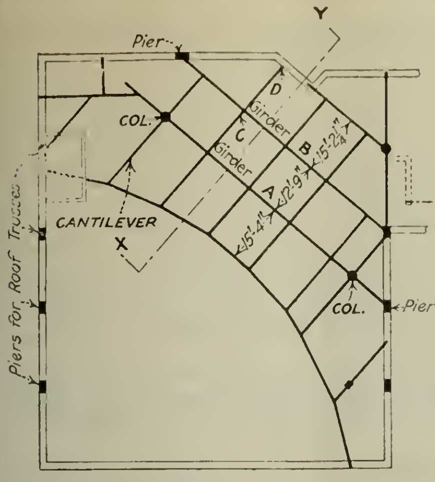
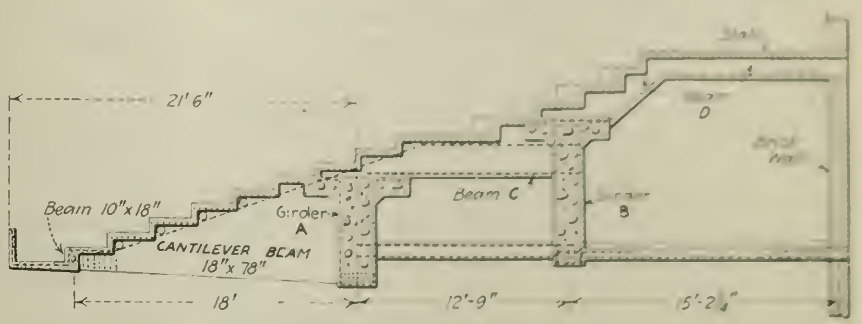


FIG. 2. DESIGN OF CONCRETE ROOF TRUSS



Plan of Balcony Framing



Section of Balcony at X-Y

FIG. 3. BALCONY FRAMING, WITH CANTILEVERS AND LONG GIRDERS

opposite corners instead of along opposite sides of the rectangular building. In this way the balcony was given a much longer front and its seating capacity is said to have been increased nearly 30 per cent. Concrete framing for the balcony was included in the original design. Its main members are two girders of

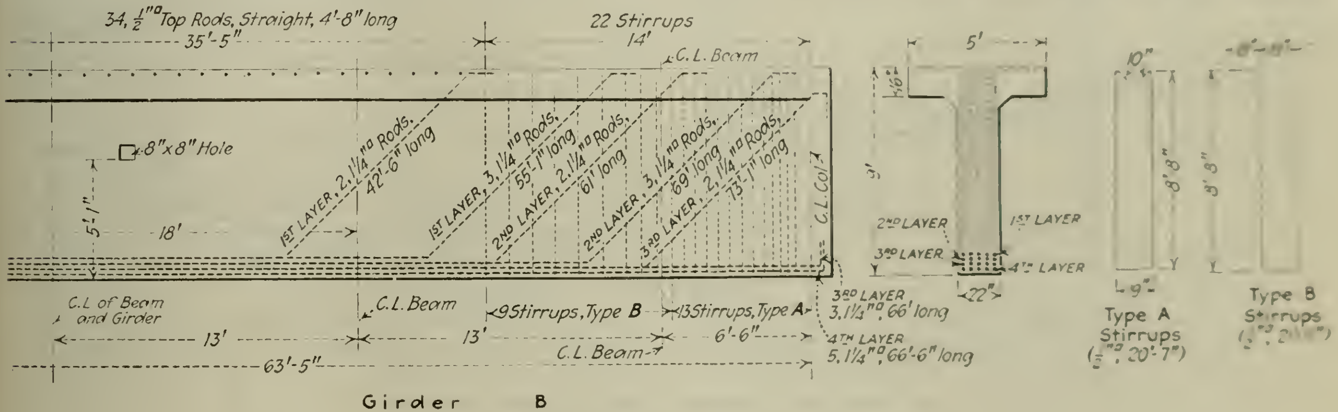


FIG. 4. CONCRETE T-GIRDER OF 63½-FT. SPAN

T-section having main spans of 63½ and 58½ ft. As shown by the framing plan, Fig. 3, these girders extend across the corner of the theatre space, the longer one resting on columns in the side walls and the shorter one being carried by interior columns but extending beyond these to support auxiliary parts of the framing. It will be seen by the drawing that the T-heads are not embedded in the floor slab.

Cantilever girders having their upper sides inclined to conform to the slope of the balcony floor extend beyond the second main girder. These girders and cantilevers, with the 3 in. stepped floor slab which they carry, are designed for a live-load of 80 lb. per square foot. The longer girder is 9 ft. deep and 5 ft. wide over the T-head or flange, with a thickness of 22 and 16 in. for the web and flange respectively. In the shorter girder the depth is limited by the height between the ceiling and balcony floor, so that to obtain the required strength it was necessary to make the web 28 in. thick, with a 16-in. head 6 ft. 6 in. wide. The reinforcement of longitudinal bars, inclined shear bars and stirrups is arranged as shown in Fig. 4.

Circular columns with spiral reinforcement support the 58½ ft. span. Beyond these interior columns the girder projects about 11 ft., one end being seated in the side wall of the building and the other being a cantilever extension to support beams of the floor framing.

Wall columns supporting the 63½ ft. girder are of rectangular section and are diagonal to the line of the girder, as shown. The columns are seated on footings of plain concrete in good clay soil.

This theatre building was erected in 1919 and its total cost was about $350,000. Both the general and structural design were prepared by the W. S. Ferguson Co., engineers and architects, Cleveland, Ohio, and this firm also superintended the construction. The Ed. Paulson Co., of Cleveland, was the general contractor for the buildings.

Unusual Damage to Bridge by Destroyer

A drifting torpedo-boat destroyer recently damaged the Forth River bridge at Alloa, Scotland, so seriously that "it is estimated that the bridge will have to be closed to traffic for at least six months," according to *The Engineer* of Aug. 20, 1920. The bridge, crossed by the Caledonian Ry., is a wrought-iron structure of twenty-one spans, totaling 615 ft. long, and was built in 1885. A surrendered German destroyer broke away from its moorings at South Alloa on Aug. 15, and after colliding with the bridge was found wedged between two of the piers. As a result of the collision, two of the stone piers are damaged "and a considerable length of girders destroyed." It is to be presumed that the bridge was not of very substantial construction, as indicated by the nature of the damage.

Chicago-Indianapolis Improvement Big Four Railroad

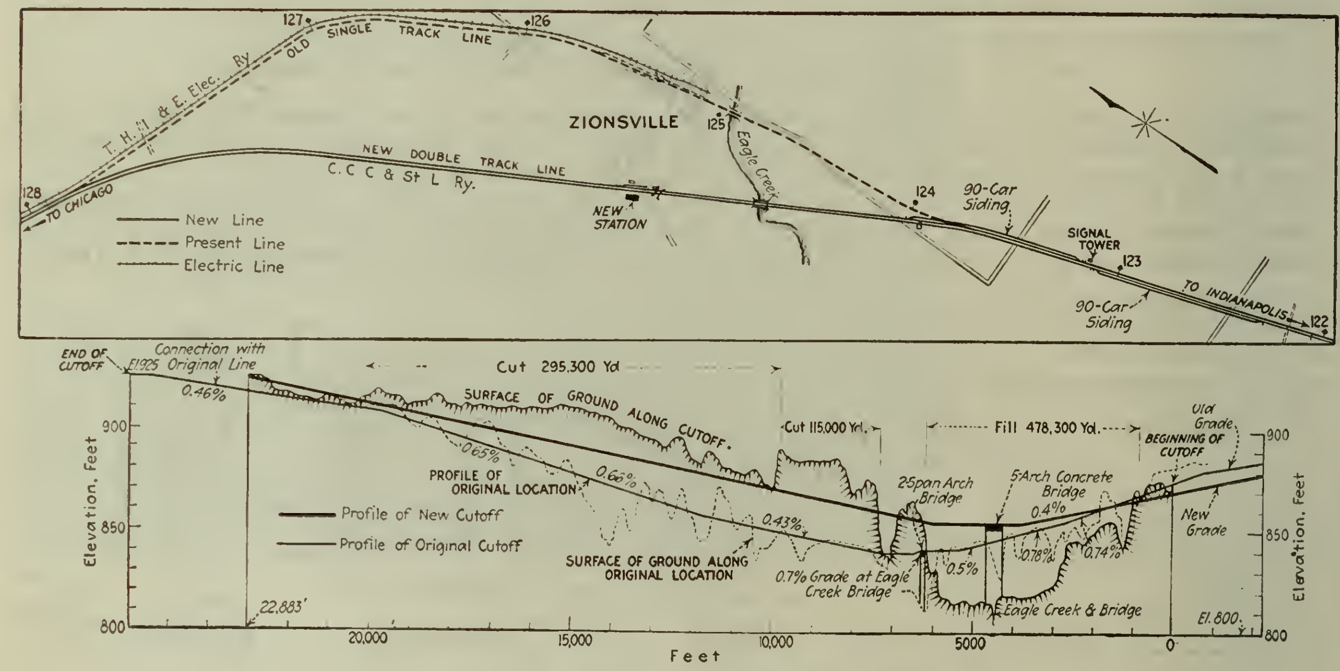
Grade Reduction and Double-Tracking Program to Reduce Time for Heavier Trains—Short Cut-Off Costs $1,000,000

RELOCATION and grade reduction at considerable expense on a line of comparatively easy grade is included in the double-tracking of the Chicago-Indianapolis line of the Cleveland, Cincinnati, Chicago & St. Louis Ry. This improvement is being undertaken in order to increase train loads and reduce running time, thus providing for increasing traffic and also eliminating overtime pay for train crews. That the wage question has become an important factor in railway improvement work was shown in *Engineering News-Record*, of March 25, 1920, pp. 602 and 615.

From Indianapolis to Kankakee, where the line connects with the Illinois Central R.R. for access to Chicago, there are numerous grades of 0.6 to 0.78 per cent, but the improvement program provides for a maximum grade of 0.4 per cent, except for pusher grades at Lafayette, Ind. The maximum curves will be of 2 deg. In grade reduction the original location is retained as a rule, and in most cases only light earthwork is involved. As there are few watercourses crossed the work consists mainly in lowering summits rather than raising sags.

A stretch of relocation with heavy grading has been introduced at Zionsville in order to improve both profile and alignment as shown in the accompanying drawing. The old line from the south is on an ascending grade of 0.4 to 0.63 per cent from Mile 122 to 123, beyond which it drops with long stretches of 0.33 to 0.78 per cent to Mile 125, traversing the town at street level and then ascending again on grades of 0.4 to 0.66 per cent to Mile 128. A long 3-deg. curve with a central angle of about 80 deg. occurs near the top of the steeper grade. This combination of grade and curve is troublesome for heavy trains. The passage through the main part of the town, with several grade crossings, is also objectionable.

The new line descends at 0.4 per cent to Eagle Creek, crosses the valley by a concrete arch bridge 300 ft. long having five arches of 45 ft. span, and ascends on a grade of 0.4 per cent to connect with the present line. This diversion passes outside of Zionsville, eliminating the street level line and spanning the main road from town by an overhead concrete bridge adjacent to the new passenger and freight station. It will be seen from the two profiles that the new line has much heavier grading, being carried through high ground which was avoided in the original location in order to keep down the construction cost. A fill of nearly 480,000 cu.yd. is required across the valley, with a maximum height of about 40 ft. Beyond this are two long cuts 10 to 20 ft. deep, aggregating 411,000 cu.yd. Two steam shovels worked the long cuts and were served by 10-car trains of 12-yd. dump cars which made the fill by dumping from a framed trestle having posts and bracing of round timbers.



RELOCATION IMPROVES GRADES AND CURVES

Traffic between Chicago and Indianapolis, 206 miles, averages six passenger and ten freight trains each way daily, these figures being for both schedule and extra trains. Movements are controlled by the manual block system, the blocks being about fifteen miles long and having the signal towers located mainly at the meeting ends of double passing sidings about 4,000 ft. long. Some of these sidings will be linked into the new double track, but others will remain as relief or passing tracks. Freight trains have 50 to 60 cars, the standard loading being 1,800 tons for engines of the 2-8-0 class. With the completion of the improvement these engines will be able to take about 75 cars with 2,300 tons train load. Further, the double track will eliminate delays at sidings to such an extent that the overtime pay to freight train crews will be negligible.

The improvement program is being carried out under the direction of C. A. Paquette, chief engineer, and

O. E. Selby, principal assistant engineer, of the Cleveland, Cincinnati, Chicago & St. Louis Ry.; A. M. Turner is district engineer in charge of the Zionsville work. The Dunn & McCarthy Co., Chicago, had the contract for grading; the Eagle Creek bridge was built by A. J. Yawger & Co., and the highway bridges were built by the A. C. Loomis Co., both of Mattoon, Ill. The total cost of the cut-off was about $1,000,000.

Costs on Four Types of Pavement in Philadelphia Test Road

Twenty-Six Sections, Comprising Bituminous Macadam Mixed and Penetration Methods, Concrete and Vitrified Block Compared

A GROUP of eight sections of penetration macadam road, forming a part of a test road built in 1912 and 1913 by the Bureau of Highways, Philadelphia Department of Public Works, has proved the least expensive to the city as compared with the other types upon the test road—bituminous macadam, mixed method, concrete and brick. Averaging the first cost, the interest at 4 per cent for 7 yrs., and the maintenance, the average total cost at the first of this year on the penetration macadam sections is shown to be $1.7738 per sq.yd. as compared with $2.0776 for bituminous macadam mixed method, $3.006 for concrete and $3.5109 for brick. Twenty-six sections in all were laid over a total length of road of 3.41 mi. Six sections of bituminous macadam mixed method were laid, eight of penetration macadam, five of concrete base with a bituminous top, and seven of vitrified block. All sections were laid upon the same subgrade, it being an old water bound macadam road. Surface treatment was given practically all of the concrete sections, two of which are patent pavement—hassam and bicomac.

After the winter of 1919-1920, all the penetration sections except Section 24 required rebuilding. Considerable work was also done on Sections 1, 2, 6 and 9 of the mixed type. No work was necessary on any of the brick sections. Section 25—bicomac—was cold patched.

The penetration macadam sections were built to a compact thickness of 3 in. of 1½-in. trap rock, each section penetrated with either a different amount or kind of binder, and sealed with a coat of the same material as that used in the binder. The best known of the binders available at the time of the construction of the test road were used in these penetration roads, the amount of the binder varying from 1 gal. to 1.3 gal. per sq.yd. In the construction of the bituminous macadam, mixed method sections, ½-in. to 1½-in. trap rock was used in four sections, limestone on a fifth section and bank gravel not over 1 in. in diameter on the sixth section. Various patent methods of laying bituminous macadam, mixed method, paving were used in the construction of these six sections.

TABLE II. FIRST COST, INTEREST, MAINTENANCE AND TOTAL COSTS ON TWENTY-SIX TEST SECTIONS

Type and Section	First Cost	Interest at 4% for Seven Years	Maintenance Cost for Seven Years	Total Cost
Bit. Mac., Mixed Method				
Section 1	$0.7573	$0.2120	$1.1044	$2.[illegible]
Section 2	1.6118	.4512	.2741	2.[illegible]371
Section 6	1.2581	.3523	.3927	2.[illegible]
Section 7	1.4291	.3901	.2734	2.[illegible]
Section 11	1.2836	.3594	.1078	1.7[illegible]
Section 12	1.6083	.4503	.1500	2.[illegible]
Average				2.[illegible]777
Bit. Mac. Penetration				
Section 16	.8866	.2482	.2183	$1.6[illegible]
Section 17	1.0599	.2968	.5220	1.8787
Section 19	1.0577	.2962	.3056	1.6[illegible]
Section 20	1.0154	.2843	.7301	2.[illegible]
Section 21	1.0780	.3018	.4977	1.877[illegible]
Section 22	1.2150	.3402	.1893	1.744[illegible]
Section 23	1.1511	.3223	.1424	1.6[illegible]
Section 24	1.2997	.3639	.0881	1.75[illegible]7
Average				1.7738
Concrete Base—Bit. Top				
*Section 3	1.1462	.320[illegible]	1.8424	3.309[illegible]
*Section 5	.9834	.2754	2.1913	3.4501
†Section 9	1.2101	.3388	.7750	2.3239
*Section 14	1.2505	.3501	1.7842	3.3848
Section 25	1.8671	.5228	.1718	2.5617
Average				3.0[illegible]
Vit. Block				
Section 4	2.6531	.7429	.0518	3.4478
Section 8	2.6032	.7289	None	3.3321
Section 10	2.5532	.7149	None	3.2681
Section 13	2.8443	.7964	None	3.64[illegible]7
Section 15	2.6401	.7392	.1295	3.5088
Section 18	2.8670	.8028	None	3.66[illegible]
Section 26	2.8834	.8075	None	3.69[illegible]
Average				3.5083

* Entire new sheet asphalt surface placed in 1918.
† Partly new base and top of different character in 1916.

Concrete sections were built in three cases 5 in. thick, of a 1:3:6 mix. The fourth section was built according to hassam specifications and the fifth constructed 4 in. thick of a 1:3:6 mix, a 1-in. wearing surface being laid following the bicomac specifications. Expansion joints were omitted in Section 3, but included in Section 5, being laid at 40 ft. intervals and being

TABLE I. MAINTENANCE DATA ON TWENTY-SIX TEST SECTIONS OF PHILADELPHIA HIGHWAY

Section	Type of Road	Surface Area in Sq.Yd.	Original Cost per Sq.Yd.	1913	1914	1915	1916	1917	1918	1919	Average Annual Maintenance Sq.Yd.
				Total Maintenance Cost per Year							
1	Bit. mac., mixed method	6,578	$0.7573		$3	$104	$849	$5,040	$862	$365	$[illegible]1569
2	Bit. mac., mixed method	1,788	1.6118					9	49	432	0393
3	Concrete, bit. top	533	1.1462			87	31	37	683	144	2632
4	Vit. block, conc. base	444	2.6531					21	8		0074
5	Concrete, bit. top	1,244	0.9834			180	66	76	2,094	310	3130
6	Bit. mac., mixed method	2,222	1.2581					168	.	704	0561
7	Bit. mac., mixed method	2,222	1.4291						8	600	0390
8	Vit. block, conc. base	533	2.6032				No Repairs				
9	[1] Concrete	2,933	1:2101			[2] 884	885	2		502	1177
10	Vit. block, conc. base	533	2.5532				No Repairs				
11	Bit. mac., mixed method	1,067	1.2836	25		23	67				0551
12	Bit. mac., mixed method	1,067	1.6083					6	154		0215
13	Vit. block, conc. base	622	2.8443				No Repairs				
14	Hassam, bit. top	978	1.2505				53	25	1,067		2549
15	Vit. block, conc. base	533	2.6401						69		0184
16	Bit. mac., penetration	1,067	0.8866		10	22	103	12	68	15	0312
17	Bit. mac., penetration	640	1.0599			3	78	16	237		0747
18	Vit. block, conc. base	427	2.8670				No Repairs				
19	Bit. mac., penetration	1,067	1.0577			12	109	32	124	49	0437
20	Bit. mac., penetration	1,067	1.0154		4	40	204	41	490		1043
21	Bit. mac., penetration	1,067	1.0780			8	174	240	86	23	0711
22	Bit. mac., penetration	1,067	1.2150				76	13	64	49	0270
23	Bit. mac., penetration	1,067	1.1511				88	46	28		02[illegible]
24	Bit. mac., penetration	1,067	1.2997				79	15			0127
25	Concrete, bit. top	978	1.8671		128	3	14	22	10		0274
26	Vit. block, conc. base	1,004	2.8834				No Repairs				

1. With and without bituminous top. 2. Concrete base renewal.

asphalt filled. All concrete sections were given bituminous treatment.

The vitrified block pavement was laid in the usual method upon a 4-in. concrete base, a sand cushion and cement grout being used in each of the seven sections. A concrete curb was also provided for brick paving.

Cost analyses made in the accompanying tables cover all costs: Preparation of foundation, the pavement itself, trimming of shoulders, bituminous treatment in the case of concrete sections and the concrete curbs in the case of the brick section.

In general the sections of road are in good condition, though extensive repair has been made to various sections during the past two or three years. At the end of 1919, when the last minute inspection was recorded, all the bituminous macadam, mixed method, sections, were found to be in good condition, though in Section 11 the edges were breaking away in Section 12, there was some sign of disintegration of the pavement itself. The penetration macadam sections were also in good condition with the exception of Section 17, which was reported wavy, possessing longitudinal side cracks and frayed edges. Sections 23 and 24 also were breaking away at the edges of the pavement.

All the concrete sections were reported as being in good condition except Section 25, the bituminous surface of which was wavy, had bad worn out spots at one end and showed distinct signs of disintegration along the edges.

On all the brick sections longitudinal cracks were noted, usually appearing at, or to one side, of the crown. The concrete header had disintegrated upon all brick sections. The bricks themselves were generally in good condition except in Section 10, where they were found to be chipped and cracked at one end of the section through settlement of the foundation, and on Section 13, where a few bricks were found to be slightly chipped.

The cost analysis takes into account rental of some equipment used such as road rollers, water wagons and tar kettles. No allowance, however, was made for the use of the asphalt plant on the bituminous macadam, mixed method sections.

Unit Suburban Service Proposed for Chicago

Suburban through routes for Chicago steam railway service, crossing the city and operated as units regardless of separate ownership of different parts of the lines were advocated by J. R. Bibbins, supervising engineer of the Arnold Co., in a recent paper before the Western Society of Engineers. As an example he suggested a connection of the Chicago & Northwestern Ry. terminal on the northwest side with the Illinois Central R.R. terminal on the southeast side of the city. This would distribute the crowds now concentrated at the two points and would eliminate much of that part of the congested street car traffic which consists of suburban passengers going to and from the main stations. This is only one of several possible connections. As to unit operation, Mr. Bibbins says: "The through routes will require the interchange of equipment, yard terminals, coach yards, etc., resulting from the overlapping service. But these conditions, now opposed largely from the viewpoint of independent competitive operation, will be completely remedied when the day arrives for that far more important consideration dictated by economy and common sense, namely, complete ultimate terminal unification."

Loss of Head in a 12-Inch Gate in a 16-Inch Pipe Line

By Thomas E. Lally
Assistant Engineer, Water Department, Boston, Mass.

Abstract of Paper Read Before the New England Water Works Association, September, 1920.

THE loss of head caused by placing a 12-in. gate in a 16-in. pipe line under 57-lb. static head on the Boston water-works was found to range from 0.01 lb. with a flow of 500 gal. per minute to 0.92 lb. at 10,200 gal. per minute. So far as the writer knows, losses due to such large flows through a gate of this size have never before been recorded.

The 12-in. gate was placed between two 16 x 12-in. reducers. The gate and reducers were of the Boston Water-Works standard taken from stock and placed in the line. The test line was provided by cutting in a 12-in. gate on a 30-in. feeder line. From this gate a 12-in. line was extended to the street line, where it was brought to the surface by easy curves and continued on blocking so that the bottom of the pipe was about 6 in. from the ground. The line was further extended by putting in a 12 x 16-in. increaser and then 16-in. pipe for a certain distance when a 16 x 12-in. reducer and a 12-in. gate with a 12 x 16-in. increaser were set. The pipe was then 16 in. for a certain distance, where a 16 x 12-in. reducer and a 12-in. gate were introduced. Then the line was continued with 12-in. pipe to a curve and a special casting, with a flange, increasing to 14 in. internal diameter. To this casting was attached a bronze forebay to which it was possible to attach nozzles varying from 8 to 2½ in. in size.

Carbon tetrachloride with a specific gravity of 1.60 was used as an indicator in the U-tube employed to determine the loss of head caused by the gate. Mercury might have been used but, as the loss expected was small, and the specific gravity of mercury is about 13.56 it will be seen that the carbon tetrachloride is eleven times more sensitive and small differences in pressure give greater deflections in the U-tube.

Flow was controlled by the last 12-in. gate, thereby keeping the gate under test always full of water. This control gate was operated by a hand wheel and any pressure desired could be obtained in the forebay within the range of the nozzle used. From pressure readings on the forebay gage, after corrections for the height of the gage over the center of the nozzle, the discharge was calculated by the use of Freeman's formula. Readings on the gage and the difference on the U-tube were taken simultaneously and from these readings, it was possible to know the discharge and the loss for any flow up to the capacity of the nozzle. When the pressure in the forebay did not increase on the wider opening of the control gate, it was assumed that the capacity of the nozzle had been reached. The next larger nozzle was then used and by the control gate the full range of the discharge was run.

The results of the tests were plotted on cross section paper. The curve did not follow the mathematical curve for losses. This rule that "the loss in friction is as the square of the discharge," while near enough for practical purposes, did not obtain in these tests. This caused a feeling that there was something wrong in the first test and other tests were run, special care being taken to get the air all out of the lines and the connections tight in every way.

It was found that the plotting of the curve, on a large scale for the losses, caused the difference to stand out and while it was small it looked large on the plot. Then, taking Freeman's paper, "Hydraulics of Fire Streams" and analyzing some of the tabulated data, it was found that the loss did not vary as the square but ranged from 1.775 to 1.92. Freeman, in the same paper (p. 338) says that his results do show "that there is a slight divergence from the law." Flinn, Weston and Bogert "Waterworks Handbook," 1916 edition, p. 560, says: "Textbooks make the general statement that the friction head in pipes varies nearly as the square of the velocity. Researches indicate that this exponent varies between 1.75 and 2.00."

The velocities in the 12-in. gate under test varied from 1.3 ft., per second discharging 750 gal. per minute to 34 ft. per second at 12,000 g.p.m. With these references in view, the writer felt that the fact that the curve did not agree with the curve of the squares was not due to errors in the methods or the gage connections or readings.

With a flow of 500 g.p.m. the loss was 0.01 lb.; at 1,000 g.p.m. it was scarcely larger; at 2,000 g.p.m. it was about 0.03 lb.; 4,000 g.p.m. showed about 0.12 lb.; 5,000 g.p.m. about 0.20 lb. 6,000, 0.29 lb.; 8,000, about 0.51 lb. 10,200 g.p.m. gave 0.92 pounds.

These losses show clearly that we may place this smaller size gate in our pipe lines and not loose over one pound pressure, with a discharge which I think would seldom be required even in a 16-in. line.

Concrete Cantilever Construction in Chicago Garage

Single and Double Cantilever Beams Support 11-Ft. Span of Floor and Roof Slab and Carry 50-Ft. Monitor Trusses

EXCEPTIONALLY long and heavy concrete girders, with cantilever construction for portions of the second floor and roof around large light courts, are striking features in the structural design of a two-story automobile storage and service building recently completed in Chicago for the Packard Motor Car Co. The purpose of this design is to minimize the number of columns obstructing the floor area and to give ample light and ventilation throughout the central part. The floor area of nearly 90,000 sq.ft. is unusually large for a building of this character and necessitates special provision for effective lighting of the first floor, this being provided by two light courts 48 x 162 ft. Other notable features are the large ventilating skylights in steel truss monitors and the provision of a ramp or inclined driveway between the two floors.

This garage is 304 x 298½ ft. on the building line, with a height of 17¼ ft, for the lower story and 16 to 17½ ft. for the upper story, the clear headway under the girders being about 14 ft. The typical column spacing is 38 x 33 ft., but at each light court one row of columns is omitted giving a 76 ft. space, with a 14 ft cantilever shelf on each side and a clear opening of 48 ft. Along each side of the building the first interior columns are 18 ft. from the wall, forming bays 18 x 33 ft.

From the floor plan and section Figs. 1 and 2 it will be seen that the framing system consists of heavy girders of 33-ft. span running in one direction and having 38-ft. transverse beams between them, with cantilever brackets on four of these girders, the cantilever and beams being spaced 11 ft. c. to c. The heaviest girders, which are those carrying the cantilevers, are 24 x 42 in. and 22 x 42 in. in section with a span of 33 ft. The beams between these are mainly 12 x 34 in. All main interior columns are of circular section, rectangular columns being used at stairways and elevator shafts and for the ramp.

A 5½-in. floor slab is incorporated in the depth of the girders and beams, reinforced with ½-in. rods spaced 7½ in. c. to c. in one direction and ⅜-in. rods 18 in. c. to c. in the opposite direction to take care of temperature stresses. Both straight and bent bars are used in the girders and beams, as shown, the bent bars being continued into the adjacent spans. Stirrups of U-shape supplement the bars. All reinforcement is of plain

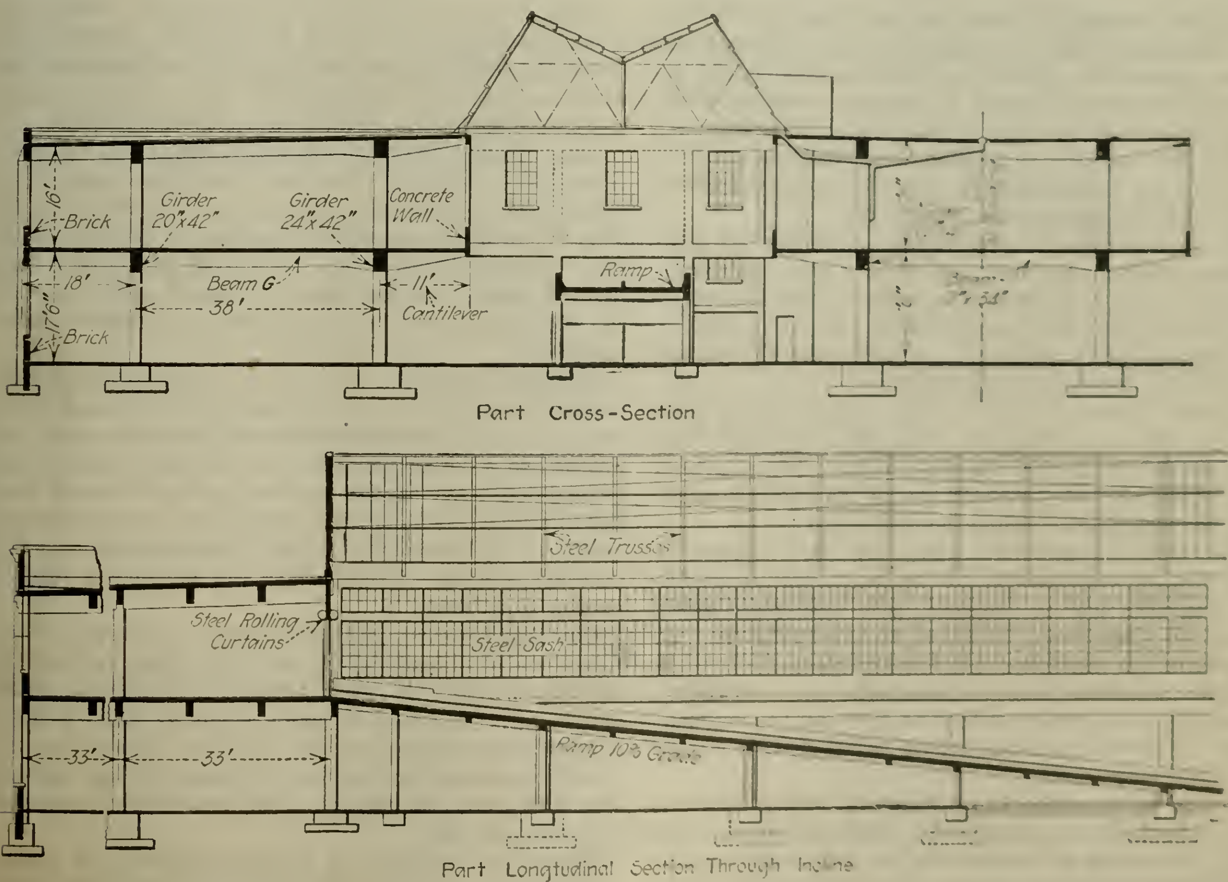


FIG. 1—CANTILEVER FLOOR AND ROOF CONSTRUCTION FOR GARAGE

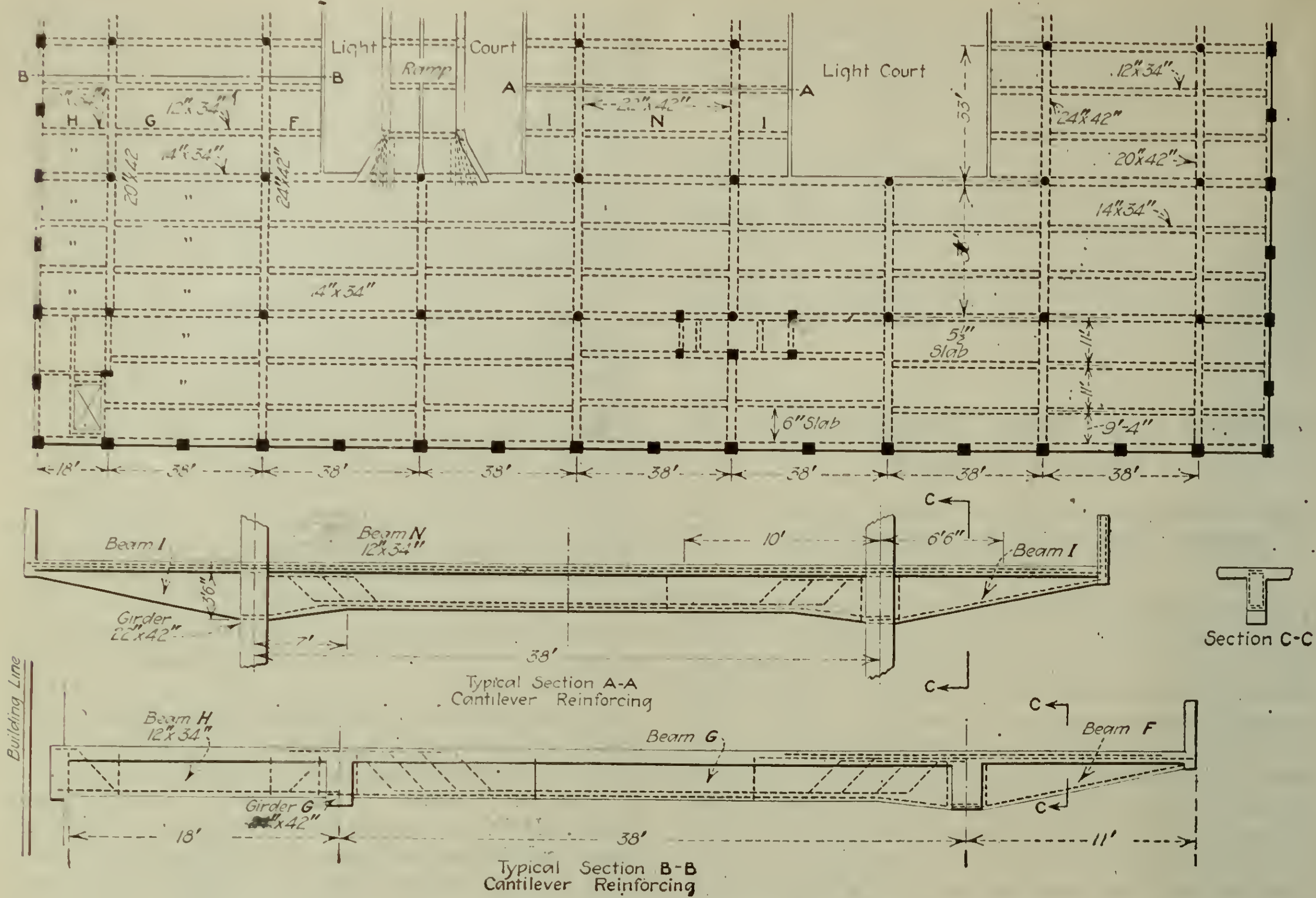


FIG. 2—PART PLAN OF FLOOR FRAMING

square bars, except that round bars are used for the ¼-in. size. The second floor is designed for a live load of 125 lb. per square foot. Holes in the beams are formed by 1¼-in. pipe sleeves to allow of placing overhead pipes and for attaching a light monorail system over one part of the floor. Inserts in the slab are spaced about 5½ ft. apart for the attachment of shaft hangers and other fixtures for the repair work equipment.

For the roof, the framing system is similar but with somewhat lighter sections and with a 4-in. slab reinforced by ⅜-in. bars of 8-in. spacing. Both the main roof and the monitors are designed for a live load or snow load of 25 lb. per sq.ft. A pitch and felt waterproof roofing is laid upon the slab.

Exposed concrete spandrels are reinforced for temperature stresses with $\frac{7}{32}$-in. bars, the horizontal bars being spaced 24 in. and the vertical bars 12 in. c. to c. Brick spandrel walls are built above the concrete spandrels, the latter being below the floor slabs.

Steel sash is supported upon the brick spandrels, except that on the street front the sash framing extends from the first floor to the roof, with steel plate filling instead of glass panes in front of the spandrels. At the edge of the cantilever slab is a stiffening rib beneath the floor and above this is a low curb wall or spandrel, supporting steel sash similar to that of the exterior walls. These walls are finished by painting with factory enamel cement coating.

For the ramp, which has a grade of 10 per cent, column supports independent of the structural columns are used. The width is divided into two 9-ft. driveways by a central curb, but the parapet walls or girders are flared outward at top and bottom for the convenience of vehicles entering and leaving the driveways. This ramp is designed for a load of 125 lb. per sq.ft. A 5½-in. slab forms the floor and is finished with a roughened surface to give a good grip for the wheels. Stairs and passenger elevators are provided, but there is no car elevator.

Steel trusses of 48 ft. span and spaced 11 ft. apart form lofty monitors over the two light courts, the trusses being seated on concrete shoes or blocks on the ends of the 14-ft. cantilever brackets of the roof framing. The sides have steel sash and wire glass, with pivoted panels for ventilation. Cement tiles cover the top of the monitor, being supported on purlins of 6-in. channels.

Creosoted block paving is used on both floors, except at the spaces where cars are washed and cleaned, these spaces being of concrete shaped to drainage planes and finished to a smooth surface. A low and rounded curb around the edge of the concrete prevents water from flowing onto the floor but allows cars to pass over it readily. The wood blocks are laid directly on a paint coat of pitch on the concrete slab and pitch filler is poured over them.

Concrete for structural work was a 1:2:4 mix; made fairly wet and using ½-in. crushed stone so that the concrete would pass freely around the reinforcing steel and have a minimum of voids. Chutes from a tower outside the building and an auxiliary tower near the middle delivered the concrete to hoppers from which it was distributed by buggies. All reinforcement consists of deformed bars.

Forms for the sides of the large beams and girders were built up on the ground and hoisted into place, being fitted against cleats spiked to the 2-in. bottom of

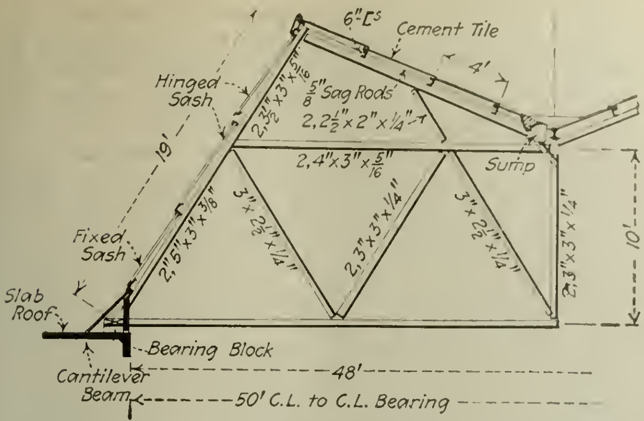


FIG. 3—STEEL TRUSS FOR MONITORS OVER LIGHT COURTS

the form and held at the top by wiring and by the 2 x 8-in. joists of the floor forms, these joists being spaced about 16 in. c. to c. The forms were designed for easy removal so that they could be used over again. They were not lined nor were the interior surfaces oiled. For the supports, 4 x 4-in. posts were used, spaced about 30 in. c. to c. and having the usual T-head construction. Falsework was left in place for about two months after pouring the concrete, this being necessary on account of the work being done during the winter.

This building was designed by Albert Kahn, architect and engineer, Detroit, Mich., the structural design being worked out by J. T. N. Hoyt, chief structural engineer. The contractor was the Edward L. Scheidenhelm Co., Chicago.

Increased Salinity in Waters of the Lower Sacramento River

Irrigation and Potable Water Systems Face Permanent Problem — Remedies Suggested by T. H. Means

A SUDDEN increase of salinity in the lower reaches of the Sacramento River has presented new problems in those irrigation and domestic systems that depend on this source of water supply. When the tidal effects and the accompanying salinity were found to have passed all previous records and to be steadily moving still farther up the river, question arose as to what caused the change; whether it could be atributed to the diversion of water for irrigation, to the straightening and deepening of the channel, to the several years of drought or to other causes. At a meeting of the San Francisco Section, Am. Soc. C. E., held to discuss the situation, T. H. Means, consulting engineer, read a paper on the subject from which the following is quoted:

Carquinez strait is the outlet for the 45,000-sq. mile area of the Sacramento and San Joaquin River basins, the great interior valley of California. The discharge of the Sacramento River formerly varied from less than 10,000 sec.-ft. in late summer to over 500,000 sec.-ft. during floods. The San Joaquin Valley discharge probably varied between a minimum of 5,000 sec.-ft. and a maximum of over 300,000 sec.-ft. In 1919 the Sacramento at one time flowed less than 2,000 sec.-ft. at Sacramento and the San Joaquin delivered probably little in excess of 500 sec.-ft. The decreased flow in that year was due to the low run-off and to the large amount diverted for irrigation in all parts of the tributary watershed.

The low flow alone does not account for the encroachment of salt water. There probably never has been a time when there was not some fresh water coming down the streams; that is, the diversions in the delta have probably not exceeded the flow from the lower Sacramento and San Joaquin. The cause of the encroachment of salt water is the fluctuation caused by the tides. Tidal fluctuations at San Francisco vary from 3 ft. at neap tides to over 7 ft. at times of spring tides. Some effect of this tidal fluctuation was felt during the summer of 1920 as far upstream as the city of Sacramento on the Sacramento and above the mouth of the Stanislaus on the San Joaquin River.

The tidal prism above Carquinez Straits is approximately 75,000 acre-ft. for spring tides. During ordinary tides it amounts to perhaps 50,000 acre-ft. In other words a flow of about 100,000 sec.-ft. would be required to prevent a reversal of current in the straits. This amount of inflow occurs only a few days in the year, consequently the current usually reverses twice a day in the straits. The tidal movements rapidly carry water upstream and mix it with the fresh water coming down so that with each reversal of flow the salt water passes higher until a point is reached where the tidal prism above is equal to the quantity of fresh water coming down stream. Thus as the flow decreases, the salt water passes upstream.

Under present conditions the entire low flow of all the tributaries draining through Carquinez Straits is apt to be diverted every year, leaving practically nothing but the return seepage to pass down into the tidal portion of the rivers. Thus what was once a very rare occurrence, the appearance of salt water in the lower rivers, is now to be expected every year and for longer periods of time than formerly.

What Causes Inflow of Salt Water

Prior to 1918 salt water seldom reached Pittsburgh. In both 1918 and 1919, water at Pittsburgh and far beyond became brackish. This sudden change was due to large diversions made in the Sacramento Valley for irrigation purposes. In previous years the encroachments by irrigation had been so gradual that they were not noticed from year to year. The sudden large increase in diversions by the rice irrigators, coming in a series of relatively dry years and just at the point when the salt water limit was reaching upper Suisun Bay, combined to bring about a sudden change in lower river conditions.

New storage reservoirs are planned and spring floods will in part be prevented. The June rise from the San Joaquin tributaries is going to be lower and of shorter duration as more reservoirs are built Future irrigation developments will increase the difficulties by decreasing the low flow. While return seepage will increase, it is not likely that it will ever amount to enough to keep salt water out of the lower island country. Undoubtedly unless something is done this region will henceforth face a salt water problem in most years.

Towns along the lower river must find some other source for domestic supply. At one time the lower Sacramento River at Rio Vista was proposed as a source for San Francisco and other bay cities. Salt water now goes miles beyond that proposed point of diversion. The problem of securing water for the tidewater towns has always been serious, it is now more so. There is little left for us to do but consider high mountain sources where storage is available. The fallacy of San Francisco going to the head waters of the Sacramento River and diverting low flow is now apparent. A larger acreage would have had to remain dry in the Sacramento Valley than will be deprived of water by Hetch-Hetchy storage. Good storage sites are not known on the upper Sacramento River.

Several remedies suggest themselves. They are:

1. Reduce the tidal prism by cutting off sloughs and shallow parts of Suisun Bay and completing the reclamation of the island lands. This will reduce the tidal fluctuations through the straits and lessen the up-flow of salt water. This will not be a cure, however, for salt water will continue to go far beyond its former limits.

2. Build a dam with tide gates to prevent up-flow of salt water. This suggestion has sufficient merit to warrant its serious consideration. It is not likely to prove feasible except at great expense. It does not look like a job for any but the Federal Government.

3. Build storage reservoirs and maintain a low flow, sufficient to keep salt water below the head of Suisun Bay. No suitable reservoir sites are known; surveys of the Sacramento watershed for this purpose are badly needed. Iron Canyon is not available for it is needed to supply the lands immediately below Red Bluff.

4. Allow salt water to continue its fluctuation and provide for the island country by diverting fresh water from some point above tidal fluctuation. This, too, will be costly, but in our present state of knowledge it is one of the promising solutions for the water supply for a part of the area.

5. A combination of the four suggestions above may provide for a large part of the island area. Even under the best conditions the cost will be large and in our present state of knowledge we cannot even suggest what it will amount to.

An investigation of the problem by impartial engineers should be made at once. Remedies should be investigated and recommendations should be made. The entire Sacramento and San Joaquin Valleys are interested in the outcome.

Road Work Speeded Up By Service Commission Car Orders

Pennsylvania Adds to Mileage by Request That Railroads Place Weekly 531 Cars for Cement, 1,439 for Aggregates

IN AN ENDEAVOR to assist in speeding up the highway construction program outlined for 1920 by the Pennsylvania State Highway Department the Public Service Commission of Pennsylvania issued, on July 12, the first of several orders directing the various railroads operating within the state to place at the disposal of the consignors of road materials enough box and open-top cars to fulfill needs of contractors having highway contracts with the state. Needs of contractors were based upon information secured in a questionnaire sent out some time previously by the Highway Department requesting data as to the amount of cement or aggregates needed, manufacturer with whom the contractor had placed his order, the point from which shipments should be made, and the point at which delivery should be made. Such questionnaires were sent to each of the 265 road contarctors doing state highway work. The order of July 12 was based upon more or less fragmentary information resulting from the circulation of this questionnaire, though supplemental orders dated July 26 and Aug. 7 were issued as more complete information was had from contractors.

Origin of Car Orders

Action was taken by the Public Service Commission after complaint was filed by the Pennsylvania Highway Department that its highway construction work was being materially hampered through inability of contractors to secure materials. As most of the cement manufacturers, as well as firms supplying sand, crushed stone and slag, with whom road material contracts had been made prior to the pronounced car shortage, are located in Pennsylvania, the Public Service Commission considered that, in the interest of public safety, anything it could legally do to assist in the highway construction problem would be justifiable.

The commission's first order, calling for the distribution to various manufacturers of 474 box cars per week for the transportation of cement, specified the number of cars to be supplied by each railroad and also the point from which the shipments were to be made. The first order called for the following allocation of cars by the various railroads concerned: Pennsylvania, 186; Philadelphia & Reading, 124; Delaware, Lackawanna & Western, 65; Central Railroad of New Jersey, 18; Lehigh Valley, 48; Lehigh & New England, 21; Pittsburgh & Lake Erie, 6; Baltimore & Ohio, 6. This number of box cars was increased to 531 through the supplemental order of July 26, in which it was directed that the following railroads place at the disposal of various cement manufacturers the following number of cars weekly: Pennsylvania, 157; Philadelphia & Reading, 182; Delaware, Lackawanna & Western, 117; Central Railroad of New Jersey, 23; Lehigh Valley, 15; Pittsburgh & Lake Erie, 5; Baltimore & Ohio, 8; Bessemer & Lake Erie, 24.

For the transportation of sand, crushed stone and slag another supplemental order was issued on Aug. 7. That order directed the following railroads to supply various aggregate producers with the following number of cars per week: Pennsylvania, 703; Philadelphia & Reading, 167; Western Maryland, 118; Baltimore & Ohio, 161; Pittsburgh & Lake Erie, 51; Huntington & Broad Top Mountain, 38; Lehigh Valley, 69; Bessemer, 24; New York Central, 18; Buffalo, Rochester & Pittsburgh, 60; Central Railroad of New Jersey, 6; Erie, 6; Lehigh & New England, 18; making a total of 1,439.

Co-operation Only Sought

The State Highway Department points to the fact that the issuance of Public Service Commission car orders is merely a step toward closer co-operation between the Highway Department and the various railroads delivering highway materials. The statement is made by Highway Department officials that the various railroads involved have all viced an appreciation of the situation and pledged all assistance possible. The questionnaires circulated among the road contractors have been able to give the commission adequate information as to the exact amount of road materials needed. The car orders, it is asserted, is but one way of disseminating this information.

An accurate check is kept by the department of shipments necessary and those actually made, and the effect of the Public Service Commission orders has been noticeable in the amount of mileage constructed since the first order was issued. A statement of one of the officials of the Highway Department is to the effect that the mileage has been more than quadrupled since July 12.

At the same time the information was sought of the various road contractors as to their actual needs, a letter was sent to each contractor in which it was urged upon him to unload cement and aggregate supplies as soon as possible. In fact, the statement was made by the Highway Department that unless cars would be unloaded within 24 hr. little co-operation could be expected from the Highway Department. The questionnaires requesting information applied not only to cement and aggregate, but to other road building materials—brick, asphalt and tar.

Besides the number of cars necessary to transport cement and aggregates for building Pennsylvania high-

ways, another idea may be gained of the size of its program by the assertion of one of the highway officials that this year's program called for the construction of 600 mi. of reinforced-concrete highways, for which approximately 2,500,000 bbl. of cement would be necessary.

Model Industrial Town Layout at Marysville, Mich.

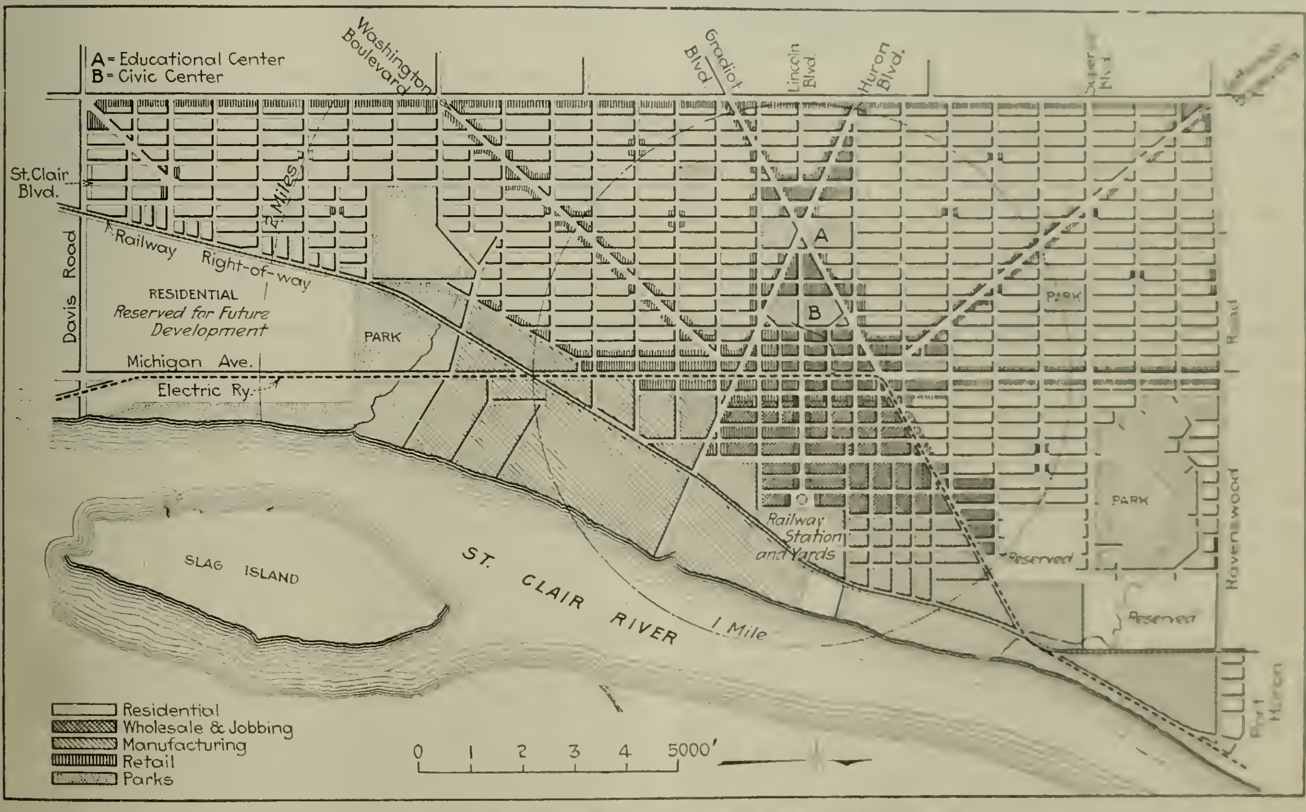
Zoning Combined with City Planning—Site Was Farm Land—Public Utilities, Parks And Civic Center Provided

AN INDUSTRIAL city for a population of 150,000, designed with equal consideration for social and commercial aspects, has been laid out at Marysville, Mich., which was formerly a village of about 150 inhabitants. This enterprise has been undertaken by C. H. Wills in connection with the establishment of a large automobile factory at this point. It was Mr. Wills' idea to have the plant so located that it could be served by railroad and water transportation; also that there should be sufficient property available for the construction of other plants making automobile accessories, as well as sufficient room for the proper housing of employees and other people necessary for a manufacturing center of the size required, all of which would form the nucleus of a future city.

With this thought in mind the new Marysville has been planned with a system of streets, parks and boulevards and with zones for residential, business and manufacturing districts in proper relation to each other so that the future would be free from the troubles of many cities where corrective measures are being taken to overcome faults produced by haphazard street systems and uncontrolled growth.

Marysville is about four miles south of Port Huron on the west side of the St. Clair River. The property purchased by Mr. Wills covers about 1,400 acres, in a parcel four miles long and from 1½ to 2½ miles wide. The accompanying map shows the general outline of the property, which includes the old village of Marysville and a smaller community called South Port Huron. The ground rises rather abruptly at the river front and slopes gradually from the river, affording natural drainage, the soil containing gravel over clay. Two creeks within the area are made part of the park system.

The Port Huron Southern R.R. runs through the property, as shown, but the right of way has been increased to allow other railroads access to the factory districts and to confine them all to one route across the town, with grade separations at the principal streets. An electric line of the Detroit United Ry. provides electric interurban car service along the river front, but its route will be changed to Michigan Ave. and Gratiot Road, connecting at the north end with the original line. In the street system provision has been made for future transportation requirements.



LAYOUT OF NEW INDUSTRIAL TOWN OF MARYSVILLE, MICH.

In designing the street layout it was necessary to retain certain roads, such as Gratiot Road, Huron Boulevard, Michigan Boulevard north of Huron, James Boulevard and the northwest and south boundary line roads. As some of these are township roads and Gratiot Road is an old military road, their direction could not be changed.

Factory sites are located between the river and the railroads, reserving a large portion of the river front-

age for the park system and for future residential development. The retail business center is on Michigan Ave. between Gratiot and Huron boulevards. With the addition of two diagonal streets, Washington and Jefferson boulevards, the existing roads form a radial system that reaches all parts of the property. The radial streets do not converge at one point, as this would concentrate traffic and create a bad condition. Instead, they have been kept a half-mile apart, with some of the radial streets split before they reach the centers. To handle this diverted traffic the adjoining streets east and west have been widened. At and between the above-mentioned centers the future retail district will develop.

West of the business district a space has been reserved for a civic center fronting on two main boulevards and connected to the business district by a third—Lincoln Boulevard—which extends to a space reserved for the railway passenger station. The wholesale, jobbing and market district is convenient to the railway freight yards and the retail districts.

The remaining territory has been utilized for residential purposes, away from the business districts and on the higher parts of the property. This area has been laid out on a combination of the gridiron and radial street system, as indicated on the map. A little study of the street system will show the convenient access from one part of town to another. The main radial streets which will handle the heavy traffic of the future are 100 and 120 ft. wide, permitting a planting space through the center until increased traffic requires its removal. For residence streets a general width of 80 ft. has been adopted for streets running east and west, and 60 ft. for those running north and south. Asphalt paving probably will be laid eventually, but at present the streets are being laid mainly with cinder beds.

Topographical conditions governed the location of the park system, preserving the best of the wooded areas and serving the residential districts. Large parks are located near the north and south of the property, with smaller parks one or two blocks in area provided at various points throughout the residential and business districts. In addition, the boulevards have been provided with parking in the center and at the junction of the diagonal thoroughfares with the cross streets planting spaces have been arranged. This park system is linked up by a boulevard system with Superior Boulevard on the north and St. Clair Boulevard on the west, thus connecting all the radial streets, which will be planted like the boulevards. The boulevards extend to a large piece of property at the south, reserved for future residential development.

Residential lots, generally speaking, are 40 x 120 ft., on 60-ft. streets, with 45- and 50-ft. lots on the 80-ft. streets and boulevards. In the business districts the lots are 20 x 100 ft. Alleys have been omitted in residential blocks, but an easement has been provided and so arranged that alleys may be formed if future residents desire. A comprehensive plan of zoning has been provided, as indicated on the map. Properties are being sold subject to restrictions for use according to this zoning. Aharbor line has been established, so that future factories may take advantage of the ultimate development along the waterfront.

Water supply is obtained at present from the Port Huron system, but independent water-works are contemplated, with an intake from the river and a filtration plant. The sewer system is to have mains running east and west in about every fourth or fifth street, with laterals extending north and south. These mains will connect with an intercepting sewer near the river front, leading to disposal plants.

Apart from the laying out of many streets and lots, the construction has been confined to the plants of the American Bushings Co. and the Athol Manufacturing Co. and the first units of the new plant for Mr. Wills, which is expected to be in production in a few months. To take care of the employees of these factories a considerable number of single and multiple houses have been built and others are under construction in the various subdivisions, as well as the necessary roads, sidewalks, sewers and water mains in that part of town where the first developments are being made. About 135 residences, mainly of frame construction, have been built and both residences and business buildings are under construction. At the end of August, 1920, the population was about 1,000.

This new town site occupies property which was farm land a year ago. With a comprehensive plan adopted and proper action taken during the next few years to see that the ideals developed in the town plan are carried out consistently, it is expected that Marysville will develop as a model town. All the town planning, engineering design and architectural work for the project are in the hands of Smith, Hinchman & Grylls, architects and engineers, Detroit, Mich.; L. R. Hoffman is the engineer in charge. Construction work has been done by the Walbridge-Aldinger Co., of Detroit, under the direct supervision of the owner's staff.

Railroad Tie Production and Demand

The normal demand for railroad ties is somewhere between 100 million and 125 million annually, says the recent United States Forest Service report compiled in response to the Capper Resolution in the Senate. In 1918, purchases were slightly under 77,500,000 according to the report, and in 10 months of 1919, were slightly over 84,500,000. During the war and the period of Government supervision of the railroads, extensions could not be made and improvements were necessarily confined to those of an urgent character. Lumber purchases were therefore at a minimum. Even under such a policy of retrenchment railroad purchases of sawed materials, excluding hewn railroad ties, telephone poles, etc., aggregated approximately 4½ billion feet or 14 per cent of the total lumber cut of the country for 1918. That there have been profound changes in the lumber distribution from different regions during the past year, continues the report, is shown by the invasion of the Middle Western and Eastern States by Dogulas fir ties. These are regions which in the past have been supplied with the standard oak tie cut immediately along the rights of way or with southern pine ties from the South. During 1919 orders amounting to nearly 100,000,000 board feet were placed for Douglas fir ties for eastern roads because of the uncertainty of securing adequate supplies along their rights of way and because of the excessive costs of local ties. In other words, oak ties cut within a few miles of the right of way are now being replaced by fir ties hauled overland.

Notes from Foreign Fields

ENGINEERING ACTIVITIES IN SWITZERLAND

By E. J. Mehren
Editor, *Engineering News-Record*

BEFORE the United States entered the war we had experienced disturbed industrial conditions. It is therefore easy to appreciate that Switzerland, hemmed in by belligerents, must have suffered, even though a neutral. The cost of living is now between two and three times the pre-war rate, while some articles cost four times as much as before. Common labor has risen in price from 50 centimes per hour (9½ cents) to 1.40 francs (27 cents). The corresponding figures for skilled labor are 80 centimes and 2 francs. Before the war, 10 hours was the working day; now it is 8, and while working production is at only two-thirds the pre-war rate.

In general, then, Switzerland, a neutral, is contending with the same difficulties as the former belligerents. To complete the sum of its troubles there is housing shortage and there have been a goodly number of strikes.

The Swiss franc stands at 18 cents (American), less than 2 cents below par and the exchanges with other nations are nearly normal. That enables Switzerland to continue buying on more favorable terms than the belligerents.

On account of high wages and material prices, however, there is relatively little construction, excepting in railway electrification and water-power development. In addition, the second bore of the Simplon tunnel is being completed.

The water-power construction is the result of the rapid and great increase in the cost of coal. Developments not economical under pre-war coal prices, are economical today. The Swiss Federal Railway System (*Staats Bundesbahnen*) has under way three high-head developments, one of which, the Ritom plant, will be in operation before this is printed. In addition, two large plants for general electric service have just been completed, one at Eglisau (38,000 hp.) on the Rhine, and the other at Mühleberg (64,000), on the Aar, near Berne.

With the likelihood of coal prices remaining high, additional water-power developments may be looked for. The government estimates that the total net horse-power (15-hour power) developed and capable of development is 4,000,000. Of this total only 720,000 hp. have been developed, or about 18 per cent.

Ritom Power-Plant—The Ritom plant, to which reference has been made, takes water from a small lake lying roughly 800 m. above the floor of the Tessin Valley. A tunnel of only 900 m. (2,952 ft.) brings the water through the mountain to a point above the turbine-house. Thence steel pipe lines lead down to the wheels. The storage at the lake has been increased by a dam 7 m. high, and the tunnel is at such a nelevation that the available draw-down capacity is 23,000,000 cu.m. The operating head will vary from 820 to 800 m. (from 2,690 to 2,624 ft.). Pelton wheels of 12,500 hp. capacity, built by Piccard, Pictet & Co., of Geneva, are used. The current will be used for the electric operation of the St. Gotthard tunnel and the adjoining line north and south. At present four wheels are installed Two will be added later.

At Amsteg, just north of the St. Gotthard (the Ritom development is at Ambri-Piotta, just south of the tunnel) the Federal Railway System has a 280 m.-head plant under construction. The water of the Reuss is to be led through a tunnel 8 km. long, and then dropped through steel pipe lines to the wheels. The plant will have a capacity of 90,000 hp.

A third development for the railway system has just been taken in hand in the western part of Switzerland but progress there will be slow since the snow conditions are such that work can be carried on only five months in the year.

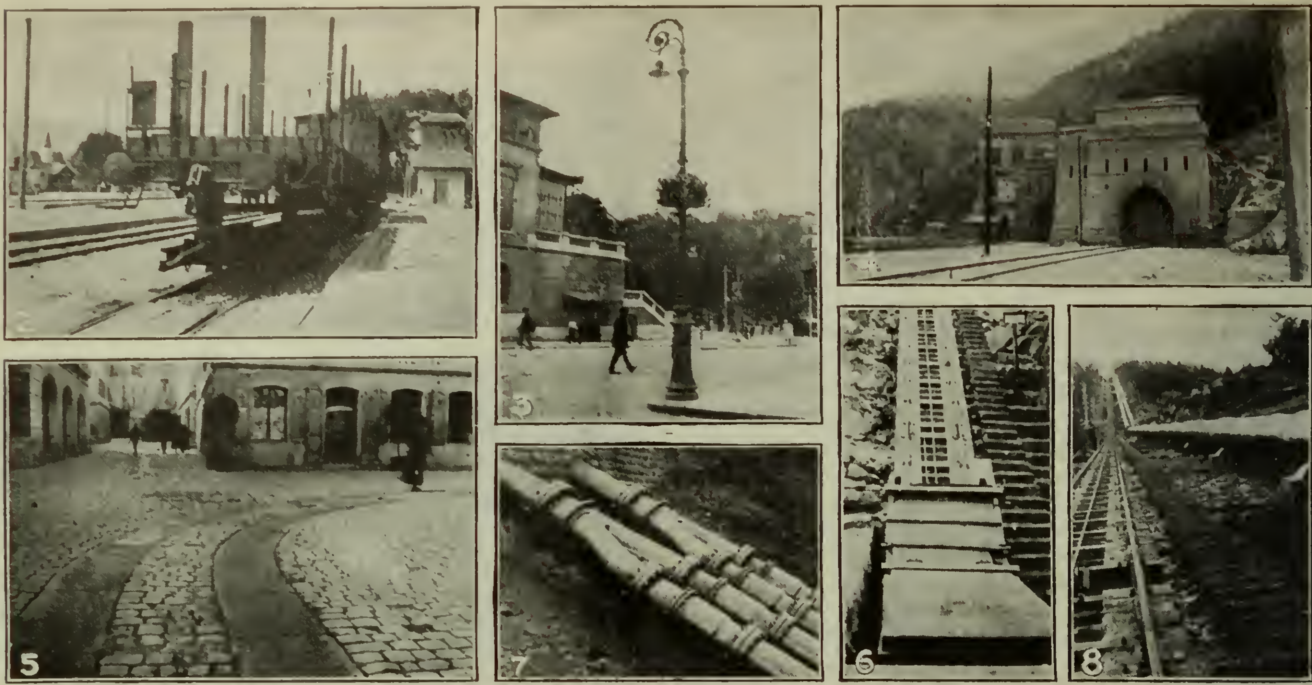
FIG. 1. ELECTRIC LOCOMOTIVE FOR THE ST. GOTTHARD TUNNEL LINE
Traffic through this tunnel has just now been put under electric operation.

The other plants referred to operate under lower heads, Eglisau under 11 m., Mühleberg under 20.

In this connection it is worth while noting that the highest head plant in Switzerland (in operation some years) is the Fully plant, at Martigny, where the head is 1,635 m. (5,363 ft.).

Railway electrification is actually under way in Switzerland, whereas in some of the other countries of Europe, where much talk is heard about it, it is still in the project or preliminary stages. In Belgium, for example, an electrification commission is at work, but a report carrying recommendations has not been rendered. France is further ahead; a commission representing the government and all of the interested railroads has, after studies in England, the United States, Italy and Switzerland, advised that all electrification there be direct current, 1,500 volts, after the pattern of our Chicago, Milwaukee & St. Paul. However, no electrification work is actually under way. In Germany, on the other hand, the Bavarian Goverment has well in hand a large hydro-electric plant which will supply current for railway electrification.

In Switzerland the work is proceeding apace. In 1918 the line from Berne to Thun, 31 km., was electrified, using the single-phase system, which has been adopted as standard for all future Swiss Federal Railway electrification. During the war, however, there was surplus power and surplus equipment available from the Simplon development and a 53-km. stretch from Brigue to Sion was electrified, using 3-phase current, the same as used in the Simplon tunnel. This is a temporary installation, and will be changed later to single phase. It is not the intention, however, to do away with 3-phase in the Simplon tunnel, for when the Italian electrification joins up with the Swiss, 3-phase current will be used on the Italian lines. That is due to the extensive development



2. STANDARD-GAGE FLAT CAR CARRIED ON NARROW-GAGE BOGGY. 3. FLOWERBOXES ON ELECTRIC-LIGHT POST—AN INTERESTING TOUCH IN GENEVA. 4. PORTAL ON RIGHT IS THAT OF SECOND SIMPLON TUNNEL. 5. STONE WHEEL TRACKS, ALTDORF. 6. CAR ON RITOM SERVICE RAILWAY. (Seated on the back of this car, with an Italian workman as companion, the writer had a ride up the mountainside, rising 2,624 feet. The view over the Tessin Valley can never be forgotten.) 7. DIVISION IN PIPE LINES, RITOM HYDRO-ELECTRIC DEVELOPMENT. 8. INCLINED SERVICE RAILWAY AND PIPE LINES, RITOM HYDRO-ELECTRIC PLANT.

of 3-phase power on the Italian side of the Alps.

While I did not have opportunity to enquire thoroughly into the present electrification experiences on the Simplon line I gathered, not only from the decision to use single-phase on the other lines, but also from rather disparaging remarks about 3-phase equipment, that the 3-phase system has not lived up to expectations.

The electrification work actively in hand (and to be finished this year) is the two-track section from Erstfeld to Bellinzona, which includes the St. Gotthard tunnel. On this section maximum grades of 2.7 per cent are encountered. The tunnel portion itself was practically completed several weeks ago, and before this is printed will be electrically operated.

The short stretch from Bellinzona to Chiasso, where the connection with the Italian lines is made, should be finished next year, while either next year or the year after the section from Erstfeld to Lucerne should be in electric operation, thus giving a 226-km. electrified stretch between Lucerne and Chiasso.

The other large construction job under way in Switzerland today is the completion of the second Simplon Tunnel. When the original bore was driven, a small ventilation tunnel (3 m. wide, 2.5 m. high, and 17.5 m. on centers from the first tube) was driven on the center line of the future second tunnel. This bore, which serves the purpose of a heading is now being enlarged to full section. Of the total length of 19.8 km. (approximately 12.3 miles) all but about 3 km. are finished, while of the unfinished stretch there is left not more than about 1,500 m. to be blown out to full section. The new tunnel from the Swiss portal to the center is completely finished, track laid and overhead installed for electric operation. On the Italian side for a distance of 7 km. the section is completed and lined but neither track nor overhead are installed.

Work on the second tunnel was started from both ends in 1914. After Italy entered the war the labor supply on the Italian side became unsatisfactory and in 1917 it was found necessary to shut down the work there. Progress continued from the north, however, until August, 1918, when the effect of the war upon Swiss conditions became such that all work was suspended. In November, 1919, construction was resumed, and with the present rate of progress the second bore should be in operation early in 1922.

In the driving of the second tube much of the difficulty that was experienced in the first work has been repeated. Large flows of water have been encountered, some with temperatures up to 60 deg. C., (140 deg. Fahr.) while bad rock under heavy pressure has been common. Naturally, the experiences developed in the first work have been invaluable and the driving accordingly has gone on with far less anxiety than did the first operation.

Tourists—In one respect the visitor to Switzerland at present fails to get a normal impression. One of the chief pre-war businesses was tourists. With the adverse exchange in the neighboring countries only war profiteers can afford to go to Switzerland. English exchange is in better condition, while Americans find exchange in their favor. However, there are relatively few English people here and Americans are almost rare, so that the hotels are deserted. In fact many of the large ones have not opened at all this year. This merely adds to the sum of Switzerland's difficulties referred to in the opening paragraphs of this letter.

Despite her troubles, however, she is in much better condition than the other countries I have visited, and with a currency in good shape and with a population not exhausted by a long war strain, her difficulties will disappear long before those of her neighbors.

Zurich, July 8.

Letters to the Editor

Members Pledge Support for Am. Soc. C. E. Administrative Reforms

Sir—Amplifying our recent appeal to the membership of the American Society of Civil Engineers for a progressive as against a radical policy for the society, we endorse and pledge ourselves to support the following administrative reforms:

A. The creation and strengthening of the local section as an essential part of the structure of the society.

B. The selection of directors by the districts they are to represent.

C. A progressive policy as regards the duties and obligations of the society as well as the broadening and strengthening of its technical and professional activities.

To accomplish these purposes we again urge the defeat of Amendments A, B, F, and G, so that in their place there may be adopted progressive amendments that will accomplish these essential reforms without incurring the dangers to the standing and stability of the society that lie in the amendments now before it.

We furthermore pledge ourselves to the introduction of such amendments as may be necessary to accomplish these objects.

We repeat and emphasize that this appeal is on behalf of the great body of the non-partisan membership of the society which stands for genuine progress and which is not allied with or interested in any faction.

E. S. Alderman.
W. E. Baldry, W. L. Benham, L. E. Bishop, R. D. Black.
W. G. Brown, W. V. Buck, L. Bush.
F. W. Cappelen, W. T. Chevalier, V. H. Cochrane, M. L. Cunningham.
P. A. Dallis, J. V. Davies.
T. Earle, F. W. Epps, A. C. Everham.
R. Fletcher, G. W. Fuller.
A. L. Gabney E. M. Graham, R. C. Gray.
J. L. Harrington, F. D. Hartford, E. M. Hastings, J. H. Haylow, A. Hazen, J. P. Hogan, C. A. Holden, C. M. Holland, R. Hortenstine, E. E. Howard.
R. H. Jacobs, F. G. Jonah.
F. M. Kerr, V. H. Kriegshaber, K. B. Kumpe.
H. A. Lane, G. H. Leland, E. E. Lochridge, G. L. Lucas
J. L. Ludlow.
A. Maitland, Jr., R. R. Marsden, J. S. Means, C. A. Mees, R. A. Meeker, R. Messer, A. N. Miller, B. S. Morrow, E. T. D. Myers, Jr.
W. R. Neel, A. M. Nelson.
I. W. Patterson, J. N. Pease, J. H. Polhemus.
F. M. Randlett, A. O. Ridgway, J. G. Ross.
N. H. Sayford, W. C. Shaw, Jr., W. F. Shulz, L. K. Sherman, J. W. Smith, L. B. Smith, H. A. Sumner, R. S. Sumner.
J. L. Tighe, L. R. Tillotson, H. P. Treadway, A. A. Trocon, R. D. Trimble.
N. E. Widdell, G. S. Walsh, H. A. Wells, H. F. Wiedeman, J. R. Wilbanks, P. B. Winfree, F. E. Winsor, C. C. Witt, D. Witten.
J. J. Yates.

[It is stated by the authors of the foregoing communication that lack of time has prevented the receipt for inclusion in this week's issue of additional signatures from the original signers of the appeal.—Editor.]

Reply to President Davis on Am. Soc. C. E. Amendments and the "Appeal"

Sir—In *Engineering News-Record* of Sept. 16, p. 570, appears a letter from President Davis of the American Society of Civil Engineers in which he attempts to discredit the appeal recently circulated by 182 representative members of the society, whose earnest hope is to save the society from the radical program embodied in some of the proposed amendments.

It would be well in the first place to correct any misapprehension that may be aroused by President Davis' reference to the "partisan author" of the "Appeal." It is too bad that he was not more specific on this point, for as it stands the reference means just exactly nothing at all. It is pure assertion, wholly unsupported, and not borne out by the Appeal itself. As such it will not command the respect of open-minded readers.

But it seems to me that the authorship of the Appeal is unimportant. What does matter is the endorsement it has received. I count 182 names subscribed to that Appeal. More than 60 of these are from west of the Mississippi. I see names from Montreal, Boston, San Francisco, Seattle and many cities and towns between. This group is larger and far more representative of the Am. Soc. C. E. than was the Portland convention to which President Davis alludes. The man would be rash indeed who would characterize it as sectional, partisan, or reactionary. These signers doubtless represent diverse shades of opinions on many subjects, but they have been drawn together by a common purpose that is deep enough and strong enough to submerge all other considerations. That purpose is the preservation of the Am. Soc. C. E. from the dangers that lurk in some of the proposed amendments. It seems to me that the members of the society may rest assured that the Appeal is just exactly what it professes to be—the appeal of a representative and non-partisan cross-section of the membership which has no purpose but to preserve the society from domination by any faction of whatever complexion.

But let us turn back to the letter. It is too bad that in writing it President Davis has not taken just a little trouble to get all his facts straight. He states, for example, that the Portland convention ordered the amendments to letter ballot by a vote of 73 to 13. If the proceedings of the convention have been correctly reported that vote had nothing whatever to do with the amendments, but dealt with the new federation.

Of even greater significance and far more practical importance is President Davis' statement that the amendments "commit the society to no additional expense." If this be true, I should be interested to learn the source of the funds that are to pay the "travelling expenses within continental United States on a mileage basis" for the delegates to the Annual Conference provided for in Amendment G.

In this connection it is interesting to observe that Prof. Gardner S. Williams estimates that there would be "100 or more" such delegates. At the conservative estimate of $150 each on an average for expenses, it appears that this one item alone will call for at least $15,000 per year for purely political purposes.

I cannot understand the meaning of President Davis' statement that "paragraphs D and E of the Appeal absolutely cancel each other" and that "both cannot be valid." Those paragraphs have nothing to do with each other. D refers to the proposed Annual Conference while E has to do with the Local Sections. If President Davis can explain how these "cancel out" and why both "cannot be valid" he is indeed a wizard of logic.

In his paragraph B President Davis ventures that it is "fair to assume" that there are no defects of inco-ordination, inconsistency or ambiguity in the amendments because they were not pointed out in the circular Appeal. His assumption is neither fair nor valid. Several such defects were clearly pointed out at the New York meeting of Sept. 1 and were published in the Sept. 9 issue of *Engineering News-Record*. It is needless to rehash them here. It looks as though President Davis had found one of them for himself, for he rushes to cover in the wired postscript to his letter (see last week's issue, p. 573) by showing that, very luckily, a holdover director would be available to fill the breach until a new amendment could be adopted to make good the oversight. As it is, the adoption of the amendment would require a unanimous vote of the board to elect new members for several months until the new amendment could be put into effect. But it was a close shave, and an excellent indication of the poor articulation of the amendments with the existing constitution.

President Davis makes much of the methods by which the amendments passed the Portland convention in his effort to show "mature consideration." It all sounds good enough as he tells it, but let us look for a moment at the realities. The Portland convention included less than 2 per cent of the membership of the society. It was one of those bodies which, in the words of Prof. Gardner S. Williams, "are never representative of any but the members in the

immediate vicinity of the place where the meeting is held or of a few devoted ones who make a commendable practice of attending all such meetings." In this case there were relatively few of the latter. The committee which "considered and co-ordinated" the amendments had them in hand not more than three hours.

President Davis drags a red herring across the trail when he talks of the Development Committee and the questionnaire. They had nothing to do with the amendments; they dealt with general principles and ideas, not with the machinery which should carry them into effect and which shall be carefully co-ordinated with the constitution of the society.

All this does not create the impression of "mature consideration" such as should be given to a matter of such vital importance and I sincerely hope that the appeal will be heeded and an opportunity given for the adoption of sound and well-considered amendments.

It is too bad that President Davis must fall back on the classic resource of factional politics, i.e., the stirring up of sectional prejudice. A disproportionately large part of his letter is devoted to the justification of the proposed shake-up of directors. He dwells upon the "unfairness" of the present representation. He reckons by the formulæ of civic politics and seems to be little interested in the efficient administration of the society. Perhaps there *are* more directors in the Metropolitan District than would be justified by numbers Perhaps the number might be scaled down. But the headquarters of the society are there, and its business must be conducted there. Several of its committees must function there. *The prime consideration is the efficient management of the society, not numerical representation.* The Am. Soc. C. E. is not a state, with police power over the affairs and the lives of its members. We can carry worship of this "democratization" fetich to an extreme that may be theoretically ideal but will certainly be injurious in its practical application. If the present apportionment of directors effects an "unfair domination of a minority" then correct it, but in the name of the Am. Soc. C. E. do it in a way that will minister to efficient management rather than to sectional prejudice.

It is useless to go on into more detail. The amendments are a sad mixture of what is good and what is vicious. As they stand we cannot accept the one and reject the other. There is but one safe course. Reject those having to do with the administrative reforms, viz., A, B, F and G, and let us formulate a new plan that will include the essential reforms without danger to the welfare of the society.

In his last paragraph President Davis insinuates a charge for which there is not a scintilla of foundation. The Appeal conveys no threat of any sort and as one of the signers I wish to protest his statement. I am confident that the standing and character of the other signers carry their own refutation of the charge. WILLARD T. CHEVALIER.

New York City, Sept. 20.

Effect of Increased Rates on Railroad Construction

Sir—On my return after several weeks' absence I found your letter asking certain questions as to my views as to what will be done by the railroads in the way of improving transportation facilities within the next year. This is a pretty hard question to answer, owing to the peculiar financial situation and difficulty in securing material from the manufacturers.

A great deal of complaint has been made regarding slow delivery and inadequate transportation. Our experience on this railroad is that we are having difficulties in getting the material delivered from the manufacturers. There has never been a year before this in which we have had the difficulty that we have this year in getting track fixtures such as bolts, spikes, nut locks, joints, tie plates, frogs, switches and guard rails. It is hard to plan and carry out improvements promptly under the present conditions in connection with the securing of material.

With the exception of a few companies with high credit, railroads are up against the proposition of financing on a seven or seven and one-half per cent basis. There are many improvements on which, under the Transportation Act, they will receive at the most but six percent and will not receive this until such a time as some future adjustment in rates is made to include the value of the railroads, due to the addition and betterment charges that have accumulated since the tentative value set by the Commission.

This means that the class of expenditures that the average railroad can afford to make are those which will make for an economy in operation that will at least make up for the difference between six percent and whatever they have to pay for their money, and in addition to that which will make economies that will take care of the total expenditures between the time they are made and the time that readjustments of rates is made to cover this expenditure.

There will be improvements to the extent of the money that can be secured from the revolving fund created by the Transportation Act, but this will probably be along the lines of additional motive power, rolling stock, the purchase of labor saving tools and machines and of new rail, ties and ballast to make up for the shortage of these items during the period of Federal control.

Expenditures in addition to these that will be made first will probably be for the extension of passing tracks and additional passing tracks, due to the increase in business during the last three or four years. It is my thought that but a small part of these expenditures, however, will be made during the balance of the present year, but that they will be included in the budget of the different railroads for 1921.

There is a possibility that the rates which have been allowed by the Interstate Commerce Commission will permit of some roads, and possibly many roads, earning more than six per cent. The result of these rates will not be well enough known to decide this matter until after Jan. 1.

Should the earnings under the rates show up well the railroads will be warranted in making much needed improvements, due to the improved credit on the basis of such earnings. Should this turn out to be the case it is my opinion that there will be during 1921 much improvement made by the railroads in increasing terminal facilities as the greater majority of the roads have outgrown many of their terminals.

The changes in working conditions brought about in connection with the increased wage scale is going to require a large expenditure on the part of the railroads in better housing facilities for their employes, and there will be, in my judgment, large expenditures made if the money is available for this purpose. However, with the money available for improvements it is my opinion that the progress that can be made on these improvements will depend to a great extent on the ability of the manufacturers to furnish material and equipment needed.

Regarding the question of expansion of the engineering departments, this depends entirely upon the size of the program. Any marked increase in construction programs will, of course, call for an expansion of the engineering department.

As to the difficulty of transporting materials, it is my opinion that by the spring of 1921 the increase in locomotives and rolling stock, together with the overtaking of the deferred maintenance on the old locomotives and rolling stock will make a marked improvement in the transportation facilities, and that there will be no great difficulty in handling the business after about May 1, 1921. But with the provision of improved yard and engine terminals and with the additional passing tracks and second tracks that will be constructed there should be a continual improvement in transportation for the next two or three years.

Chicago, Sept. 8. C. A. MORSE, Chief Engineer,
Chicago, Rock Island and Pacific Railway Co.

[Letters on this subject from A. O. Cunningham, chief engineer, Wabash Railway Co., and L. C. Fritch, vice-

president, Chicago Rock Island and Pacific Railway Co., appeared in *Engineering News-Record*, Aug. 26, 1920, p. 424.—EDITOR.]

Applied Statics for the Rodman

Sir—You may be interested in the accompanying photograph as an illustration of labor-saving methods in field

work. I understand that the chair is a part of the regular equipment of the rodman shown. CHARLES W. SHERMAN.

Boston, Sept. 13.

Chinese Irrigation Devices—Overshot Wheel and Treadmill

Sir—In the article on water supply for irrigation in China in *Engineering News-Record*, Sept. 2, p. 448, D. F. McLeod has not mentioned the well-known device, "treadmill," used in the southern part of China. A tread-mill is, doubtless, more elaborate, ingenious and efficient than any of the three devices mentioned by Mr. McLeod. It is similar to an overshot wheel, working as a pump, set in an inclined position to suit the lift of the water required. The operator or operators tread the projecting arms of the axle, thus turning the vanes and lifting the water through a trough. This device has the advantages of maintaining a continuous flow, being workable by one or more operators, having an adjustable lift of water and keeping the feet of operators dry. In many cases it is operated through the connections of wooden gears and wheels, by animals on nearby land. The device described by Mr. McLeod as of Japanese origin has principles similar to those of a tread-mill and the tread-mill may also be used by Japanese farmers at present. C. Y. HOU.

Pottstown, Pa., Sept. 19.

Driest Season at Panama

Sir—In your issue of August 5th, page 276, article on "Driest Season at Panama," there is almost an obvious typographical error.

The 5.24 ft. drop in Gatun Lake storage from El. + 87.0 represents 20.46 billion cu.ft. of water, not 20.46 million.

I am glad to report that July rains have materially changed the water supply situation, almost daily spilling having been necessary since the Lake elevation reached + 85.5 on July 26, 1920. R. Z. KIRKPATRICK,

Chief Hydrographer, the Panama Canal

Balboa Heights, C. Z., Sept. 14.

What Is Art?

Sir—I have just read your editorial under this title in your issue of 16th inst., referring to the unhappy mixture of engineering and "architecture" in our Bensalem Avenue bridge, and I respectfully dissent from your three conclusions: (1) "Just as the engineer asks of the architect an acceptance of his assurance of strength in a structure, so must he accept the architect's assurance of beauty." (2) "Unquestionably this structure is pleasing to look at and testifies in general to the wisdom of architectural assistance in bridge design." (3) "It is a fair question whether the engineer's instinct for simplicity in bridge design is not sound."

In regard to the first of these sentences, your judicial attitude does you credit, but it has misled you. The converse does not hold. The radical difference, between the engineer's and the architect's training, which makes the engineer the authority on strength, makes him also the authority on beauty. The engineer designs a truss bridge, beautiful because fitly performing its function; but, if the bridge is to appear in a public park or in some other place where large numbers of tasteless persons are expected to foregather, an architect must be called in, and he proceeds to "beautify" the design. He will pile on meaningless pylons, or he will erect meaningless rock fortresses at the portals, or he will throw a meaningless sheet-iron arch across each panel, or he will hang a meaningless cast-iron cauliflower at each panel-point; or (if unrestrained by an engineer) he may even perpetrate all these crimes upon a single structure. The man who, in "the pursuit of prettiness," spells "music" with a "v," or who builds a column under the keystone of an arch, thereby proclaims his failure to grasp the nature of beauty.

Judging from your photographs, the Bensalem Avenue bridge would be "pleasing to look at," as your second sentence claims, from a distance sufficient to hide its architectural disfigurements, but the bridge testifies to the unwisdom of letting the architect perpetrate them. Your text states that the arch rings increase in thickness from crown to the springs, as they should; being 2 ft. 6 in. at the crown, and 6 ft. 8 in. at the springs. This, if shown, would have been an element of beauty, for it accords with nature and satisfies the eye unperverted by "architecture"; but the photograph at top of p. 561 indicates that the architect has deliberately hidden this beautiful feature by a thin veneering of camouflage slabs, much deeper than the crown thickness, counterficiting a flat-top arch, extending for some distance each way from the crown, and merging the arch (in appearance only) with the "ornamental" horizontal coping!

As to your third sentence, there is no question as to the soundness of the engineer's instinct for simplicity; for that instinct is based upon the nature of things.

In his address at the Denver convention of the American Society of Civil Engineers in 1908, President Charles Macdonald well said: "The structure which has been designed upon the most scientifically accurate proportions, that is to say, which accomplishes, in accordance with Nature's great law, the object for which it was intended, will present the most pleasing outline," and the addition of architectural scroll-saw work to that outline serves only to obscure and to belittle its beauty. JOHN C. TRAUTWINE, JR.

Philadelphia, Pa., Sept. 18, 1920.

Why Flat-Slab Action Is Not Understood

Sir—I note your editorial in the Aug. 12 issue (p. 289), in which you state that the theory of reinforced concrete flat slab design is anything but exact. You might add that the theory of reinforced concrete beams is likewise anything but exact.

The difficulties with both lie in the failure of the majority of members of the engineering profession to apply the elementary principles of mechanics thereto. Thus the trouble with determining coefficients in flat slabs is found in the failure to appreciate that if the slab is fixed the amount of positive and negative bending is equal. Hence the moment resisted over the support is to that between the supports as the respective moment areas divided by the moments of inertia, an elementary consideration which indicates clearly that no fixed rule of thumb is applicable to the wide variations in design commonly employed.

When the columns are not stiff enough to practically fix the slab at the support the rigidity of the column should enter into the computation.

The total bending moment is easily determined and separated from the twisting moment, if we consider the lines of zero shear. Thus, if the column were but a point the total applied moment from column to column would be WL/12. In a diagonal direction it would be WL'/16 in which L' would be the diagonal dimension. These values would be reduced in the ratio of the half span less the half diameter of the capital to the half span.

The resisting moment is another matter which is ordinarily treated in an incorrect manner. The bending is in two directions and the mechanical operation of such bending can be understood by taking a slice of a hollow rubber ball. If you bend it in one direction it flattens out in the other. In other words, two bending moments at right angles to each other mutually reduce the effect of each and if equal the resisting moment that it is essential to provide for is less than half that which it would be necessary to consider were the bending cylindrical.

The writer is of the opinion that in any well executed concrete design there should not be a discrepancy greater than 5 to 8 per cent between computed stresses and measured stresses. Such stresses, however, must be measured in a rational manner. The concrete when it cures is subjected to shrinkage stresses which prevent it from deporting itself in an elastic manner. Accordingly, recovery readings and not initial readings are those which determine the true stress. That this is obviously the fact will be apparent upon considering the case of a steel bar which has been stressed beyond the elastic limit. If we take a reading under the maximum load and note the recovery when the load is removed we can multiply the recovery difference in the readings by E, the modulus of elasticity, and determine approximately the load to which the bar has been subjected. We must do the same thing with the concrete. Then when the difference between synclastic and cylindrical curvature is taken into consideration there will be no difficulty in figuring true stresses, which will prove to be in harmony or keeping with measured stresses, and the data at present apparently inharmonious will assume a determinate and harmonious aspect. Establishment of Joint Committee assumptions or opinions will not matter. Painstaking application of the principles of mechanics and scientific procedure in testing only will accomplish this result.

One of the apparently indeterminate questions in flat slab design is that of arch action. Were the assumption of the ordinary theory correct that a plane section remains plane and normal to the curve of flexure after bending, arch action could not exist in a continuous beam or slab, but this assumption is in error. Horizontal shear deformation occurs, and, as this deformation in the simple span or cantilever increases as the moment area and decreases as the horizontal sectional area resisting it, the natural deformation or detrusion in the cantilever part of a fully restrained beam is greater than that in the suspended span portion. Hence a thrust is propagated along the under surface of the beam which develops arch action, an amount which is readily computed and permits the elimination of the last uncertainty or indefinite question presented by the flat slab problem or the continuous beam of reinforced concrete.

The settlement of these indeterminate matters is a question of pure mathematics—not a question of opinion or of vote by any committee of engineers. The popular tendency of late to introduce "real democracy" in the field of science, that is, to determine scientific facts by the votes of the members of a professional body instead of by painstaking application of mathematics and scientific methods, will never attain unquestionable results. C. A. P. TURNER.

Minneapolis, Minn., Aug. 19.

Highway Subgrade Study

Sir—In commenting on the letter of H. G. Shirley, regarding subgrades and foundations for highways, published in *Engineering News-Record*, Sept. 9, p. 521, one is reminded of the old English play "Our American Cousin."

"The proper study of mankind is man," and the proper study of the materials of the subgrade of a highway is the observation of them *in place*. In the glacial drift, which covers much of the northern part of the United States, occurs so much uncertainty in quantity as well as different quality that it is absolutely impossible to determine, from laboratory tests, how a certain patch of material will act in practice. (A patch of quicksand may be shallow or deep—a bed of quicksand may be overlaid by a thin sheet of high-grade gravel.) In glacial drift no two feet of a road layout are sure to be of the same material or to extend to the same depth, nor is it practicable to determine, by test-pits what underlies the surface stratum.

The only sure and practical way to determine the ability of the subgrade to carry the load to be imposed upon it is by the method described in an article on highways appearing in *Engineering News-Record* under date of March 21, 1918, p. 543. The Almighty has so constructed this old mother earth that some nature problems *must* be solved by the "cut and try" plan, and highway construction and maintenance is about as near to nature in all its parts as anything man has undertaken.

We have had a whole lot of "scientific" work exhibited on our highways and all or nearly all in the northern states are confessed failures. Why not begin now to study underlying principles and conditions and better those basic conditions before expensive hard surfacing is put on?

Many a foreman of a fifteen-man road gang knows more about the needs of the subgrade than any commissioner is showing signs of realizing.

By working highway layouts as improved dirt roads for a matter of two years, to prepare properly the subgrade, there will be found thousands of miles which need no more special treatment than oiling to harden them for use.

Where the materials are known they may be studied scientifically, but where they are unknown or imperfectly known the only possible method is by trial and elimination.

Jewett City, Conn., Sept. 16, 1920. A. A. YOUNG.

Remarkable Bridge Proposed for China

Plans are being entertained to build a combination reinforced-concrete girder and steel-truss cantilever bridge over Soochow Creek at Shanghai, China, according to note in *The Engineer* (London). An old wooden bridge now crossing the creek is to be replaced by a three-span cantilever bridge, built of reinforced concrete except that the suspended span is to be of steel. The central span is to be 120 ft. long and each of the side spans about 56 ft. The structure is to have a deck 56 ft. wide over all, and is to carry normal highway loading, with a 14-ton roller as maximum concentration. Incidentally, the pier will be skewed 14 degrees.

Hints for the Contractor

Derrick Boom Supports Leads For Steam Hammer Driving Batter Piles

IN THE construction of the barge canal terminal in Flushing Bay, Flushing, Long Island, the McHarg-Barton Co., New York City, has driven a large number of long foundation piles including several hundred spur piles, 17 to 19 in. in diameter and 80 to 85 ft. long, battered 1:3, by the use of swinging leads supported by a derrick boom. Piles are driven to an average penetration of 55 ft. through mud, clay and mud strata to bearing in a heavy blue clay, without the use of a pile driver tower or the elaborate mechanism often employed for driving battered piles.

The piles are set in position by a floating derrick and penetrate the mud several feet by their own weight. The tops are guyed and pulled into position giving approximately the required angle at which they are maintained by the guy ropes while the pile is driven by a No. 7 McKiernan-Terry double-acting steam hammer making about 225 strokes per minute. The hammer weighs 5,000 lb. and the striking part weighs 800 lb. giving it a high efficiency which drives the piles at an average rate of 32 per 8-hr. shift. Piles were considered to be driven to the refusal point when they would not move over 1 in. under 100 blows of the hammer with steam pressure at 90 to 100 lb.

DRIVING AN 85-FT. PILE WITH STEAM HAMMER IN SWINGING LEADS

The pile hammer operates in a pair of 6 x 6-in. swinging timber leads, with 2-in. planking extending about 8 ft. below the butt of the pile, thereby affording a batter support. The leads and hammer are handled by a hoisting tackle operated from the end of a 78-ft. derrick boom which is very quickly adjusted to the required position for successive piles.

The water is 14 ft. deep at low tide and 20½ ft. deep at high tide, and the piles have a 6-ft. cutoff making an approximate total of 26½ ft. not driven.

This method of operating the hammer was designed, constructed and operated by J. S. Mosher, superintendent for the McHarg-Barton Co., contractors for the work.

Record of Rock Drills and Drill Work

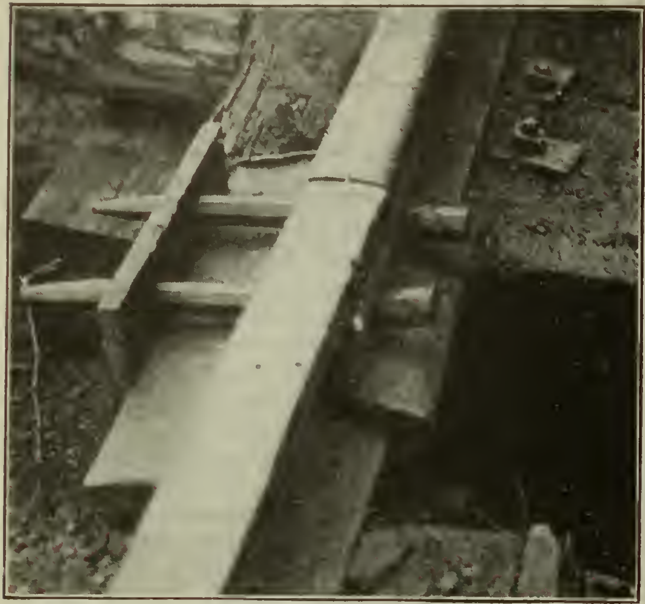
EFFICIENCY of drill steel in the Copper Range mines, Michigan, is promoted by records that show the actual underground performance of the drills. Reports from each drill machine are made daily by the shop and mine. Tables compiled from these reports show the footage drilled, steel broken, drills received and sent out at the shop, drills sharpened, and bits cut off. These data show what each machine or party is doing and whether the miner's supply of drills is kept up to date. The daily records show the number and condition of drills on hand at all times

This system, which may be adapted to tunnel work, is described in a paper by H. T. Mercer and A. C. Paulson, Painesdale, Mich., read at the recent Lake Superior meeting of the American Institute of Mining and Metallurgical Engineers.

A Quick Assembly Rail Joint

THREE blows with a sledge disconnects the rail joint shown in the accompanying photograph. The clamp, two tapered pins and a flat tapered wedge, 4 in. wide, can be reassembled in two or three minutes by unskilled labor. The joint was devised because of the time required to assemble and dissemble regular splice bars, bolts and nuts on joints frequently made in a track carrying a pipe-laying machine at work on the new concrete water supply conduit for Denver, Col., described in *Engineering News-Record*, Sept. 16, 1920, p. 551.

The clamp passes under the end of the abutting rails. One side fits snugly under the rail head. The other edge is upturned and has two holes to receive tapered pins passing through the rails. Under these pins the broad



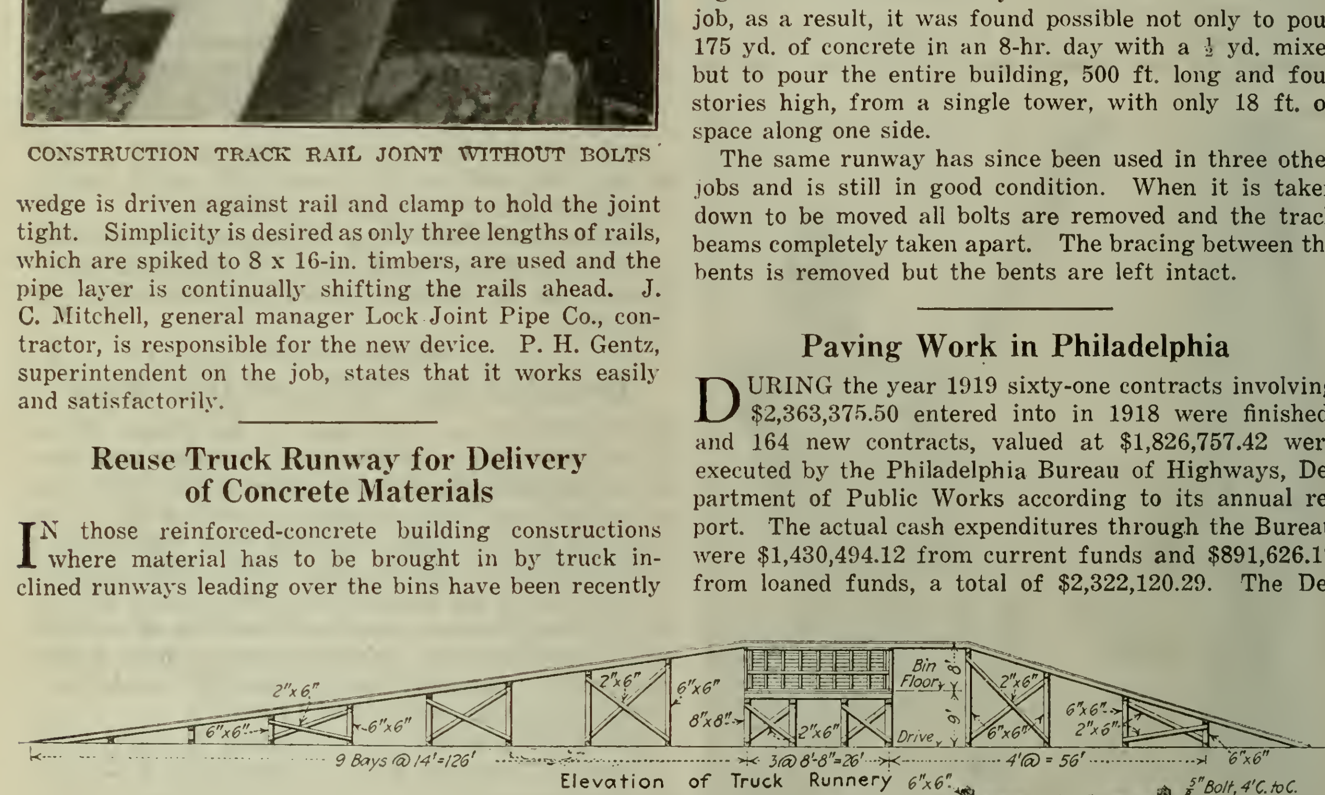
CONSTRUCTION TRACK RAIL JOINT WITHOUT BOLTS

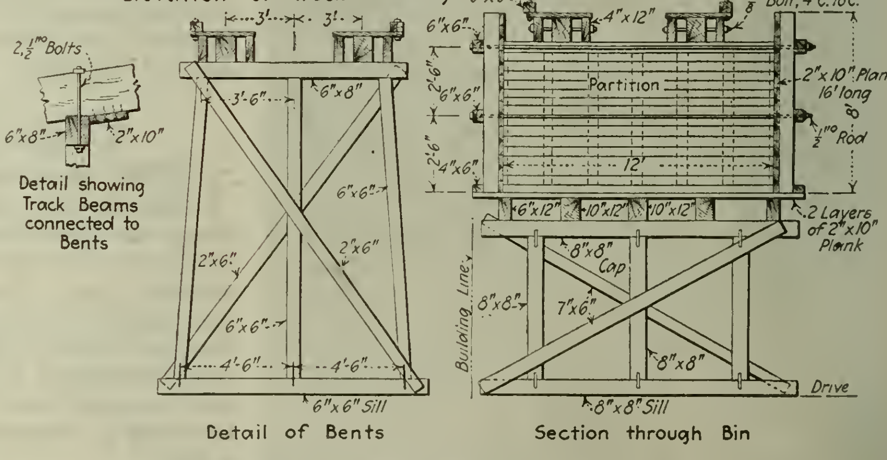
wedge is driven against rail and clamp to hold the joint tight. Simplicity is desired as only three lengths of rails, which are spiked to 8 x 16-in. timbers, are used and the pipe layer is continually shifting the rails ahead. J. C. Mitchell, general manager Lock Joint Pipe Co., contractor, is responsible for the new device. P. H. Gentz, superintendent on the job, states that it works easily and satisfactorily.

Reuse Truck Runway for Delivery of Concrete Materials

IN those reinforced-concrete building constructions where material has to be brought in by truck inclined runways leading over the bins have been recently successfully used. One such structure, built by the Sam W. Emerson Co., general contractors, of Cleveland, Ohio, was so designed and erected as to permit its ready removal and consequently has been used on four separate jobs.

The runway is designed with two sets of track beams, each set consisting of a 10 x 12-in. and two 4 x 12-in. timbers in 28-ft. lengths. These timbers support two plank trucks, each about 2 ft. 6 in. wide, with a 6 x 6-in. curb bolted to the outside. The beams are supported by bents at 14-ft. centers, each bent consisting of a 6 x 6-in. upright and a 6 x 8-in. cap. The 10 x 12-in. timbers and the 4 x 12-in. timbers in the track beams are spliced at alternate bents.





DETAILS OF DEMOUNTABLE TRACK RUNWAY

After reaching the top of the incline the loaded trucks dump into the sand and stone bin, the floor of which is 9 ft. above the ground. The inside dimensions of this bin are 12 x 24 ft. The floor is built of two layers of 2 x 10-in. plank, supported on 10 x 12-in. beams and the sides of one thickness of 2-in. plank. The partition which separates the sand compartment from the stone compartment is located 14 ft. from one end, which gives a stone capacity about 40 per cent greater than the sand capacity. The floor of the bin is flat. Two 24 x 30-in. gates in one side feed the sand and stone into a super-hopper, which discharges into the mixer. The axis of the mixer is about 4 ft. from the surface of the ground, and the tower bucket in its lowest position rests directly on the ground.

The runway was first used in May, 1919, on the building for the Forster Realty Co. in Cleveland. On this job, as a result, it was found possible not only to pour 175 yd. of concrete in an 8-hr. day with a ½ yd. mixer but to pour the entire building, 500 ft. long and four stories high, from a single tower, with only 18 ft. of space along one side.

The same runway has since been used in three other jobs and is still in good condition. When it is taken down to be moved all bolts are removed and the track beams completely taken apart. The bracing between the bents is removed but the bents are left intact.

Paving Work in Philadelphia

DURING the year 1919 sixty-one contracts involving $2,363,375.50 entered into in 1918 were finished, and 164 new contracts, valued at $1,826,757.42 were executed by the Philadelphia Bureau of Highways, Department of Public Works according to its annual report. The actual cash expenditures through the Bureau were $1,430,494.12 from current funds and $891,626.17 from loaned funds, a total of $2,322,120.29. The Department of Supplies expended for the Bureau of Highways for material $291,377.68, making a grand total of $2,613,497.97.

News of the Week

New York, September 23, 1920

Congress Expected To Aid Construction Work

(Washington Correspondence)

That the next session of Congress reasonably may be expected to do all within its power to help the nation meet its construction problem is regarded as a certainty. It is believed that it will look with favor upon appropriations intended for studies to devise means of reducing costs.

One of the ways in which economies can be effected, it is believed, is by increasing efficiency in the mining and the handling of the non-metallic minerals. The construction industries alone will use non-metallic minerals to the value of $400,000,000 in 1920, it is estimated. It is believed that convincing information can be compiled looking to the substitution of mechanical equipment for hand labor and the practice by more operators of the short cuts which have been developed by the more highly organized companies. It is thought that much waste can be eliminated and that ways can be found to utilize unavoidable waste.

To Map Production Centers

It is suggested that centers of production of basic raw materials should be mapped, as well as centers of consumption, so that savings can be made on freight charges and rolling stock can be economized. The governmental agency charged with the work, in addition to disseminating such information as the fact that per-man production oftentimes can be increased seven-fold by substituting steam-shovel loading for hand labor, would undertake, for instance, to establish a nationwide use of standard screen sizes.

Limestone screenings are valuable for fertilizer purposes. Ways could be devised, it is believed, to utilize all limestone waste. Little research has been done on the mineral pigments. There is said to be much room for improvement in the technology of the calcination of gypsum. A useful brick is made from grinding granite waste and mixing it with lime, but few of this particular type of brick are made in this country.

The foregoing are cited to indicate possibilities of a methodical study of economies in the non-metallic minerals. The list could be extended almost indefinitely it is declared. The Bureau of Mines has been doing some work along these lines, but its activities have been incidental because of lack of appropriations and have been entirely inadequate to meet the demands of the construction industries.

Philadelphia Section, Am. Soc. C. E., Protests Changed Meeting

At a meeting Sept. 13 the Philadelphia Section of the American Society of Civil Engineers passed the following resolutions:

Whereas, the call for the Sept. 1, 1920, stated meeting of the American Society of Civil Engineers announced as the business the discussion of the paper entitled "Bridge versus Tunnel for the Proposed Hudson River Crossing at New York City," and on Aug. 30, the Acting Secretary of the society sent out a postal card notification, to members of the Board of Direction and to only resident members of the society, of the postponement of this paper and giving as the subjects for discussion, the proposed amendments to the constitution and the invitation to become a charter member of The Federated American Engineering Societies, and

Whereas, the reported account of the meeting published in the current issue of *Engineering News-Record* shows that it was participated in by only 99 members; that all of the discussion was opposed to the amendments, and to the acceptance of the invitation; that resolutions were adopted authorizing the minutes of the meeting in the *Engineering News-Record,* and requesting the Board of Direction through its Executive Committee to immediately issue copies of the stenographic report of the meeting to each member of the society, and

Whereas, the result of the questionnaire ballot canvassed, April 14, 1920, shows that the New York District, by a vote of 3 to 1, was opposed to the comprehensive organization recommended by the Joint Conference Committee of the four Founder Societies, which recommendation was approved, June 3-4, 1920, by the Washington Organizing Conference,

Therefore Be It Resolved, that the Philadelphia Section of the society, at a regularly called meeting, Sept. 13, 1920, notice of which meeting was sent to all of its members, hereby protests to the Board of Direction of the Society,—

(a) that the program of stated meetings should not be changed without due notice to each member of the society;

(b) that the meetings of the society should not be conducted as New York local meetings;

(c) that no business vital to the welfare of the society should be transacted unless each corporate member is duly advised, in advance, of the properly called meeting which notice should state the business to be considered; and

(d) that under no circumstances should the report of the stated meeting of September 1, 1920, be mailed, in separate form, to the members at the expense of the society.

Be It Further Resolved, that copies of this resolution be sent to the Board of Direction, and to each local section of the society, to the technical papers, and to all members of the society resident in the Fourth District.

Morgan Engineering Cos. Establish Shanghai Office

The Morgan Engineering Cos., Dayton, Ohio, will open an office at Shanghai, China, having been retained by Chang Chien, formerly minister of commerce and agriculture, as consulting engineers for shore protection, canal improvement, drainage and other important public works in the vicinity of that city. It is also the intention to investigate the possibilities of flood control, reclamation and power development work in China.

Bids Opened for Shafts of Vehicular Tubes

Thos. B. Bryson, With Total of $650,-000, Is Low on First Contract for Hudson Tunnel Job

Five contractors submitted bids Sept. 21 for the construction of two of the ventilating shafts of the New York-New Jersey vehicular tunnel under the Hudson River, the tender of Thomas B. Bryson, amounting to a total (official) of $650,802.50 being low. The next lowest bid was that of Booth & Flinn, Ltd., at $695,000. The other three contractors were: Patrick McGovern, $922,000; Frederick L. Cranford, Inc., $950,000; and Rodgers & Hagerty, Inc., $1,244,000. The present contract is the first call for actual construction work to be made by the two state commissions created to administer jointly the project of providing a subaqueous route for vehicles between New York City and Jersey City. (See *Engineering News-Record*, Feb. 19, p. 357.)

The contract covers the construction of two ventilating shafts at the Manhattan end of the tunnel located respectively at Canal and Spring Sts., near Washington St. The shafts are rectangular and involve the sinking of two caissons consisting of steel walls filled with concrete. Measured to the outside of the cutting edge of the caisson, both shafts have sections 47 ft. 1½ in. by 42 ft. 5½ in. The inside dimensions, measured to the face of the skin plates, are 36 ft. 8 in. by 32 ft. The thickness of the concrete filling in the walls is 5 ft. 1½ in.

By the terms of the contract the contractor is allowed twelve months in which to complete the work. This time is believed by the commissions' engineers to be adequate, inasmuch as it is thought that actual construction need only consume six months, the other six months being leeway to provide for delayed deliveries of steel. A penalty of $1,000 a day is specified if the work is not finished within a year's time.

The principal quantities involved in the construction are: Earth excavation above mean high water, 870 cu.yd.; earth excavation below mean high water, 8,330 cu.yd.; rock excavation, 10 cu.yd. Concrete in caissons, 2,710 cu.yd.; concrete placed in compressed air, 770 cu.yd. Steel in caissons, 1,190 tons.

The shafts will form permanent ventilating openings connecting with the tubes. The present contract does not involve any equipment. The Spring St. shaft is about 54 ft. deep, while the Canal St. shaft is 60 ft. deep.

In their essential features the specifications follow former practice as exemplified in the New York subway work. In one detail, that of waterproofing, a change has been made. Cotton fabric and asphalt are specified instead of burlap and coal-tar pitch. It is believed that the hot asphalt in compressed air will give less trouble in the matter of fumes than the coal tar pitch.

As for concrete, there is a clause giving the engineer control over the mixture by varying the amount of stone, but the quantities of sand and cement are always to be constant.

The ventilating shaft contracts have been advertised in advance of the remainder of the work inasmuch as money for their construction is immediately available. Chief Engineer C. M. Holland emphasized to *Engineering New-Record's* representative that the type of ventilating shaft specified makes it feasible for the subsequent tunnel work to be done either by the shield process of by the trench method.

Presidential Candidates Favor Engineers' Program

Answers to questions on public policy relating to engineers and engineering submitted to Senator Harding and Governor Cox by the American Association of Engineers indicate that both presidential candidates favor the views of the engineers. The questions asked if the candiates favored (1) the establishment of a National Department of Public Works; (2) assembling and coordinating all federal engineering and construction (excepting the purely military works) in such a department; (3) appointment of an engineer on the Interstate Commerce Commission; (4) a progressive and constructive program of conservation and development of our natural resources; (5) a budget system; (6) reclamation of waste lands by drainage, irrigation, flood control and other methods; (7) giving the settler the advantage of procuring the land by a sound financial system such as is provided by a rotating fund.

Governor Cox writes L. K. Sherman, president of A. A. E., as follows:

My reply to every one of the questions you ask is unequivocally "yes."

Time will not permit, nor do I consider it proper that I answer the ordinary questionnaire. My past record and public utterances must be sufficient, however, as in the case of your letter, the reply to questions asked and my record and public announcements are one and the same. I therefore take great pleasure in making this statement.

Senator Harding's letter is more detailed in his reply to C. E. Drayer, secretary A. A. E.

It is not an easy matter for me to make a detailed reply to the inquiries conveyed in your letter and I do not care to enter into a categorical reply to questionnaires, no matter how friendly they may be and no matter how reputable and high-standing is the source from which they come.

My theory of a campaign is that a man's candidacy ought to be based on the formal and public utterances, though, of course, we are all of us informal enough to discuss informally many of the problems which are in the minds of various groups of our American citizenship.

I have had up the matter of the Department of Public Works in some personal interviews and quite agree with you that the question is an exceedingly interesting and important one. I fear I should be unworthy of public confidence if I ventured to decide so important and far-reaching a question without the very fullest study. It involves the reorganization of several departments. Undoubtedly there is necessity for this, but I should be very reluctant to unalterably commit myself to it without the very fullest of understanding.

You may be interested to know that I have already sent for the Congressional hearings on this particular question.

I may say, in a general way, that I think very well of the appointment of an engineer on the Interstate Commerce Commission and I have always spoken heartily in favor of a progressive and constructive program of conservation. I am sure you know that I favor the budget system and a very forward policy relating to reclamation and irrigation.

A. A. E. States Its Position on Federation

The following letter in reference to the position of the American Association of Engineers relative to The Federated American Engineering Societies, has been sent to Richard L. Humphrey, chairman of the Joint Conference Committee, by C. E. Drayer, secretary of A. A. E.:

Careful consideration was given by the Board of Directors of the American Association of Engineers at its meeting on Sept. 11 to the invitation dated Aug. 25 of the Joint Conference Committee to this Association to become a charter member of the Federated American Engineering Societies.

The American Association of Engineers, as expressed by its delegates at the Organizing Conference June 3 and 4, fully considered the idea of a Federated American Engineering Societies and its objects. It was then understood that as the purposes of A. A. E. and the F. A. E. S. are to deal with the non-technical activities of engineers, there should be devised an effective system of co-operation in order to avoid overlapping and duplication of effort.

At the Washington Conference the representatives of A. A. E. brought out the fact that A. A. E. is already doing much of the work proposed for the F. A. E. S. and has in existence a successful "going concern" consisting of a central executive office, numerous subsidiary offices with paid help, and some 225 chapters and clubs. These facilities were offered to the proposed federation. Having already in existence this organization, necessary for its existence, the American Association of Engineers cannot be expected to delegate to another body the trust that has been placed in it by 21,000 members to do their welfare work. It therefore appears that the effective method of co-operation between F. A. E. S. and A. A. E. will be for A. A. E. to be represented in F. A. E. S. as a co-operating member, A. A. E. doing its share of the work with its own organization at its own expense. Likewise F. A. E. S. should be represented in the American Association of Engineers.

We will therefore be glad to be represented at the November meeting and will designate a delegate upon our being advised that this plan meets with your approval. We will be glad to have you designate a delegate to the official meetings of A. A. E. and inform us his name.

Western Society Endorses State Regulation of Utilities

Following an extended report by its Public Affairs Committee on state regulation of public utilities vs. home rule, the board of directors of the Western Society of Engineers has gone on record as approving the state commission side of the argument. The board also recommends to the members and to the public that the Illinois Public Utility Commission be retained. Instead of impairing the law which created the commission it urges strengthening that law.

Canadian Engineers Meet at Niagara Falls

Advantage was taken of the concentration of engineering construction around Niagara Falls by the Engineering Institute of Canada in its professional session which was held at the Ontario city of that name, Sept. 16-18. On the Canadian side of the Falls are located the two largest projects now under way in Canada, if not on the continent, the Queenston-Chippawa power canal of the Ontario Hydro-Electric Power Commission and the reconstruction of the Welland Canal by the Canadian government to accommodate ocean-going ships. Both of these works are within easy distance of the Falls, and to each was devoted an afternoon excursion. Trolley cars leaving the hotel were run under their own power to construction tracks which parallel each canal, where they were switched over and drawn by the construction locomotives alongside the work so that the visitors had a unique opportunity of viewing all of the operations.

In addition, two sessions were devoted to papers describing the project. On the first day the meeting listened to an illustrated talk entitled, "The St. Lawrence Route and the Welland Ship Canal," by Alexander J. Grant, engineer in charge, Welland Ship Canal. This described in considerable detail the ship canal project which has been noted a number of times in past issues of *Engineering News-Record*. The second morning was given over to papers by members of the staff of the Hydro-Electric Power Commission of Ontario, describing the new 500,000-hp. hydro-electric development at the Falls. These papers were as follows: "Design of the Queenston-Chippawa Power Canal," by T. H. Hogg, assistant hydraulic engineer; "Hydraulic Installation of the Queenston-Chippawa Power Development," by M. V. Sauer, hydraulic engineer of design; "Electrical Features of the Queenston-Chippawa Power Development," by E. T. J. Brandon, electrical engineer, and a final summarizing paper by H. G. Acres, hydraulic engineer, entitled "General and Economic Features of the Queenston-Chippawa Power Development." For the first time these papers gave some of the underlying design considerations of the Queenston project and the general details of the installation. Abstracts of the papers will appear in later issues of *Engineering News-Record*.

On the final morning N. R. Gibson, hydraulic engineer of the Niagara Falls Power Co., Niagara Falls, N. Y., gave a demonstration of his new method of measuring the flow of water in closed conduits for determining the efficiency of hydraulic turbines. This method is also to be treated in some detail later in this journal.

On two days luncheon was given to the vistors at the Administration Building in Queen Victoria Park overlooking

the Canadian Falls. On the first day the Department of Highways of the Province of Ontario was the host, and the second day, the Park Commission. Besides these two functions, there was a dinner on the first evening and a banquet on the second, the two differing only in the formality of the occasion, so that for the two and a half days of the meeting the members were brought together at all meals, except breakfast.

The professional meetings of the Engineering Institute of Canada are a recent development, the one at Niagara Falls being the seventh. They are held at different parts of the Dominion so as to attract the membership from certain localities. One in August of this year in Banff was under the general direction of the Calgary Branch and one to be held in Halifax in October will be in charge of the New Brunswick Branch. The one at Niagara Falls was in charge of the Niagara Peninsula Branch. In each case the branch assumes full responsibility for the program, which is as a rule devoted to subjects of specific interest to the district where the meeting is held.

At the Niagara meeting there were well over 200 members and guests present, together with a great number of ladies who participated in all of the events, acting particularly as spectators in a series of interbranch baseball games held on Saturday afternoon.

Engineering College of Maryland University Reorganized

Linking up of its engineering work with the State Roads Commission and with the U. S. Bureau of Public Roads, and the appointment of A. N. Johnson, former consulting engineer for The Portland Cement Association, to be dean, are the first steps in the reorganization of the engineering college and the strengthening of the general engineering work of the University of Maryland.

An arrangement was recently completed with the Maryland State Roads Commission and the U. S. Bureau of Public Roads, whereby an engineering experiment station will be established here and run in connection with the engineering college, under the direction of the new dean. The new arrangement, effected after a series of conferences between John N. Mackall, chairman, State Roads Commission, T. H. MacDonald, chief of the Bureau of Public Roads, and Dr. A. F. Woods, president of the University of Maryland, will go into effect October 1, and Mr. Johnson will assume his new duties at that time.

A. A. E. to Vote on Increase of Dues

The board of directors of the American Association of Engineers has authorized a chapter referendum on the question of increasing the dues to $15. With it is a proposition to apportion a greater percentage of receipts to the chapters.

Engineers Participate in Public Health Convention

Many sanitary engineering phases of public health work were discussed at the forty-ninth annual meeting of the American Public Health Association held in San Francisco Sept. 13 to 17, but outstanding as leading topics were control of industrial-wastes disposal, sanitation of bathing places and garbage disposal by hog feeding. Engineering sessions had a representative attendance and there was a refreshing readiness to discuss papers. Under the chairmanship of Paul Hansen, this general discussion, reflecting opinions from widely different viewpoints, was crystallized into helpful suggestions to the several standing committees and specific instructions covering new lines of investigation were framed.

In the general sessions there was discussion of progress toward co-ordinating all federal health activity under central authority, with the eventual establishment of a department of health and a chair in the President's Cabinet. Hugh S. Cummings, surgeon general, U. S. Public Health Service, spoke in support of this plan.

Dr. M. P. Ravenel, University of Missouri, was elected president of the association for the coming year. In the engineering section Samuel A. Greeley, consulting engineer, Chicago, was elected chairman and Edward R. Rich, state sanitary engineer, Lansing, Mich., secretary.

The committee on waterway sanitation was instructed to consider particularly the destructive effect of industrial wastes on the biological action which affects the self purification of waters. Due to the great increase of such wastes attendant upon wartime industrial activities this was agreed to be perhaps the greatest problem now before the sanitary engineer.

The committee on bathing places has before it much important work, and outside aid in gathering necessary data was urged. It is to develop the technique of testing the sanitary condition of suits and towels, to study means of satisfactorily disinfecting them and to determine if possible what diseases may be transmitted by pool waters, particularly whether typhoid and venereal diseases can be so transmitted.

The refuse collection and disposal committee reported increasing favor for the tractor and trailer method of collection and for disposal by hog feeding. Hog feeding is an incomplete method of disposal, however, because there remains from 15 to 50 per cent of inedible material and hog manure may amount to more than 50 per cent of the garbage fed. The committee is to try to secure some expression of opinion as to what sanitary requirements are reasonable on hog farms where garbage is fed.

[The foregoing telegraphic report from this journal's Pacific Coast editor will be supplemented by a more complete account of the convention proceed ings in a later issue.—EDITOR.]

State Commissions Organize for Rate Hearings

A special committee, representing some of the state railroad commissions has been organized to "safeguard" the interests of the state commissions in the hearings to be held on the application made by railroads asking the Interstate Commerce Commission to remove alleged discrimination against interstate commerce because of refusal of various state commissions to authorize increases in intrastate freight and passenger charges to the same extent that interstate rates have been increased.

The committee is composed of: Fred W. Putnam, member of the Minnesota Commission; H. G. Taylor, member of the Nebraska Commission; R. Hudson Burr, member of the Florida Commission; Joseph A. Kellogg, member of the New York Commission, Second District, and Joshua Greenwood, member of the Utah Commission.

Alaska Road Commission Is Reorganized

The Alaska Road Commission, as recently reorganized, is composed of Major James G. Steese, Corps of Engineers, president; Captain John C. Gotwals, Corps of Engineers; and Capt. C. S. Ward, Corps of Engineers, secretary and disbursing officer. The headquarters of the commission are located at Juneau, Alaska, and sub-offices are maintained at Valdez, Seward, Fairbanks, and Nome.

The commission is now responsible for the maintenance of a system of wagon roads, sled roads, and trails, aggregating nearly 5,000 mi., including a connected system of 4,600 mi. reaching into all occupied parts of the territory, and several hundred miles of isolated stretches. About 1,050 mi. are classed as wagon roads. The system is being extended as funds permit.

Short Courses Give Two Hours' Credit on Master's Degree

A series of graduate short-period courses in highway engineering and highway transport offered for the winter of 1920-1921 by the University of Michigan, will be given in periods of two weeks each, each course to contain 30 lectures or the equivalent thereof and each course counting as two hours credit toward the total of twenty-four hours required for a master's degree. The practical equivalent, therefore, of a two-hour course running an entire semester is offered in these short-period graduate courses. In addition to the various highway engineering and highway transport subjects available to those registering for the graduate short courses, more complete details of which were published in *Engineering News-Record*, August 12, p. 333, a student will have the opportunity of participating in the seventh annual Michigan conference on highway engineering which will be held from Feb. 21 to 25, 1921, in the engineering building of the university.

Chicago Engineers Discuss Am. Soc. C. E. Amendments

Eighteen members of the Illinois Section of the American Society of Civil Engineers, at a meeting in Chicago, Sept. 17, discussed the proposed amendments to the constitution. Few arguments were presented other than those brought out at the meeting of the New York Section, as reported in *Engineering News-Record*, Sept. 9, p. 525.

T. L. Condron stated that when the ballot first came to him he was inclined to favor most of the amendments, but after spending a day's time investigating the situation, interviewing several members and reading the report of the New York meeting in the technical journals he had come to the conclusion that most of the amendments had not been given sufficient consideration, were not well correlated with other portions of the constitution and that inasmuch as a committee of the Board of Direction was at work upon a set of amendments, which would have behind them legal advice to avoid the taxation feature and the inconsistencies, it would be wise to "clear the deck" by rejecting amendments A, F and G. A resolution substantially in accordance with Mr. Condron's views was passed unanimously.

E. S. Nethercut had made a plea for the adoption of amendment C, calling for an increase in the dues of nonresident members so that this added income might become available Jan. 1, 1921. Every speaker held that more money must be collected.

G. H. Bremner and Murray Blanchard were in favor of the amendments on the general ground of doing something now. "If it accomplishes nothing else it will stir up interest in the organization," said Mr. Bremner. Sutton Van Pelt was in favor of immediate action.

In discussing amendment F, Mr. Nethercut voiced opposition to having more than one past-president on the board. It is his opinion that a past-president's only function on the board should be to carry into a succeeding administration knowledge and advice as to past actions and policies, all of which should be sufficiently well in hand by the end of one year. If then he was wanted on the board he should be elected.

American on Australian Railway Gage Commission

The State Department at Washington has announced receipt of advice from the American consul-general at Melbourne that the Australian ministry had decided to secure the services of a railway expert from this country and another from England, to act with an Australian railroad man as chairman, in an investigation of uniform railway gage. There are three different gages at present. An article on the subject appeared in *Engineering News-Record*, Aug. 5, 1920, p. 255.

Federation's Council To Meet for First Time

The first meeting of the American Engineering Council, consisting of representatives of member societies of the Federated American Engineering Societies, will be held in the New Willard Hotel, Washington, D. C., Nov. 18, 19 and 20. The morning session of Nov. 18 is to be a business meeting. In the afternoon, after an address by J Parke Channing on "Engineering Council," there will be a discussion of the field of activity for the federation.

Committee reports and election of permanent officers will occupy the morning and afternoon sessions of Nov. 19. In the evening Herbert Hoover will address the meeting.

The Executive Board of the American Engineering Council will hold an organization meeting at 9. a.m. Nov. 20.

San Francisco Contractors Charged With Conspiracy

The secretary and five members of an "inner ring" in the Team and Auto Truck Association of San Francisco were indicted Sept. 13 for manipulation of bids on grading contract in that city. A grand jury investigation was started when a contractor who said he had refused to join the ring claimed illegal pooling and boosting of bids. Twelve per cent was added to all bids, he said, to be put into a "kitty" or secret fund. Contractors among the accused admit the addition of a percentage on certain bids, but assert that this is "a strike fund which is used to protect our members in case of labor trouble." The scandal has been occupying generous front-page space daily in San Francisco newspapers.

Rehabilitating Cantonments

The shifting of several Army divisions, made necessary by the abandoning of certain camps, has brought the Construction Service face to face with the difficult problem of rehabilitating housing at the camps to which the divisions have been ordered. For instance, the division at Camp Taylor has been ordered to Camp Dix: The buildings which the division will occupy at Camp Dix have been unused for a considerable period and are badly run down. To put these buildings in shape to house the men this winter will be a difficult task, it is stated at the Construction Service, when the limitations of personnel and funds are considered.

All-American Canal Survey Begun

A survey and general investigation of the proposed All-American Canal to serve the Imperial Valley has been begun by the U. S. Reclamation Service. W. W. Schlecht, the project manager at Yuma, is in immediate charge of the work. Local interests recently raised $40,000 to add to a Federal appropriation of $20,000 to defray the costs of this survey.

Recent Activities of American Association of Engineers

Almost 3,000 men were referred to positions in August by the service department of the American Association of Engineers. The average salary of the 306 men placed through the efforts of the national and branch offices was $209 per month.

At the recent convention of the Washington State Assembly in Everett a committee was appointed to arrange with the state educational institutions for extension courses for members. A recommendation was made that county engineers be appointed instead of elected, that they have full charge of road funds and that their salaries range from $3,000 to $6,000.

The San Francisco chapter has engaged a full time secretary with offices at 960 Pacific Building. This is the ninth field office established in addition to the one at Omaha for which no quarters have as yet been found.

Chapters in Arizona are preparing a license bill to be introduced into the next legislature.

The Interstate Commerce Commission has advised the association that its request has been granted for a hearing relating to the interpretation of the term "engineer of mechanics" under which professional engineers have been classed. The question to be decided is whether or not mechanical and electrical railway professional engineers are to be included under this classification of subordinate officials which was established last March.

Railroad sections of A. A. E. have been notified of increases in salaries of engineering employees on the Union Pacific, Burlington, Kansas City Terminal, Missouri, Kansas & Texas, Great Western, Boston & Maine, Pennsylvania and several other railroads.

Katherine M. H. Blackford, character analyst, New York City has accepted appointment on the national employment council of A. A. E.

National Convention of Free Employment Heads

As a means of determining how free employment agencies can best serve engineers and employers of engineers the American Association of Engineers is sponsoring a national convention of free employment representatives to be held Nov. 12 in Chicago. All engineering societies or other agencies maintaining free employment service are invited to participate.

Many Seek Engineer Commissions

The results of the examinations for appointment as commissioned officers in the regular army are now being made public. There were more applications per vacancy for engineer commissions than for commissions in any other branch of the service. There were 432 applicants for the 96 commissions which can be granted in the Corps of Engineers.

Philadelphia Favors Amendments

The following resolution was passed, Sept. 13, by the Philadelphia Section of the American Society of Civil Engineers:

Whereas, proposed amendments to the Constitution represent the two years effort to inaugurate a progressive policy in the American Society of Civil Engineers, and amendments "A," "B," and C" are based upon the recommendations of the Committee on Development which were approved by a more than 2 to 1 vote of the Society, April 14, 1920, nearly fifty per cent of the members voting,

Therefore Be It Resolved, that the Philadelphia Section of the Society at this September 13, 1920, meeting, endorse, and urge each corporate member to vote YES for the proposed amendments, thus making effective the recommendations of the Committee on Development;

Be It Further Resolved, that copies of this resolution be sent to each local section of the Society, to the technical papers, and to all members of the Society resident in the Fourth District.

Larger Reclamation Fund for Next Year

Due to the enactment of the oil land leasing act, and to the increase in the repayments for past construction, the U. S. Reclamation Service fund will make possible a larger expenditure on reclamation projects during the next fiscal year. The appropriation which is available during the current fiscal year is approximately $9,000,000. It is expected that at least $5,000,000 can be added to the appropriation for the next fiscal year.

In addition there is considerable sentiment in favor of asking Congress to make a liberal loan to the Reclamation fund, the loan to be repaid later, as in the case of the loan of $20,000,000 in 1910. The chances of securing this loan are believed to be enhanced by the pledges which are being made by the presidential candidates. Regardless of this loan the increase in the reclamation fund will enable the U. S. Reclamation Service to take up important new construction work in connection with existing projects. It is probable that new work will be undertaken on the Shoshone project in Wyoming where storage water already is available for new units.

On the North Platte project in Nebraska and Wyoming there is urgent demand for more funds to push construction on the Ft. Laramie Canal. This canal eventually will water 100,000 acres. At a recent opening of a small unit under this canal there were 40 applicants for each farm and the applications were limited to former soldiers.

On the Rio Grande project and on a number of others there is an insistent demand for the construction of drainage systems. A large amount of drainage has been put in, but the work on the irrigation system is somewhat ahead of drainage operations.

On the Yakima project in Washington an additional large storage reservoir is being constructed as the land under cultivation has extended to the point where the present facilities are inadequate.

Chemists Decline To Affiliate

The Council of the American Chemical Society at the semi-annual meeting in Chicago Sept. 6 to 10 decided that the society could not affiliate with the Federated American Engineering Societies. It was pointed out that the financial obligations which would be incurred through affiliation would be impossible under the present circumstances and it was urged that the chemists should co-operate upon an independent basis rather than affiliate with the tendency to subordinate the chemical activity to strictly engineering service.

A resolution was also passed by the council urging that local sections of the American Chemical Society refrain from affiliating with other local engineering and technical societies in state or district federations.

Bishop Leaves Indiana State Highway Department

Owing, it is stated, to a disagreement in policy with L. H. Wright, director of the department, H. K. Bishop has resigned as chief engineer of the Indiana State Highway Department. It is understood that several changes in personnel either have been made or are to be made in the department. Mr. Bishop's place is being temporarily filled by C. Gray, former chief of the bureau of contracts of the highway department. Before his appointment as chief engineer of the Indiana Highway Department Mr. Bishop was a district engineer with the United States Bureau of Public Roads.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF PORT AUTHORITIES, Montreal; Chicago, Sept. 30-Oct. 2.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Valparaiso, Ind.; St. Louis, Oct. 10-15.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION, Chicago; Atlanta, Ga., Oct. 26-28.

NATIONAL DRAINAGE CONGRESS, Chicago; Atlanta, Ga., Nov. 10-12.

The Engineers' Society of Western Pennsylvania, at its regular monthly meeting, held in Pittsburgh, Sept. 21, listened to a paper entitled "Small Steam Turbines," by W. J. A. London, president of the Steam Motors Co., Springfield, Mass. The paper was illustrated by lantern slides.

The Engineering Society of Western Massachusetts held its fall meeting Sept. 21 at the General Electric Co. Works, Pittsfield, Mass. An inspection trip was made through the G. E. Works, particular attention being given to motor construction. Among the speakers at the meeting were L. F. Adams, of the Power Mining Department, G. E. Schenectady Works, on "Motor Application," and Neal Currie, head of the G. E. Pittsfield Works, whose subject was "Principal Characteristics of Various Kinds of Motors."

The Texas Section, Am. Soc. C. E. will hold its fall meeting in Austin, Oct. 20 and 21. The following papers will be presented: "Concrete Construction" by G. G. Wickline, bridge engineer, State Highway Department; "Probable Flood Discharge of a 48 Square Mile Area Near Paris, Tex." by Major John B. Hawley, consulting engineer, Fort Worth; "Early Irrigation in Texas" by E. P. Arneson, consulting engineer, San Antonio; "Manufacture of Pipe and Clay Products Used in Sewer Construction" by M. C. Erwin, sewer engineer, City of San Antonio; "Contributing Factors to the Increasing Cost of Road Building" by T. H. Webb, State Highway Department; "Presentation of and Discussion on 'Standard Form of Contract with Arbitration Clause'" by Major John B. Hawley; "Organization and Progress on the Dallas Levee District" by E. N. Noyes, district engineer, and secretary-treasurer of the section.

Civil Service Examinations United States

For the United States civil service examinations listed below apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the Civil Service Commission for Form 1312.

Highway Bridge Engineer, $2,400 to $3,000 a year.

Junior Highway Bridge Engineer, $1,500 to $2,220 a year.

Master Computer, $1,800 to $2,400 a year.

Computer, Grade I, $1,400 to $1,800 a year.

Computer, Grade II, $900 to $1,400 a year.

Canada

Application forms may be obtained from the office of the Employment Service of Canada, or from the Secretary of the Civil Service Commission, Ottawa.

Supervisor of Timber Tests, $2,700 to $3,180 a year.

File application not later than Oct. 8.

Personal Notes

CLARENCE B. HOOVER has been appointed engineer in charge of the bureau of water-works extensions of Columbus, Ohio.

HENRY J. DARCY, Oklahoma City, has been appointed state sanitary engineer of Oklahoma. He succeeds J. W. Evans, who has resigned to enter private business.

M. O. BENNETT, division engineer, Oregon State Highway Department, Pendleton, Ore., has resigned to take up farming at Lewistown, Mont. His tem-

porary successor is R. H. Baldock, who has held a similar position with the state highway department in Baker, Malheur, Harney and part of Grant counties.

J. B. McAndrew, St. Catharines, Ont., has been appointed by the Canadian Civil Service Commission structural engineer for the Welland Ship Canal.

Ralph Arnold, Martinez, Cal., has been appointed highway engineer of Contra Costa County.

O. N. Powell, Dallas, Tex., has been appointed engineer of Nueces County, Tex., succeeding H. A. Stevens, resigned.

Emory W. Lane has gone to Shanghai, China, as Eastern representative and manager for the Morgan Engineering Cos., Dayton, Ohio, to study the question of flood control, land reclamation and water power development.

Siteman & Cooper, civil engineers, Paxton, Ill., have opened new offices in the Federal Reserve Bank Building, St. Louis, Mo.

John A. Bruce has resigned as city engineer of Omaha, Neb., and will return to private business.

Stanley M. Hands, former city engineer of Iowa City, has organized and incorporated the River Products Co., to handle building and paving rock from Iowa river quarries. Mr. Hands is president of the company.

A. E. Warren, general manager Western lines, Canadian National Rys., has been made also general manager of the Grand Trunk Pacific Ry.

Sidney W. Cooper, since the close of the war connected with the New Jersey State Highway Department, has been appointed assistant division engineer, 4th division, Alabama Highway Department, located at Selma, Ala. Previous to the war for a number of years he was a drainage engineer in the U. S. Department of Agriculture in charge of work in the southwestern states.

Colonel E. B. Cushing has retired as engineer of maintenance of the Southern Pacific Lines in Texas and Louisiana after 40 years of service with the company. He will be succeeded by H. M. Lull, at present division engineer of the Southern Pacific at Portland, Ore., who takes title as chief engineer of the Southern Pacific Lines in Texas and Louisiana and assumes the duties of engineer of maintenance of way and structures. Colonel Cushing graduated from the Agricultural and Mechanical College of Texas in 1880 and entered railway service as instrumentman on the location of the Galveston, Harrisburg & San Antonio Ry. From 1881 to 1883 he assisted in locating and constructing the Mexican International R.R. to Palla, Mex. From the latter year until 1885 he was again with the Galveston, Harrisburg & San Antonio as division engineer, and later as contractor of masonry and bridge construction. In 1887 he entered the service of the Gulf, Colorado & Santa Fé as office engineer and chief clerk of construction, and in 1888 attained the grade of engineer of roadway. A year later he went to the Texas & New Orleans and the Galveston, Harrisburg & San Antonio, as resident engineer. In 1897 he became general superintendent of the Houston, East & West Texas and later, in addition to his other duties, was made chief engineer. He entered the service of the Sunset Lines as engineer maintenance of way in 1901 and attained the grade of chief engineer of construction in 1908.

Obituary

Hayden Lewis Demeritt, Government engineer in the Rivers and Harbors service, with headquarters in San Francisco, died, Sept. 7, at Oakland, Cal. He was a native of Rhode Island and was 71 years of age. Captain Demeritt had lived in California for 40 years. He was in charge of construction work on Government projects in San Francisco Bay and on the Sacramento and San Joaquin Rivers, and many years ago was identified with the U. S. Geodetic Survey, stationed at Reno, Nev.

George Leighton, civil engineer, who was engaged in the design and construction of the Pennsylvania tunnels under the East River, New York, the East Shore Terminal at Charleston, S. C., and the construction of two sections of the New Jersey cut-off of the Lackawanna R.R., died, Sept. 13, at Glenburn, Pa., in his sixty-second year. He was born at Waverly, Pa., and was a graduate of Lehigh University. Mr. Leighton also aided in the construction of the Rockport tunnel of the Lehigh Valley R.R. and the tunnel for the Croton Aqueduct. He was assistant engineer on Washington Bridge, New York, made examinations and borings on the line of the proposed Cape Cod Canal, and did considerable location work for the St. Louis, Keokuk & Northwestern R.R. For several years Mr. Leighton was in private practice at Scranton, Pa., engaged on sewerage, water-works, railroad and mine surveys.

Colonel Charles Neville, during the war chief of the Accounting Division of the Construction Division of the United States Army, was killed in the explosion in Wall St., New York City, Sept. 16. Previous to entering the Government service Colonel Neville was traffic manager of the Stillmore Airline Ry., general freight and passenger agent and auditor of the Coast & Piedmont Ry., vice-president of the Brinson Ry. (now the Savannah & Atlantic Ry.), and subsequently practiced as a public accountant in Savannah, Tampa and Birmingham. He was senior partner of Neville, McIver, Barnes & Co., certified public accountants, and a member of the American Institute of Accountants. During his period of Government service he had full charge of policy, organization, commissions, civilian personnel, requests for commissions, travel orders, etc., and acted for the chief of the Construction Division in all accounting matters. Colonel Neville was born in New York City in 1875.

Business Notes

Dwight P. Robinson & Co., Inc., have recently established a branch office in Youngstown, Ohio, in charge of C. I. Crippen.

The Easton Car & Construction Co., Easton, Pa., has opened a branch office in the Railway Exchange Building, Chicago.

Chris D. Schramm & Son, Inc., 709 Arch St., Philadelphia, Pa., announce that in future their administration offices will be located at West Chester, Pa., where the factory is situated. The company's Philadelphia office will be retained as a sales force only.

Concrete Support for Telegraph Poles

The type of concrete support for telegraph poles shown in the accompanying illustration is used on the Loetschberg Railroad, in Switzerland, for the obvious purpose of doing away

CONCRETE BASE FOR POLE

with the decay usual when timber posts are set in the ground. On the Wengeralp Railroad, also in Switzerland, the holding device is entirely of steel set in a concrete foundation.

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—James H. McGraw, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

F. J. Mehren
Editor

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Using Large Size Aggregate

PROVIDED it can be readily secured so that the cost of transportation is not governing, large stone makes the most economical aggregate for mass concrete, particularly when strength necessities are so low that the leaner mixtures can be used. The main reason why stone above the standard 3 or 4 in. is not more generally used is the fear that the ordinary concrete machinery will not handle it. Nevertheless, in an increasing number of cases it is being proved that regular mixing and chuting equipment, with only a few changes to provide proper clearance, will stand up under the battering of the big stones and deliver a well-mixed concrete. The latest instance is the Stevenson dam work described on another page. Here there was an ample gravel supply handy to the site, a condition which often exists but is not always utilized, and the engineers estimate that about $250,000 was saved in the concrete cost due to the decision to use the gravel even up to the 6-in. rejections, which means some irregular pieces of larger dimensions. Furthermore, they testify that the maintenance charge and out-of-order time losses were little if any greater than with stock material. The practice is well worth consideration for other jobs.

"Direct Action" in Britain

THE COAL STRIKE threatened in Great Britain, it appears at this writing, may be averted. Owing to Lloyd George's influence it has been postponed for a week to give opportunity for further attempts at settlement. Only the wage matter is now at issue, the miners having withdrawn the demand that the domestic price of coal be reduced by the amount collected as a tax on export coal. The respite of a week is not only a triumph for Lloyd George but probably an indication that the miners' leaders realize that they would lack the support of the public in their efforts to force the Government into submission. The real issue, though the immediate questions were raised over the price of coal and wages, was never concealed. Smillie, the leader, declared that it was other than the nationalization of the mines. The miners were determined to attempt to bring about a fundamental change by force instead of through the ballot box. They had chosen "direct action" instead of the constitutional process. Though the leaders would have frowned on destruction of property, their proposed method was no less anarchic than that of Lenin or the Italian workmen. The fundamental nature of the issue was appreciated by the British public, and there seems to be no doubt that even the miners began to realize that "direct action" could not succeed without popular support. The railroad strike last year lacked public sympathy, even though the issue was not fundamental. There was certainty, therefore, that this one would have been equally unpopular. It was doomed to failure. The Government would have appealed to the country and doubtless would have been enthusiastically supported. All of which is another way of saying that the sanity which has so consistently marked the attitude of the British people is still strong. Industrial and labor conditions there are unsatisfactory. Much stress is expected before there is stability, but there is as little reason for expecting a Bolshevistic England as a Bolshevistic Canada or United States.

To Aid Train Movements

DOUBLE TRACKING of main lines from each important terminal to the first passing track and a more general use of automatic block signals are among the measures recommended by the American Train Dispatchers Association to relieve the serious congestion of railway traffic. Considerable attention has been given to facilitating operations within freight yards for the relief of this congestion, but a frequent cause of interruption in traffic movements is a delay to trains approaching or getting away from yards on single-track lines. On double-track lines with especially heavy traffic there may be an equal advantage in providing additional trackage for several miles from a terminal or division point in order to facilitate the movements of freight trains within the congested district. The advantages of automatic block signals for a similar purpose are obvious, since they permit of short blocks at comparatively small expense, while with the manual system the cost of installation and operation makes short blocks prohibitive. In the earlier days of automatic block signaling on American railways there were numerous objections from operating officials to the effect that the introduction of this system would make it impossible to handle heavy traffic. Experience very soon showed, however, that the heavier the traffic the greater were the advantages of the automatic block system. Near terminal points it is especially desirable to reduce the length of the block sections to a minimum, in order to increase the traffic capacity; the automatic system meets this condition with efficiency and economy.

Strength of Wood

UNDER QUITE unusual circumstances, data tending to overturn existing views on the bearing strength of wood on surfaces inclined to the grain are contained in two articles printed in this issue. Hitherto it has been assumed that the variation of bearing strength with angle between surface and grain could be expressed by a single general law, applicable to any kind of wood. In fact, both of the investigators who now present their test results assumed this to be the case. One of them worked with yellow pine, the other with Douglas fir and white pine, and each believed that the law indicated by his results would apply generally. But by comparing the two test series it may be seen that the two investi-

gators deduce quite different laws. Since in each case the results are satisfactorily consistent among themselves, it can only be concluded that different kinds of wood are subject to different laws in this particular phase of bearing strength. Just what laws hold for other woods than those involved in the present tests is bound to be uncertain until further experiments are made. On this account, safety would seem to dictate that in any practical application the lower of the two existing formulas, the Howe formula, should be used, at least until fuller guidance is obtained by special tests on the particular wood in question. From the standpoint of theoretical study, the case is even more interesting, for present knowledge of the mechanical action of wood seems to afford no reason for the observed difference between different varieties of wood. Yet such a reason should be determinable; in other words, if our present knowledge of wood does not explain this difference of behavior, it is very likely in error. However, before such a conclusion could be considered well founded it would be necessary to repeat the tests, arranging them in such a way as to eliminate shearing. In practical design, shear is provided for separately from surface crushing, while in the tests there was a possibility for the specimens to fail by shearing without developing the full strength of the bearing surfaces. Due to this peculiarity of the tests, their value for the present is only cautionary.

Research in Soil Mechanics

THREE LINES of attack on the problem presented by earth as an engineering material are available, and by a remarkable coincidence the past few months have brought to knowledge important attempts along each of these three lines. It is our privilege to publish one of them in the present issue. The problem involved is so important that it deserves to be ranked as the outstanding research problem in civil engineering. Vast sums of daily expenditure are affected by it.

More money and more labor are expended in earthwork or in construction depending directly on the properties of earth than in any other kind of engineering construction. Yet the field of earthwork, which should be the most fruitful of all in the application of scientific method, is the playground of raw empiricism. Dealing with more different kinds of earth than of any other material—for soils are of infinite variability—engineers are virtually unable to compare two earths or differentiate between them in quantitative terms.

The problem has been with us for decades. Its solution would mean that we can deal with earth as with other materials of construction, by predetermination of effect and by efficient proportioning of structure to service. For brevity we may call it the retaining-wall problem, since the retained bank is the classic type-example of earthwork analysis; but its real scope is vastly broader, covering all questions of condition and of cause and effect in the excavation and deposition of earth as well as in every case of contact of a mass of earth with water, earth or structures. The retaining-wall problem concerns foundations, embankments, tunnels, stream channels, dams, roads and docks.

Established earth-pressure theory has long been discredited. During the last thirty years or more a large bulk of literature on the defectiveness of the theory has grown up, and instance after instance has proved that the basis of fact on which the theory rests is so microscopically small that the theory cannot stand. In spite of this proof, however, the old formulas continue in use, simply for the reason that the destructive criticism included so little new work that the building up of an improved science has not been possible. Perhaps most of the investigators were blinded by the brilliancy of the mathematical devices used in developing the old theories; at any rate, they failed to see that a new start should be made, by measuring and weighing elementary facts about earth and its behavior. Making this new start is the work of the early future, by all prognostications.

What is to be the direct objective of the study of earth as an engineering material? The infinite variability of the material brings this question to the front. Shall a true and complete theory of the mechanics of earth be aimed at, or ought we seek for a classification of earth into a limited number of soil groups? Probably the latter is the more immediate objective.

For, while it is possible that we may succeed in discerning and measuring all the pertinent properties of soils, and in developing from these data of fact the mechanics of earth so completely as to equip us for handling any practical problem by advance computation, it is unlikely that such outcome would be of much practical utility. The methods would necessarily be highly complex, and they would be unlikely to give more than tentative results because the material encountered in the work will always be variable, and usually cannot be known in advance. The whole aspect of the problem as it appears at present makes it probable that soils can be dealt with by relatively simple special methods devised for each of several groups of earth types, with sufficient quantitative differentiation within the group to suit the range of properties covered. For this purpose we may study the kinds of earth by groups, and assemble and average the data for each. But to render this possible the properties of earth and how they vary must be searched out, their similarities and their effects on the engineering of earth must be determined, and from this knowledge a classification into groups worked out.

As to the three available lines of attack on the general problem: The first, which comprises formulating a new hypothesis of earth action and comparing its results with experience-data, is represented in newest form by a paper of H. G. Moulton read last February before the American Institute of Mining Engineers. Mr. Moulton's paper, a notable contribution to earth-pressure literature, is entitled to careful study. But however valuable his hypothesis may prove for retaining walls and trench sheeting, we may safely assert that with respect to the general earth problem this line of attack has been exhausted, and that its failure indeed was inevitable in view of the hopeless lack of data on earth properties. For the time being it may be written down as an axiom that constructing new hypotheses of earth pressure is wasted effort. Further, earth pressure is not the only point of inquiry; there are many other problems in earthwork.

Second is the statistical method of study, used by the foundation soils committee of the American Society of Civil Engineers. A progress report of this committee appears in last month's *Proceedings* of the society (August, 1920). The committee has attacked the problem of classification by grain-size grading, leading up to a basis for statistical collection of observed facts on soil behavior, forecast by a synopsis outlined in the report

mentioned. The crux of the matter is whether a valid classification will be achieved. As yet the outcome cannot be foreseen, but the effort made is of great promise.

Dr. Terzaghi's article in this issue represents the third method: research into the elementary facts of earth mechanics, as a preliminary to either theory or classification or both. In its first stages such work is a study to determine not laws but mere facts of earth action, from which characteristic properties may be discerned. It is a groping search for the quantities which are to be measured, a search which in itself must be conducted by measuring, weighing and comparing to detect regularity of behavior. The slow procedure of investigating the nature of an unknown thing must be followed, necessarily. This is truly starting from the beginning, with the ultimate purpose of setting up scientific knowledge based on the behavior of the material and discovery of the quantities determining that behavior.

What is published in this issue represents a small part of the summing up of several years' laboratory study. How far the total of work will lead is not yet apparent. It may be expected that in the course of the study each discovery of a lawful relation between cause and effect will bring us nearer the goal of grouping or co-ordinating soils, and defining the groups or types by characteristic properties subject to measurement. But even the present article succeeds in developing a new group of facts, and therewith it heralds the opening of an avenue of progress which promises to lead on toward a more definite knowledge of earth.

Influence of Price Declines

PRICE REDUCTIONS were so marked last week as to draw general attention to them. The newspapers display the matter prominently, and this will aid in encouraging the downward movement. As a rule, when price-cutting becomes general buying holds off in the hope of still further reductions. Under present circumstances, with prices from 100 to 300 per cent higher than before the war, we may expect still further declines.

Drops so far recorded range from 20 to 33 per cent. These are substantial on lines that increased only 100 per cent, for on them a 50-per cent reduction brings the price back to normal. A 33⅓-per cent reduction knocks off 66⅔ per cent of a 100 per cent increase.

Fortunately, the situation is being looked on complacently. The bankers, particularly, feel that the situation is well in hand, that the lowering of prices will bring a healthier business condition, that the decline was inevitable, and that, on account of its orderly procedure and the soundness of fundamental conditions, panic is not to be feared.

There are those, of course, who are pinched, or whose interest is served by a highly speculative market at high prices, but their voice, fortunately, gets little attention. They argue that the cessation of buying is reducing production and that the present lessening of demand and the shortening of supply will surely be followed by heavier demand and another rise later on. This view is based on the assumption that the buying spirit of the public last year was normal and will reassert itself in last year's intensity. Such a reassertion is quite doubtful. Last year's buying was decidedly abnormal. It was consequent upon the newness of high wages. Now the novelty has worn off, and there is thought again of laying something by and of getting one's money's worth in purchasing. Buying is more intelligent, and the attitude is not likely to change.

Of course, there is some limit to the non-buying movement, but what that limit is no one knows. It is, per capita, at some point well below the standard of 1913, for no one will contend that then there was any large degree of self-denial. In other words, there is a possibility, at least, of a very greatly curtailed demand before price can tempt the public into the market on the 1919 scale.

That is true even of housing—admittedly very short. People can get along with poor accommodations. In fact, they are getting along with them. In every stratum the tendency is toward smaller homes—more economical to rent and to operate. The cry is not so much against the character of accommodations as against the high rentals.

With marked possibilities of economy and an intelligent buying spirit among the people, we doubt whether a reaction against the present tendency is likely to come, or will be of importance if it should. We are on a more intelligent and discriminating buying level. Under such circumstances the markets are more sensitive to price increases than before. Even slight reactions will drive away those who have been attracted by the declines.

This greater discrimination in buying will naturally affect most the luxury market; this is already apparent in the slump in the automobile business. The consequences are not pleasant for luxury trades, but the business of the country, as a whole, will be on a sounder footing. The men released from luxury industries will go into the production of staples as fast as the price reductions in the latter stimulate the demand.

Fundamentally, conditions are good. The crops this years are excellent and the banking situation well in hand. Furthermore, there is such a shortage in all lines that when sane demand, based on a lower price scale, becomes operative, there must set in a long era of active business. In construction work there is, depending on the specialty, a shortage of three to six years based on pre-war business. That whole shortage need not necessarily be made up, but certainly a good part of it will be. While, therefore, engineering lines are "slow" now, there are years of solid prosperity ahead.

Building material prices, as yet, show no general recession. In fact, apparently good demonstrations have been made, based on the figures, that there will be no decline, but such demonstrations have been made on the assumption that the whole of the shortage will be made up and be made up quickly. It is our view, though, that the public will choose its time regarding building operations and that the reductions in other lines will stimulate the holding off of building activity for lower price levels. Each drop, naturally, will bring into the market a group whose necessities are such that the reductions tempt them into the market.

The problem, obviously, is not a simple one. One can get snarled up in considerations of the effects of transportation and coal shortages. They have a bearing—an important one—but the outstanding and controlling influence is the disposition of the buying public. They are returning to sanity in their purchasing. If they continue in their present temper, the declines will continue, and if those declines are orderly, without panic, the situation, in view of the shortage which promises years of steady work when prices are attractive, should be considered encouraging.

Old Earth-Pressure Theories and New Test Results

First Report on a Research Into Pressure in Granular Masses — Errors of Old Theories Due to Faulty Assumptions—Test Apparatus—Lateral Pressure Ratio—Slip Phenomena—Relation to Density

By Dr. Charles Terzaghi
Robert College, Constantinople, Turkey

The earth-pressure theories of Coulomb, Rankine and their successors still occupy today a very important place in engineering literature and in engineering practice. But the arguments accumulated during the last forty years against their validity are so powerful that these theories are ripe for being definitely discarded and replaced by more up-to-date tools.

If a retaining wall yields, a slip occurs in the backfilling, and between the wall and the backfilling a wedge-shaped body of material moves downward. The wedge slides, it is said, and the slip is considered as the only characteristic effect of the breakdown of equilibrium of the mass of sand. If the retaining wall is entirely removed, the surface of the front part of the backfilling forms an even talus of a certain angle, called the angle of repose. As the slightest increase of the slope of this talus causes a movement of sand grains, it is assumed that the tangent of the angle of repose must be identical with the coefficient of internal friction of the mass. These ideas form the foundation of the earth-pressure theories mentioned, and as long as they are considered to be correct the validity of the earth-pressure theories cannot be seriously doubted. But a number of doubts arise when the facts of earth behavior are considered. Here are three, for example:

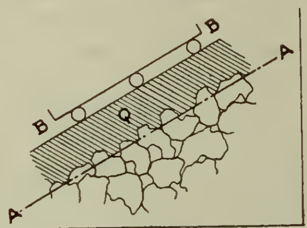


FIG. 1. ILLUSTRATING SURFACE FRICTION OF SAND AND EXTRA RESISTANCE DUE TO CHANGE OF BULK

1—If a little trapdoor located at the bottom of a layer of thoroughly compacted sand yields gradually, the stresses in the sand exceed very considerably the value determined by the tangent of the angle of repose, before equilibrium breaks down. And breakdown does not start along the planes where the tendency to slide is supposed to be a maximum, but simply in those spots where the grains have the best opportunity to move, i.e., immediately above the yielding door. Fig. 1 may explain this fact. AA is the even surface of a compacted sand mass, loaded with a slab Q, whose surface of contact is supposed to be very rough. If Q simply rests on top of AA and the slope of AA is gradually increased, a slip will occur as soon as the inclination of AA exceeds the angle of repose That is the ordinary slip of the earth-pressure theory. But if a guide BB parallel to AA be applied, such that the body Q cannot move except strictly parallel to AA, the inclination of AA can exceed the angle of repose without any slip occurring. This is simply because the grains cannot turn. Fig. 2 shows at (*b*) the structure of a well-compacted mass of sand. The grains are interlocked in a very complicated way and the grains cannot change their mutual position without passing through a state in which their association is less intimate, as indicated at (*a*). The less intimate the association, the greater is the volume of the voids. Increase of the volume of voids means an increase in bulk. Therefore no slip can occur except in those cases where the mass has an opportunity for lateral expansion, as in the case of backfilling behind a yielding retaining wall or in those cases where the structure of the sand has already been loosened by *preceding* breakdown of the equilibrium, as in the case of the yielding trapdoor. This leads us to suspect that the slip[1] is not an essential but an incidental event.

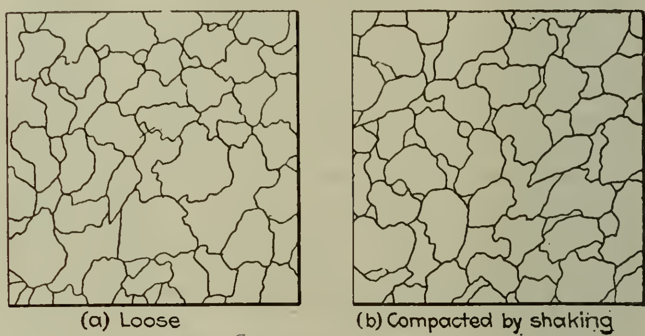


FIG. 2. LOOSE AND COMPACT STRUCTURE OF SAND
(Diagrams traced from aluminum disc apparatus)

2—The formation of a talus at the angle of repose is preceded by violent movements of the sand grains; the peripheral parts of a heap of sand consist therefore of an extremely loose and unstable aggregate of grains. How is it possible to consider the statical properties of the peripheral parts of the mass as being identical with those of the compacted backfilling? Darwin observed[2] that with quartz dust loosely poured into the space behind the wall (angle of repose 35 deg., volume of voids 44.7 per cent) the first slip occurred at a wall pressure only two-thirds that given by the Rankine formula for 35-deg. angle of repose, while in the same material thoroughly compacted (volume of voids 40.9 per cent) the experiment showed a pressure about half that of the formula.

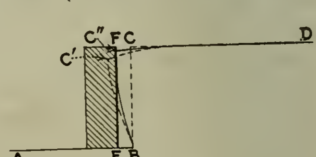


FIG. 3. HOW A SOLID BODY WOULD DISTORT IN PRESSING AGAINST A YIELDING RETAINING WALL

3—Earth-pressure theories consider earth as a solid, homogeneous material. How is it possible to discuss the lateral pressure of such a mass against an obstacle without considering its elastic deformations? In Fig. 3, representing a cross-section through a solid body uniformly loaded on CD, if the body could expand freely its cross-section would assume the shape $BC'D$. But its lateral expansion is partly prevented by the vertical back EF of a retaining wall. It is obvious, then, that the pressure acting against the wall depends in part on the distance EB over which the wall has yielded. An earth-pressure theory which ignores the elastic

properties of the backfilling must necessarily ignore such important relations.

The fundamental assumptions of the traditional earth-pressure theories cannot, in fact, stand even superficial examination. The fundamental error was introduced by Coulomb, who purposely ignored the fact that sand consists of individual grains, and who dealt with the sand as if it were a homogenous mass with certain mechanical properties. Coulomb's idea proved very useful as a working hypothesis for the solution of one special problem of the earth-pressure theory, but it developed into an obstacle against further progress as soon as its hypothetical character came to be forgotten by Coulomb's successors.

The way out of the difficulty lies in dropping the old fundamental principles and starting again from the elementary fact that the sand consists of individual grains. This method of dealing with the problem was first tried by Couplet, in 1727, forty-seven years before Coulomb published his theory, but Couplet failed. In 1916 and 1917 Professor Skibinsky of Lemberg[3] published a series of articles on the pressure exerted by a mass of spheres. Investigations of this kind are apt to be based on certain assumptions concerning the arrangement of the spheres, and the investigations result therefore in rather complicated formulas of limited value. In 1917 the author, who had no knowledge of Professor Skibinsky's publications, started to investigate along the same lines. But in the attempt to check theoretical results by observations he became convinced that earth pressure is an experimental rather than an analytical problem, and that we ought first of all to learn the physical facts of earth behavior.

Statical and Frictional Resistance

At depth t below the surface of a liquid, its pressure p against a vertical wall is, per unit of area, $p = tw$, where w is the weight of unit volume. The same relation exists between the depth below the surface and the lateral pressure of a mass of perfectly smooth spheres of equal size, in case the volume of voids of this mass is a maximum. The side pressure p' of any other regular assemblage of smooth spheres may be greater or less, and can be expressed by the equation

$$p' = ktw \qquad (1)$$

and k may be as small as 0.245. The cause of the difference between p and p' will be called the *statical resistance*, because it exists independently of any frictional resistances acting at the surfaces of the spheres. The statical resistance is merely the effect of the weight of the individual grains transmitted by their neighbors to the wall of the confining vessel.

If the surfaces of the smooth spheres suddenly become rough, the lateral pressure p' remains unchanged. And if the wall yields, the effect of the roughness of the surfaces develops but gradually, because the full development of the frictional resistances requires a certain amount of preceding deformation of the spheres. The resistance which causes the difference between the lateral pressure of a mass of smooth spheres and a similar mass of rough spheres at a given amount of yield of the wall will be called the *frictional resistance*.

Statical and frictional resistances co-operate in a rather complicated way, and their relative influence on the intensity of the earth pressure depends on how much the wall has yielded. During the first phase of the yielding process, i.e., from the moment when the wall starts to yield until the moment when the frictional resistances are fully developed, the statical resistance remains practically unchanged, while the effect of the frictional resistances increases. Thence, until final breakdown of equilibrium, the mutual position of the sand grains changes. The corresponding movements of the grains have been called by the author *inter-granular movements*. The statical resistance increases, and simultaneously the frictional resistance increases, in spite of the fact that the total friction between the grains remains constant. Final breakdown of equilibrium takes place as soon as statical and frictional resistances reach a maximum. During the first phase an additional yield of the wall is immediately followed by a corresponding change in the intensity of the earth pressure, while during the second phase the change in the intensity of the earth pressure is in addition a function of the time. In practice the first phase passes gradually into the second one.

With these three elements—statical resistance, frictional resistance and amount of yield—a fourth must be taken into consideration, the elastic properties of the grains. Since it seemed doubtful whether the laws which determine the pressure of a mass of spheres against a yielding wall strictly apply to a mass of grains of irregular shape, it was decided to investigate by experiment the details of the relations discussed.

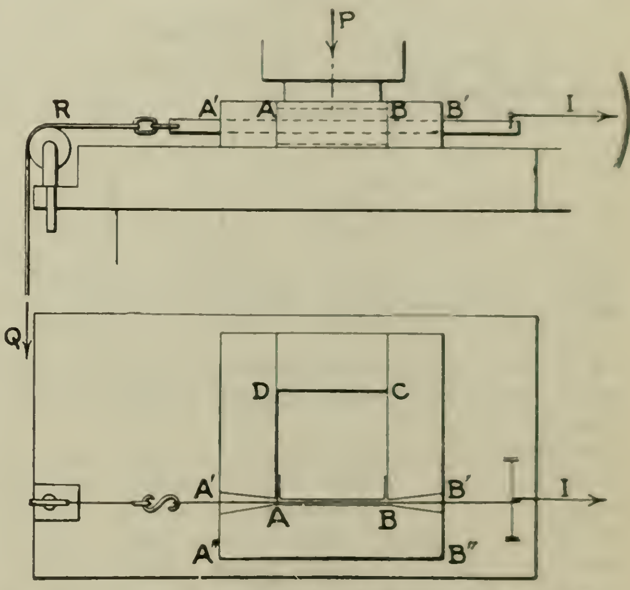


FIG. 1. APPARATUS FOR DETERMINING EARTH PRESSURE AT REST

Methods of Experiment Adopted

Since earth pressure against a retaining wall depends on the yielding of the wall, the leading idea in planning the experimental methods was to exclude strictly every deformation of the sand mass except the one whose effect was to be investigated.

Earth Pressure at Rest—For measuring the intensity of earth pressure against a perfectly unyielding wall, the *earth pressure at rest*, the device Fig. 4 was used. In this, one inside face AB of a stiff frame $ABCD$, Fig. 4, is provided with three horizontal steel tapes, whose flat surfaces rest against the face of the frame: upper and lower are fixed, while middle tape passes.

through the funnel-shaped openings AA' and BB' in the sides of the frame, being separated from the other two tapes, which serve as guides, by about 0.1 mm. Within the space AB both sides of the set of tapes are covered with paper, so that the movable tape has no contact with the sand occupying the space $ABCD$. The paper was carefully selected with a view to finding a material whose friction in contact with steel is fairly proportional to the surface pressure. It was extended over a part of the sides AD and BC, to prevent sand or dust penetrating the space between paper and tape. The frame being filled with sand, the surface was covered with a square slab S (length of side 5 mm. smaller than the frame) and subjected to pressure in a testing machine. From the front end of the movable tape a string passed over a pulley R to a loading device, while the rear end was set against the short arm of the indicator of a deflectometer I. The intensity of the pressure exerted by the sand against AB was calculated from the force Q required to overcome the friction of the tape.

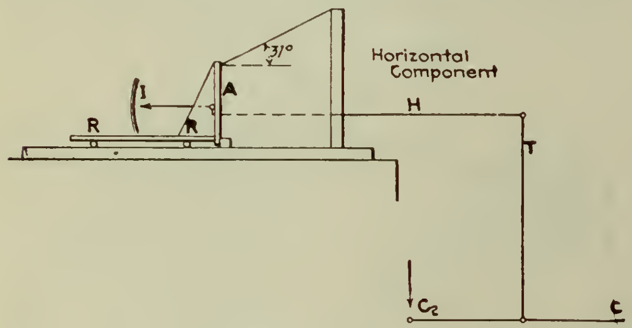


FIG. 5. RETAINING-WALL APPARATUS TO MEASURE EARTH PRESSURE UNDER LARGE DISPLACEMENTS

Even this primitive apparatus furnished very satisfactory results and it seems advisable to attempt further improvements.

Horizontal Component—Measurement of the horizontal component of the earth pressure against a retaining wall which yields in a horizontal direction was carried out thus: The retaining wall A, Fig. 5, rested on an accurately made pair of rollers R. Direct connection was made between the retaining wall and the tongue T of a weighing scale, and, while gradually reducing the resistance of the wall by loading the cup C_2, the observer noted the movements of the wall as shown by the indicator I. Similar apparatus was used for measuring the intensity of the earth pressure against battered walls.

While almost all of the older experiments were made with very fine sand, the author worked mostly with coarse sands (size of grains 2-3 mm.). It is easier to produce a fairly homogeneous backfilling with a coarse sand than with a fine sand, and the retaining wall can yield until the equilibrium of the sand breaks down without any sand entering into the space between the yielding wall and the edges of the box. It can be proved that, with equal volume of voids and similar arrangements of grains, coarse and fine materials exert the same pressure, unless the size of the grains is smaller than about 0.01 mm., in which case certain surface effects become sensible.

Vertical Component—Measurement of the vertical component of the earth pressure against a retaining wall which yields in a horizontal direction was accomplished in the following way: The retaining wall in

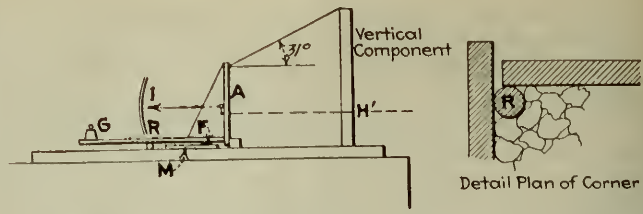


FIG. 6. MEASURING THE VERTICAL COMPONENT

Fig. 6 was supported on a single cylindrical roller R. The bottom of the front end of the wall was provided with a steel button F resting on a ground-glass surface M; weights at G balanced the wall over the roller, so that the button just touched the glass surface. Calling H the horizontal component, V the vertical component of the earth pressure and f the coefficient of friction between steel and glass, the experiment furnishes the value H'.

$$H' = H - Vf, \text{ or } V = \frac{H - H'}{f} \qquad (2)$$

The value H is known from the measurement described just above. The value of f for the friction of steel on glass is remarkably constant.

The method is an indirect one, but it excludes an important source of error common to almost all of the older methods. No pull is exerted in a vertical direction by the measuring device on the retaining wall and the measurement of the vertical component takes place while the wall yields merely in a horizontal direction, i.e., the measurements of the horizontal and of the vertical component are made under exactly the same kinematic conditions, which is the essential point.

Passive Earth Pressure—In investigating passive earth pressure the method of measuring the active earth pressure was followed except that the retaining wall was forced forward by the scale loading. At the start of every experiment the joints between the wall and the sand-box were open, and in order to prevent the sand grains from clogging the open space, the corners between the wall A and the edges of the box were provided with vertical glass rollers R, as shown in Fig. 6.

Observing Intergranular Movements—An ideal cross-section through a granular mass was obtained by cutting a great number of pieces of sheet aluminum to the shape of the enlarged cross-sections of natural sand grains, and inclosing these pieces within a frame of variable width between two parallel glass sheets spaced apart a trifle more than the thickness of the pieces. By properly manipulating the frame and gradually changing its width, the natural arrangement of the grains, the details of the movements in the sand mass and the increase of the volume of voids during such movements could be studied. The tracings for the two sketches in Fig. 2 were obtained by means of such apparatus.

The lateral pressure at rest, i.e., the pressure at the beginning of the first phase, was determined by means of the apparatus Fig. 4. In order to check the result the following method was tried: A layer of sand 5 cm. high was set under pressure. Through the center of this layer passed a horizontal steel tape with the flat side standing vertically, and at different vertical pressures the frictional resistance between the tape and the sand was measured. Then the same experiment was repeated with the flat side of the tape in a horizontal

position. The ratio between the force required to overcome the frictional resistance between the tape in the two positions at the same vertical pressure is equal to the ratio between the horizontal and the vertical pressure in the mass. In every series of experiments, the pressure was gradually raised from 0.8 kg. to 4 kg./cm.², then the load was entirely removed and gradually applied again. Both methods furnished almost identical results. It may be convenient to recall that 1 kg./cm.² is nearly equal to 1 ton/ft.²

The ratio between the horizontal and the vertical pressure was found to be independent of the absolute value of the pressures, and equal to 0.42. The angle of repose of the sand was 35 deg. With this angle, Rankine's method furnishes 0.271 and Rebhann's method 0.215, values which are 35.5 per cent and 48.8 per cent smaller than the observed value. Particular stress is laid on the fact that the preceding compression of the sand up to 4 kg./cm.² had no effect whatever on the results of the tests.

Between the beginning of the first and the beginning of the second phase, the earth pressure decreases with the distance that the retaining wall yields.

Earth Pressure During the Second Phase

Let w be the specific gravity of the sand, h the height of the retaining wall, so that $\frac{1}{2}wh^2$ would be the horizontal pressure exerted by a liquid of the same specific gravity against unit length of the wall; $H = \frac{1}{2}kwh^2$ is the horizontal component of the corresponding pressure of the sand, and $s = eh$ the distance that the retaining wall yields. Then Fig. 7 represents the relation between k and e for three typical cases. The results were obtained

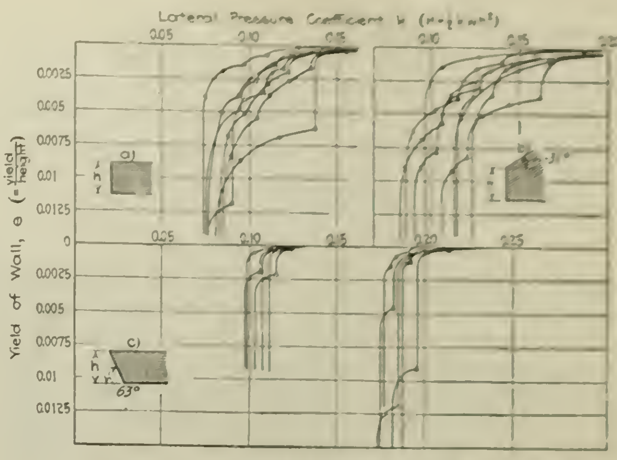


FIG. 7. TEST CURVES OF EARTH PRESSURE DURING SECOND PHASE

by means of the apparatus Fig. 5. In each figure there is introduced a diagram cross-section through wall and backfilling.

Curves (a) represent coarse river sand, size of grains 2 to 3 mm., specific gravity of grains 2.56, volume of voids 42.2 per cent, poured into place in horizontal layers. Curves (b) represent the same sand poured in layers parallel to the inclined sand surface. Curves (c) apply to a wall sloping forward at 63 deg., the sand poured in horizontal layers; the left-hand set of lines gives the values $H - 0.39V$ which were furnished by the apparatus shown in Fig. 6. Attention is called to the characteristic difference in shape between curves (a) or (b) and curve (c), the latter instancing the

TABLE 1. MEASURED PRESSURES OF SAND AGAINST VERTICAL RETAINING WALL.

No.	Material of Backfill	Surface of Backfilling	Method of Filling the Sandbox	Volume of Voids, per Cent	Coefficient of Liquid Pressure: First Phase k_0	Second Phase k_1	k_2	k_3
1	Sand (a)	Horizontal	Poured in horizontal layers	42.2	0.42	0.162	0.130	0.079
2	Sand (a)	Horizontal	Poured in layers dipping toward wall	42.2	0.42	0.168	0.134	0.053
3	Sand (a)	Horizontal	Poured in layers dipping toward the backfill	42.2	0.42	0.140	....	0.075
4	Sand (a)	Horizontal	Poured in horizontal layers, layers rammed	40.0	0.42		....	0.060
5	Sand (a)	Horizontal	Compared by stirring and shaking	39.8	0.42	.	.	Very small
6	Sand (a)	Rising at 31°	Poured in layers parallel to the surface	42.2	0.77	0.212	.	0.106
7	Sand (a)	Dipping at 31°	Poured in layers parallel to the surface	42.2	0.25	0.123		0.068
8	Sand (b)	Horizontal	Poured in horizontal layers	47.0	0.42	0.200	0.183	0.125
9	Sand (b)	Rising at 31°	Poured in layers parallel to the surface	47.0	0.77	0.270		0.177
10	Sand (c)	Horizontal	Poured in horizontal layers		0.42	....	0.140	0.126
11	Sand (d)	Horizontal	Poured in horizontal layers	44.7	0.42	.....	0.180	
12	Sand (d)	Horizontal	Poured in layers dipping toward the wall	44.7	0.42	.....	0.189	....
13	Sand (d)	Horizontal	Poured in layers dipping toward the backfill	44.7	0.42	.....	0.165	
14	Sand (d)	Horizontal	Compacted by stirring and shaking	40.9	0.42	.....	0.132	
15	Sand (d)	Rising at 35°	Poured in layers parallel to the surface	44.7	0.81	.....	0.291	
16	Beans	Horizontal	Poured in horizontal layers		....	....	.....	0.121
17	Beans	Horizontal	Placed in horizontal layers, layers rammed		....	.....	.....	0.093
18	Beans	Horizontal	Compacted by shaking		.	.....	.....	Very small

Sand (a): Coarse beach sand, grains rough, mostly quartz and feldspar. Specific gravity of grains 2.56, size of grains 2-3 mm. Angle of repose 35°
Sand (b): Fine beach sand, grains like those of (a), size of grains ¼-1 mm. Angle of repose 34°.
Sand (c): Fine river sand, grains mostly quartz, somewhat transparent, surfaces perfectly smooth, edges partly sharp, partly rounded. Specific gravity of grains 2.52, size of grains ¼-1 mm. Angle of repose 34°.
Sand (d): Flint powder (washed and sieved road scrapings from a flinty country. Angle of repose 35°.
Beans: 7mm. long, 5mm. thick, angle of repose 33°.

Intensity of pressure "at rest,"	$H_0 = \frac{1}{2}k_0wh^2$
At beginning of second phase,	$H_1 = \frac{1}{2}k_1wh^2$
At first slip,	$H_2 = \frac{1}{2}k_2wh^2$
At breakdown of equilibrium,	$H_3 = \frac{1}{2}k_3wh^2$

Remarks—All experiments were made by the author except Nos. 11-15, which are reprinted from G. H. Darwin, "On the horizontal thrust of a mass of sand," Exc. Min. Proc. Inst. Civ. Eng. Vol. LXXI, 1883. As later experiments of the author showed that the intensity of the earth pressure against a yielding wall increases somewhat with time, it may be stated that the time between the beginning of every experiment and the breakdown of the equilibrium of the sand was about 30 minutes. Every series of experiments was repeated at least eight times. Where the experiments led to considerably diverging results no average was taken and the space for the coefficient is left blank in the table. At the time the experiments were made, the method for determining k_0 was not yet known. The value k_0 was taken from the text and introduced into the table for the purpose of comparison. The value k_0 in Nos. 6, 7, 9 and 15 were approximately computed on the basis of $k_0 = 0.42$ for backfilling with a horizontal surface. The considerable differences between the intensity of the earth pressure of coarse sand, fine sand and dust are due to the fact that the coarser the sand, the denser is the backfilling, under identical methods of filling the sand box.

breakdown of equilibrium of the backfilling almost without any preceding slip. The mechanics of this process will be discussed another time.

The diagrams show that in an advanced state of the second phase the retaining wall yields only by jerks. These jerks are caused by a temporary increase in the volume of the backfilling, which takes place at every slip.

Among the different values assumed by the earth pressure during the second phase, the following three can be considered as characteristic: (1) The pressure H_1 at the beginning of the second phase; this acts at the moment when the yielding of the retaining wall becomes sensible and proceeds in a greater proportion than the earth pressure decreases. As the limit between

the first and the second phase is not sharply defined, the intensity of H_1 can be only roughly estimated. (2) The pressure H_2 acting during the first slip (the first slip appears in the diagram as the first sharp break in every curve). (3) The pressure H_3 at complete breakdown of equilibrium.

Table I contains a series of average numerical values of coefficients for H_1, H_2 and H_3.

Direction of the Pressure

Some indications of the direction of the earth pressure at rest were obtained by using the frame shown in Fig. 4, with an adjustment for preventing the dust from penetrating the space between the bottom of the frame and the base on which the frame rests. The frame was filled with sand and put under pressure. The steel tape was passed underneath the part $A'B'A''B''$ of the bottom of the frame between two sheets of paper and received a pressure equal to half of the friction between the sand and the inside of the frame. The angle between the direction of the earth pressure and the normal to the inside of the frame was computed from the frictional resistance acting between the tape and the papers. Its values for different vertical pressures are plotted in diagram Fig. 9. The angle increases with the vertical pressure, which in the opinion of the author is a consequence of the increasing effect of the sand surface being covered with a slab. For zero pressure the diagram indicates an angle of about 5 deg.; this seems to be the angle applying to a sand layer with free surface.

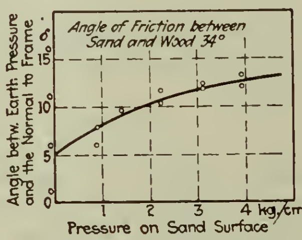


FIG. 8. MEASURED DIRECTIONS OF THE RESULTANT PRESSURE

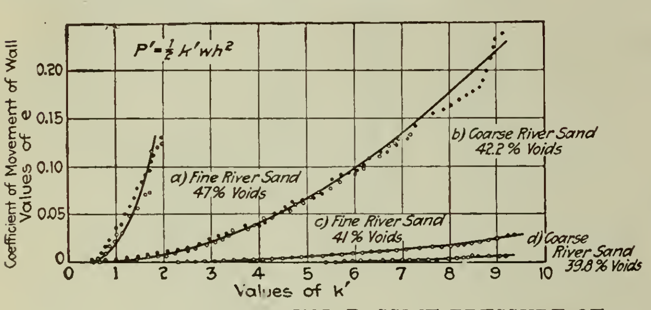


FIG. 9. TEST CURVES FOR PASSIVE PRESSURE OF FOUR MATERIALS

The values assumed by the angle during the second phase were obtained by experiments with the apparatus Fig. 6. The backfilling had a free surface. Some of the values are compiled in Table II.

TABLE II. OBSERVED ANGLE OF RESULTANT PRESSURE WITH NORMAL TO WALL

No. Description	Sand (a)	Sand (b)	Beans
1. Wall with vertical back, surface of backfilling horizontal, poured in horizontal layers......	5°0′	2°22′	3°16′
2. Like 1, but surface rising at 31°, poured in layers parallel to the surface..................	6°32′	1°35′	.....
3. Like 2, but surface dipping at 31°, poured in layers parallel..........................	3°58′	....	.....
4. Like 1, but back of the wall dipping toward backfilling at 63°........................	19°33′	19°44′	.....

The results of the experimental investigation lead to the following conclusions:

During the second phase the pressure acts practically perpendicular to the back of vertical or battered walls, whether the surface of the sand is horizontal or not. In the case (c) of Fig. 7 (wall sloping forward), the direction of the earth pressure forms with the normal to the wall a certain angle, depending on the slope of the wall; with increasing slope the angle increases, reaches a maximum somewhat smaller than the angle of friction between the sand and the wall, and then decreases again.

"Earth pressure at rest" is in every case directed at an angle with the surface against which it acts, but this angle, too, is only a fraction of the angle of friction between the sand and the wall.

Passive Earth Pressure

When a force acting against the wall tends to compress the backfilling, the resistance of the backfilling increases in direct proportion to the distance of compression until the frictional resistance which acts between the surface of contact of the sand grains assumes its maximum value. That is the first phase of passive pressure. It seems to be of less importance than the first phase of the active pressure.

The second phase starts with intergranular movements, whose intensity increases more rapidly than the pressure. For the second phase theortical considerations lead one to suspect that the ratio between pressure and movement ought to follow a parabolic law. Fig. 9 contains the results of experiments made to test this. The different symbols represent separate sets of experiments, made with the same materials under similar conditions, to check each other. Parabolas have been passed through the first and the last point of each set of observations. In tests (a) and (b) the sand was simply poured into the sandbox; in (c) and (d) the sand was placed in layers, each thoroughly compacted. From the diagrams the tremendous influence of the density of the backfilling on its resistance to lateral compression is plainly apparent.

In an advanced state of the second phase the pressing body advances by jerks, which is similar to what happens during active pressure. Theoretically an approximate relation exists between the active pressure (H_2) at which the first jerk occurs and the corresponding passive pressure (H'_2), this relation being,

$$H_2H'_2 = \tfrac{1}{2}wh^2 \qquad (3)$$

In practice H'_2 seems to be considerably greater than the theoretical value. The yielding by jerks of the retaining wall indicates that slips take place within the mass of sand. The direction of maximum tangential stress dips toward the backfilling. But the slips occur as shown in Fig. 10, simply because in the neighborhood of the surface the grains have a better opportunity to move than in the interior of the mass. Similar observations were made by Möller, who experimented with walls and backfillings resting on top of sand beds of a considerable depth.

During the second phase of active pressure, the decrease of the pressure is associated with sudden movements of the sand mass, which in turn cause spontaneous movements of the retaining wall. These events are explained as follows: The second phase starts with intergranular movements whose intensity increases more rapidly than the earth pressure decreases. If these movements existed throughout the

mass of sand there would be no opportunity for any "slip." But, as the backfilling rests on a rough surface, the intergranular movements are confined to a wedge-shaped space between the back of the wall and the remainder of the backfilling. This result was obtained by a study of the equilibrium of a mass of spheres. Along the surface of contact between stationary and moving parts of the mass the grains are forced to change their relative positions. Their equilibrium becomes more and more unstable, until they dip and overturn.

This rupture, or "slip," is simply a radical but temporary expedient to remedy a local disorder in the structure of the sand. No complete rearrangement of the grains can occur without the sand temporarily assuming within the zone of rearrangement a very loose structure (Fig. 2). The first temporary increase in bulk within the slip zone causes the first jerk. It is followed by a slight settlement within the wedge-shaped zone. Equilibrium is re-established and the intergranular movements continue until a second slip becomes necessary.

One of the conditions for the occurrence of a slip is that the stress in the sand tangential to an ideal interface (an inclined plane passing through the foot of the wall) exceeds a certain value; or, as it is expressed by the various earth-pressure theories, the value of the angle between the forces acting on the plane and the normal to the plane must exceed a certain limit. This critical value has always been identified in earth-pressure theories with the angle of repose of the material. But both theoretical investigations and experiments disprove the identification. The angle of repose of different sands ranges between 30 deg. and 35 deg., but the value of the angle of friction between wedge and plane of slip, as computed from the observed position of sliding planes, lies between the limits of 30 deg. and 54 deg. and depends chiefly on the degree of compactness of the backfilling. The angle will be called *angle of slip* and its tangent the *coefficient of slip*.

Successful attempts to determine the position of the plane of slip showed a remarkable fact. From the angle of slip the intensity of the earth pressure was computed by basing on the supposition that the plane of slip is identical with the interface of maximum tangential stress. But the computation always furnished the observed value H_2 (earth pressure at first slip), while the position of the plane of slip was determined in a state corresponding to H_3 (final breakdown of equilibrium). From this discrepancy the author concludes that *only the first slip* occurs in the direction of the maximum tangential stress, and all the succeeding slips take place along the same plane of slip. He explains this phenomenon as follows: The first slip loosens the structure of the sand within a narrow zone. Then the sand mass is no longer homogeneous, for it contains a layer of less compact material, and the following slips do not take place in the direction of the maximum tangential stress but along the plane of least resistance, i.e., along the first plane of slip.

From the facts mentioned it is evident that the slip represents only a subordinate incident in the process of lateral expansion of a backfilling. The earth pressure at first slip represents neither a maximum nor a minimum but something between. In many cases (as pressure against tunnel masonry) there is no opportunity

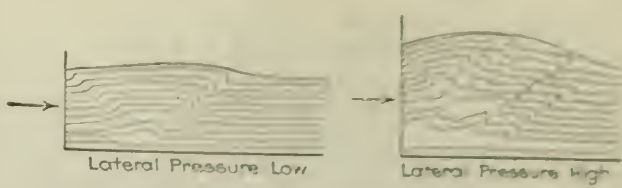


FIG. 10. DEFORMATION OF SAND BACKFILL UNDER LATERAL COMPRESSION (FORCHHEIMER)

for slip, and in these cases all theories based on the knowledge of the value of the angle of slip are worthless.

Conclusions

The earth pressure against a perfectly rigid wall seems to be fairly independent of the density of the backfilling. For sand its value is

$$H = \tfrac{1}{2}0.42wh^2$$

Any yielding of the wall causes a decrease of the intensity of the pressure, and the minimum value, according to the density of the backfilling, corresponds to coefficients of $\frac{1}{2}wh^2$ ranging from 0.15 to even less than 0.05.

During the decrease of the pressure, two phases can be distinguished. During the first phase the relations between the intensity of the earth pressure and the distance of yield are chiefly governed by the elastic properties of the backfilling. During the second phase the influence of the structure of the sand becomes prominent.

These facts indicate the existence of relations between stress and strain in sands similar to those which are known to exist for solid bodies. "Slip," if any, occurs at an early stage of the second phase and is an event of secondary importance.

Notes

[1] In this connection the term "slip" means the separation of the sand mass into a resting part and a sliding wedge along a well defined interface, and not the small individual slips occurring throughout the sand mass along the surface of contact of the grains. The latter ones are always "essential" events.

[2] *G. H. Darwin*, On the Horizontal Thrust of a Mass of Sand. Exc. Min. Proc. Inst. Civ. Eng. Vol. LXXI, 1883.

[3] *K. Skibinsky*, Das Gleichgewicht des Roiligen Materiales. Oesterr. Wochenschr. f.öff. Baudienst, 1916 and 1917.—Science Abstracts for 1917 mention a series of theoretical investigations of *J. Boussinesq*, Comptes Rendus 1917, also starting from the equilibrium of the individual sand grains, which shows that the necessity for returning to the elementary fact was felt throughout the world.

[4] In practice the sand grains are very small as compared with the height of the retaining wall and the preference given by the investigators to the fine sands seems to originate in an effort to adapt the experiment to the actual conditions by copying this perfectly non-essential detail.

New Zealand Harbor Improvements

Plans are well under way for the completion of wharves and sheds at Auckland, New Zealand, as well as the construction of three more wharves in order to meet the demands of the constantly increasing commerce of that city. Frequently the wharves are so badly congested that shipping must wait its turn. The Auckland Harbor Board has been authorized to place a loan of $4,866,500 for the developments indicated above, and the chairman of the board has announced that work will be pushed as rapidly as possible.—*Commerce Reports.*

Using 6-in. Bank Run Aggregate on Stevenson Dam

Large Size Gravel Dug by Steam Shovel From Nearby Pit and Made Into Concrete Chuted Into Place on Connecticut Hydro-Electric Development

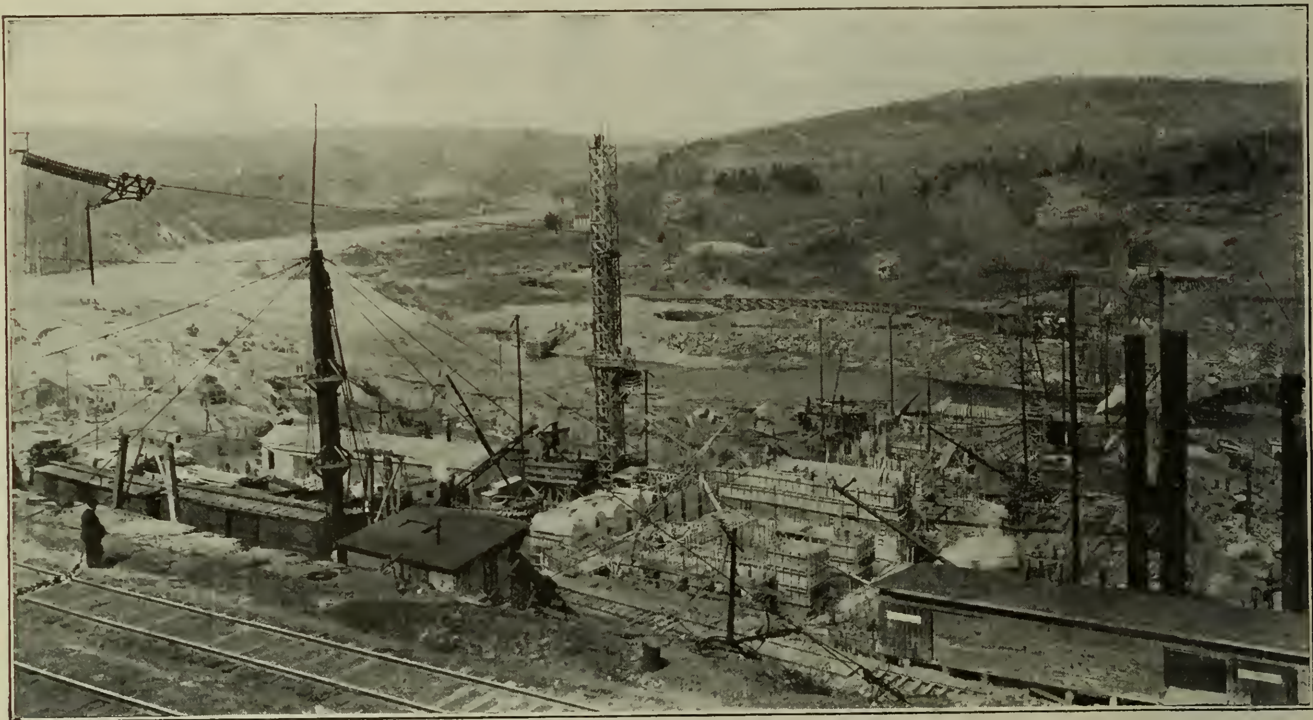
BANK RUN gravel screened down to material below 6-in. was successfully used for the concrete of the recently completed Stevenson Dam near Derby, Conn. The material was taken from a nearby deposit and economically brought to the site, where it was put through a stock concrete mixing and chuting plant, which was only slightly revised to take care of such excessive size aggregate. It is estimated that the use of the bank-run gravel saved $250,000 on the work.

The Stevenson Development of the Connecticut Light & Power Co. is located on the Housatonic River, about seven miles north of Derby, and consists of a concrete gravity section, spillway dam, concrete intake, concrete abutments and a steel and brick power house. The dam is 1,200 ft. long, about 122 ft. high, and 81 ft. wide at the base. There are about 160,000 cu.yd. of concrete in all the structures. The power house is equipped with three vertical-shaft water wheels each designed to develop 9,800 hp. at 150 r.p.m. under a 76 ft. head. These wheels are direct connected to 7,800 kva. 6,600 volt, three-phase generators. Provision has been made for the installation of a fourth unit. Current from the generators is stepped up through banks of single phase 2,500 kva. water cooled transformers to 66,000 volts for transmission to Waterbury, Conn., 26 miles away. The project also included the construction of several miles of highway, the raising of a steel highway bridge, the building of a 180-ft. span concrete cantilever bridge, the erection of several operators' dwellings, and the building of 25 miles of steel tower transmission line.

The whole area of the development is covered with an overburden of sand, gravel and boulders with bedrock at depths varying from 20 to 60 ft. This permitted a solid foundation for the dam but also suggested the possibility of the utilization of the overburden for concrete aggregate. Accordingly, an area about 1,500 ft. upstream of the dam was selected for investigation. Numerous tests of this gravel proved that an excellent quality of concrete could be made of this material using the natural bank-run and that it was necessary to vary only the quantity of cement to obtain concrete suitable for various parts of the work.

In order thoroughly to explore the gravel deposit, timbered and sheathed shafts, 6 ft. square, were sunk to groundwater level at many points over the area of the deposit. Large samples of the gravel encountered in these shafts were taken and from these samples tests were made as to the proportions of different sized aggregate. All gravel over $\frac{1}{4}$ in. mesh and under 6 in. mesh was called coarse aggregate, while all under $\frac{1}{4}$ in. mesh was termed fine aggregate. The percentage of silt was small enough to be neglected.

Other samples of the gravel taken from the shafts, passing a 6-in. mesh, were mixed with varying quantities of cement into concrete from which 6-in. and 12-in. cubes were made. In making the 6-in. cubes all aggregate over $2\frac{1}{2}$ in. in diameter was removed, the reason being that larger sized aggregate would probably reduce the compressive strength of so small a cube. These cubes were stored in accordance with standards of the American Society for Testing Materials and were broken at 7 and 28-day periods. Without exception all shafts showed a uniform gravel deposit and compressive tests showed results sufficiently high to enable the engi-



LOOKING UPSTREAM FROM STEVENSON DAM UNDER CONSTRUCTION

Gravel for concrete taken from low bank bed on far side of river in middle back-ground and delivered by train to two mixing plants at foot of towers shown.

BANK WHERE 6-IN. GRAVEL FOR CONCRETE WAS DUG FOR THE STEVENSON DAM, NEAR DERBY, CONN.
Windrows shown are the rejections over 6-in. grizzly.

neers to obtain permission to use bank-run material for the concrete.

The 12-in. cubes were used to closely determine the weight of the bank-run concrete. Subsequent data showed this weight to average about 148 lb. per cu. ft.

The quantity of cement used in making the 6-in. cubes was varied in the proportions of 4½, 5½, 6¼ bags to the cubic yard of resulting concrete, these amounts approximating the quantities of cement in the standard 1:3:5, 1:2½:4 and 1:2:4 mixes per cubic yard of concrete. The 4½-bag mix was used in the dam, intake, abutments and power-house foundations and the 5½-bag mix in the top 7 ft. of the dam, the bridge over the spillway and in thick walls. The 6¼-bag mix was used in all reinforced work around the scroll cases, the penstocks and in very thin walls. All concrete was mixed rather sloppy wet and later proved to be of high density and exceptionally water-tight.

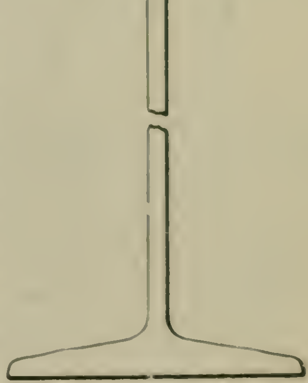
The tests proving satisfactory it was decided to take all the aggregate from the bed investigated. The overburden was stripped from the gravel deposit by ¾-yd. revolving shovels loading into bottom dump wagons. Once stripped, the concrete aggregate was loaded by a 60-ft. long boom shovel capable of cutting to a full 50-ft. bottom width and of loading at a point 26 ft. above its own track. It was equipped with a 2½-yd. dipper, which dumped onto a movable grizzly, the undersize, under 6-in. diameter, falling directly into 12-yd. dump cars. The oversize went to waste along the grizzly track, forming the windrows shown in one of the views. Grizzly bars of 60-lb. rails were first used, but this type of bar rejected an excessive amount of fine material and was soon replaced by bars made of 8-in. I-beams with angle-irons bolted to the upper flange, as shown in the sketch herewith. This bar gave a sharp upper edge and the rejections of fine aggregate were practically stopped.

Approximately 155,000 cu.yd. of aggregate were obtained in this way. This was principally hauled direct to the mixer bins and dumped directly into them. In the late winter of 1919 about 30,000 cu.yd. of aggregate was stored at a point above the high water on the right bank. This gravel formed a reserve which was used during the high-water period of that spring, during which time the gravel pit was flooded.

In certain parts of the reinforced-concrete work it was not practicable to use 6-in. aggregate because of the relatively small space between the reinforcing bars. In these cases 3-in. grizzlies were placed above the measuring hoppers and the oversize was rejected, the undersize passing directly into the measuring hoppers. This occasioned some extra work but caused the least interference with the general scheme of obtaining aggregate.

To handle the concrete two main and one subordinate mixing plants were installed, all delivering concrete through chutes and towers. Some doubt was expressed as to the ability of a chute to handle such large size aggregate successfully, but the regular 14-in. chutes of the Lakewood Engineering Co., provided however with arched braces in order to pass the large stone, were adopted and satisfactorily used.

The major portion of the concrete was mixed in two plants located one near each end of the dam. These plants were each equipped with two 1-yd. electrically driven, revolving mixers. Aggregate was brought from the gravel pit by 8-yd. cars on standard-gage track and dumped directly into bins above the mixers. From the bins the aggregate was fed by gravity to measuring hoppers, from these to the mixers, and the resulting concrete by gravity to the elevating tower buckets, where it was chuted to the various parts of the work. A small amount of concrete was mixed in a Hains gravity mixer plant located immediately below the power house on the right bank of the valley. Concrete from this plant was chuted to an auxiliary tower about midway of the length of the dam, and from there distributed into the work. The largest daily output of concrete was 1,660 cu.yd. and the largest quantity for any one month was 27,000 cu.yd., which was placed during September, 1919.



ANGLE-IRON ON I-BEAM FOR GRIZZLY BAR

It was found essential to remove all rock larger than 6 in. in diameter in order that the resulting concrete could be fully run through the 14-in. chutes. The mixers

stood up very well under the battering of the large stone. Very little trouble was experienced in handling the concrete in this manner and the engineers on the work state that, should an opportunity occur, they would endeavor to use aggregate up to 9 or 10 in. diameter providing mixers and chuting equipment could be obtained for such large sized material. Generally speaking, concrete made from aggregate containing such large material could only be used in mass work.

Daily samples of concrete were taken from each plant then running, and 6-in. compression cubes were made of these samples. These were broken at 7 and 28-day periods. Six days of the week the cubes were broken at the field laboratory and the seventh at the Mason Laboratory of the Sheffield Scientific School at Yale University. The following average results were obtained:

STEAM SHOVEL DELIVERING BANK GRAVEL FOR CONCRETE THROUGH GRIZZLY TO TRAIN

TESTS OF CONCRETE FROM STEVENSON DAM

Mason Laboratory Mix, Bags to Yd.	Time, Days	Ultimate Compr. Strength, Lb. per Sq.In.
4½	7	729
4½	28	1,576
5½	7	860
5½	28	1,909
6¼	7	1,147
6¼	28	2,133
Stevenson Laboratory		
4½	..	589
4½	..	1,171
5½	..	770
5½	..	1,292
6¼	7	941
6¼	28	1,555

It is noticeable that the results obtained in the Mason Laboratory were higher than in the field laboratory. This is probably due to the difference in character of the two machines used in testing the cubes, the one in the Mason Laboratory being an expensive well-designed machine, while in the field an inexpensive hand pump operated machine was used.

The development was constructed for the Connecticut Light & Power Co., of Waterbury, Conn., by the J. A. P. Crisfield Contracting Co., Philadelphia, contractors, with C. W. Blakeslee & Sons, of New Haven, sub-contractors. The design was furnished by the J. A. P. Crisfield Contracting Co. and the Birkinbine Engineering Offices, Philadelphia. Construction work was done under the direct supervision of H. J. Hoard, chief engineer, and E. H. Burroughs, assistant chief engineer, of the J. A. P. Crisfield Contracting Co. These two engineers furnished the material from which this article was prepared.

Ocean Sewage Disposal in Relation to Bathing Beaches

By Lynn Perry
Assistant Professor of Civil Engineering, Lafayette College, Easton, Pa.

DISPOSAL of sewage into the ocean or into watercourses in close proximity to bathing beaches is frequently considered prejudicial to the health of the bathers. Whether or not this practice actually pollutes the water bathed in, or not, the esthetic sense of the public usually demands that some other place of disposal be utilized, even at considerable additional public expense. Some seashore municipalities have recently incurred a heavy expense by constructing tanks, filters and disinfecting plants to purify their sewage so it may be disposed of into estuaries where shellfish are grown, rather than prejudice the purity of their bathing beach water.

The public health laws of New Jersey do not permit a municipality to dispose of its sewage into any watercourse within the borders of the state or into the ocean except in accordance with plans approved by the State Department of Health. That Department had uniformly required municipalities desiring to dispose of their sewage into the ocean to provide a minimum treatment of sedimentation and an outfall pipe sufficiently long to conduct the tank effluent into the ocean beyond the surf. A section of such a sewage tank and outfall is shown in Fig. 1. The effect of this method of sewage disposal on near-by bathing beaches is the subject of this article.

In the summer of 1916 the State Department of Health of New Jersey conducted a series of investigations with a view of determining what effect, if any, disposing of sewage into the ocean has upon the quality of water at bathing beaches. The cities at which investigations were conducted were carefully selected as being both large and representative seaside resorts.

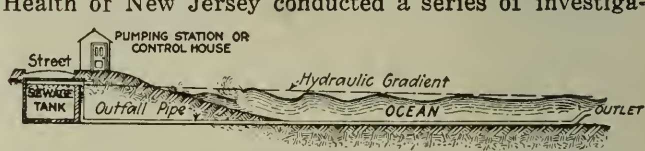


FIG. 1. SECTION THROUGH SEWAGE TANK AND OCEAN OUTFALL

During the period of investigation, the wind was south, southeast, and northeast and low tide occurred near midday, giving ebb tide in the forenoon and flood tide in the afternoon. The direction and velocity of the effluent after being discharged into the ocean was determined by the use of two surface and two submerged floats. The surface float (Fig. 2) was constructed to submerge to a depth of 9 in. No portion of the float protuded above the water surface. The float was not affected by the wind, undertow, or under-currents of the ocean except in the same measure as the surface film of water was affected. Each time the surface

float reached the breaker line, it was removed from the water to prevent its being washed ashore by the surf. The location of no samples was governed by the action of the surface float. The submerged float was of the usual wood type, $1\frac{1}{2}$ x $1\frac{1}{4}$ in. in section, 5 ft. long, with a $\frac{1}{2}$-in. spar projecting from the surface end. The projecting spar was so small that the wind effect was very small but it was necessary for purposes of observation. The floats were placed in the ocean over the outlet and followed by observers and sample collectors in a boat. Fig. 3 shows in dotted lines the courses traveled by the surface float and in solid lines the courses followed by the submerged float.

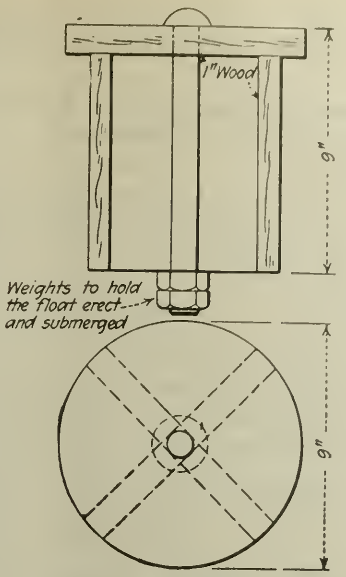


FIG. 2. SURFACE FLOAT FOR TRACING SEWAGE FLOW

The samples may be divided into two classes: Those collected from the boat that followed the float or "float samples", and those collected by wading out from the shore, or "surf samples." All samples were collected with care about 6 in. under the water surface. It was at first the intention to collect samples at hourly intervals, the "float samples" from the boat near the float and the "surf samples" at predetermined points along the beach. The first day's experience, however, showed that the float traveled so rapidly that it arrived in front of a bathing beach of another municipality before the hour had elapsed, thus samples collected at hourly intervals were so far apart and the tank effluent so highly diluted with ocean water that they showed a very low bacterial count. This was true even of the sample collected one hour from the outfall. Accordingly, on the second day the time interval of collections was reduced to 30 minutes, and on the third day, further reduced to 15 minutes. The "float samples" were not kept over two hours before plating and the "surf samples" not over half an hour.

Fermentation tubes with lactose bile medium were used for presumptive tests and lactose agar stained with azolitmin was used for plate culture medium. Both tubes and plates incubated at 37 C., using a portable field incubator.

The "surf samples" checked very closely. The results show: (1) Immediately ashore and for some distance on each side of the outfall no serious pollution exists (and no bathing beaches are located at these places). Indeed, it is doubtful if any pollution exists due to the outfall. (2) At, and in close proximity to, the bathing beaches on both sides of the outfall, both the total and red colony count increased rapidly, which, in view of the results from the float samples, was probably local and may be attributed to the bathers.

When the float was carefully placed over the center of the outfall and travelled near the center of sewage flow, the bacteria counts were remarkably consistent. But when the float travelled near the edge of the main flow, low bacteria counts resulted from the start, the samples being collected on the edge of and not in the center of the horizontal flow of the tank effluent. Samples collected equidistant from the outfall, in the center line of flow, substantially check each other. The results are shown on Fig. 3.

The results indicate: (1) That the tank effluent travels approximately parallel to the shore. (2) That the tank effluent travels in a very narrow stream which is probably not over 25 ft. wide at the outfall. (3) That the enormous quantity of ocean water rapidly dilutes or oxidizes the tank effluent. (4) That the surface film of water ultimately reaches the surf but only after it has become so diluted that it is of a higher bacterial standard than surf water where the bathers are active.

During two days of heavy northeast storm the surf was so high that it was too dangerous to launch and

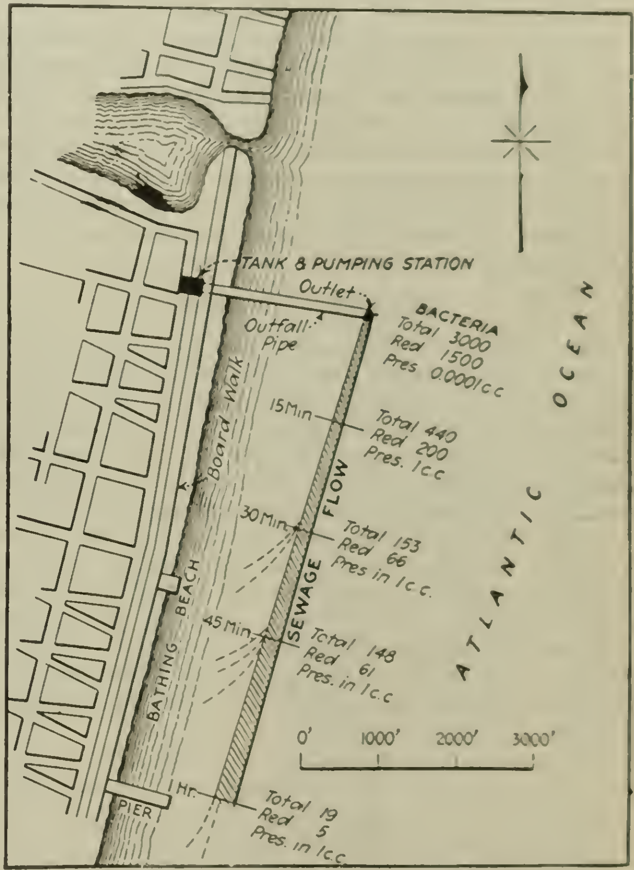


FIG. 3. COURSE OF SEWAGE AND BACTERIAL COUNTS
Averages of bacterial counts at 15-minute intervals.

land the boat. There were no bathers and only "surf samples" were collected. The results from the samples were not as reliable nor as consistent as the others. They indicate that, during extreme northeast storms, after over 24 hours duration, highly diluted effluent begins to reach the shore southwest of the outlet.

In conclusion, these investigations indicate that thoroughly settled sewage, when discharged into the ocean well outside of the surf, is not likely to impair the bacterial quality of water at bathing beaches. The investigations were planned by Chester G. Wigley, then chief engineer, and the field work was executed by the writer, then sanitary engineer, and George D. Norcum, chemist of the New Jersey State Department of Health at Trenton.

Immigration and the Construction Industry

Labor Shortage Not Yet Relieved by Growing Number of Immigrants Who Are Mostly Women and Children—Prohibition Said To Be No Deterrent

ENGINEER and contractor alike have been confronted of late with two questions, entirely new, and upon which opinion appears to be about evenly divided: Is prohibition having and adverse effect upon immigration, and is any relief from the labor shortage in sight from foreign sources? Studies of reports of the U. S. Immigration Commissioner, the U. S. Bureau of Labor Statistics, and the U. S. Geological Survey, and information coming from the Superintendent of Ellis Island, New York, seem to point to a negative answer to the first question and a positive answer to the second.

The contention has often been made and as often contradicted that prohibition is abetting the labor shortage through immigration restriction, and that, were the United States to allow the manufacture and sale of light wines and beer, a certain class of immigrants, from which the construction industry draws its greatest per cent of common labor, would again be attracted to this country. Information from immigration officials and analyses of immigration figures and reports are our best sources of information upon this question.

Prohibition No Bar

In the opinion of P. A. Baker, superintendent of Ellis Island, a stronger bar than prohibition will have to be set up before the foreigners, no matter of what race or color, will be kept out of this country. It is his assertion that before the war approximately one man in one hundred immigrated here with the intention of becoming a citizen. The vast majority come because they are attracted by high wages, plenty of work and the picture of soon returning, affluent, to their native countries. With this condition prevailing the immigrant, believes Mr. Baker, is going to be little concerned with the 18th Amendment to the Constitution. Reports on immigration for the past year and a half, and particularly for the first six months of 1920, point to a substantiation of Mr. Baker's opinion.

No figures are yet available for 1919 upon immigration for the entire United States, but figures are available for the Port of New York, which, in normal years, handles approximately three-quarters of the total immigration. However, this percentage has varied considerably during the last four or five years, and just what the present per cent of total immigration handled by New York is, cannot be known until the figures are correlated. During 1919 it was frequently said that a great many more emigrants were departing than immigrants were arriving, a contention upheld by figures contained in Table I, compiled from information secured from Ellis Island officials. Although approximately 75 per cent more people returned to European countries than arrived during 1919, it must be remembered that people of European birth were given the opportunity of visiting their war-ridden countries for the first time in five years.

TABLE I—ALIEN ARRIVALS AND DEPARTURES PORT OF NEW YORK, FOR CALENDAR YEAR 1919.

Mo.	Arrivals	Departures	Mo.	Arrivals	Departures
Jan.	2,589	9,211	July	9,432	28,354
Feb.	2,975	9,571	Aug.	9,430	32,901
Mar.	5,850	17,201	Sept.	20,577	29,746
Apr.	11,355	15,946	Oct.	24,641	24,833
May	7,462	17,786	Nov.	17,557	36,459
June	9,485	27,998	Dec.	34,529	24,549
			Total	155 882	274,455

Emigration Not New

The emigration of so many people from the United States is believed by many to be a thing of recent origin, or an after-the-war condition. It is not at all new, and a glance at Table II, giving the total alien immigrants arriving during the years named, and the alien emigrants departing, shows that there has always been a heavy outward movement during pre-war normal years amounting to from 40 to 50 per cent of the total immigration. Theh figures, given in Table II, do not include any American citizens travelling abroad, but cover only alien emigrants. Since the beginning of the war this percentage increased, until during 1919 a great many more emigrants left the United States than immigrants arrived, as Table I shows.

TABLE II—COMPARISON OF EMIGRATION AND IMMIGRATION FOR ENTIRE COUNTRY 1907-1918.

Year	Immigration	Emigration	Year	Immigration	Emigration
1907	1,285,349	569,882	1913	1,427,227	611,924
1908	782,870	714,828	1914	1,403,081	633,805
1909	751,786	284,800	1915	434,244	384,174
1910	1,041,570	380,418	1916	366,748	240,807
1911	1,030,300	518,215	1917	362,877	146,379
1912	1,017,155	615,292	1918	211,853	193,268

Despite the fact that emigration overbalanced immigration during 1919, the exact opposite is promised if the figures available for the first six months of 1920 can be used as a basis. Recent reports from Ellis Island are to the effect that from January to June, inclusive, of this year, 197,956 immigrants arrived at Ellis Island and 152,537 emigrants departed. This shows a favorable balance of immigration over emigration of approximately 25 per cent.

As perviously stated, the Port of New York handles approximately 75 per cent of the immigration during normal years. From 1909 to 1914, inclusive, this percentage ranged between a maximum of 77 for 1909 and a minimum of 72 recorded in 1912 and 1914. However, since the beginning of the war and particularly since the entrance of the United States into it, the Port of New York has been more or less closed to immigration and emigration so that this percentage has decreased perceptibly. The percentage handled by the port of New York was, according to the reports of the Immigration Commissioner, for 1915, 55 per cent; 1916, 47 per cent; 1917, 44 per cent; 1918, 26 per cent, and 1919, 19 per cent. Thus it will be noted that not only has New York so far this calendar year handled approximately the same number of alien immigrants as came into the country during 1918, but that it will probably report the arrival of approximately 400,000 immigrants for the entire year.

It is undoubtedly a false premise to assume that during 1920 New York will handle 75 per cent of the total immigration, for considerable quickening has been given

shipping in all other American ports since the war. However, assuming that the 400,000 immigrants represent 75 per cent of the immigration for the year, it will give us a total immigration of 525,000 for 1920. If, on the other hand, that 400,000 is but 19 per cent, New York's contribution in 1919, a maximum of 2,000,000 for the whole United States may be a possibility. As such a figure seems improbable, it is better to strike an average, 750,000 immigrants appearing to be a reasonable one.

Though it is apparent from the foregoing figures that prohibition has little effect upon immigration, it is necessary to go further and find out, if possible, if among these immigrants the normal percentages of common labor and skilled mechanics are numbered. As no segregation of immigrants is made at Ellis Island, all figures of that sort being compiled at Washington, no accurate figures are available now. However, Superintendent Baker asserts that, although incoming ships have capacity lists, both in cabin and steerage, the great majority of immigrants arriving are aged couples, women and children, and Italian reservists. According to him very few male adult laborers are counted among the arriving immigrants. While it is not ascertainable what effect the war had upon the quality of immigrants it is obvious that regulations against emigration of adult laborers from certain European countries have set up a considerable barrier against the United States receiving the quality of immigration it did in pre-war years.

In trying to discover what the labor shortage may be, or how it can be relieved through immigration, the presentation of certain data may clarify the situation. From 1907 to 1914, inclusive, the reports of the Immigration Commissioner show that an average of 27 per cent of all immigrants reported no occupation. The reports also show that of the total immigrants admitted an average of 19 per cent class themselves as common laborers. This figure is secured by averaging the yearly percentages for the years 1907-1914, inclusive, percentages which range from a minimum of 16.2 per cent to a maximum of 23.2 per cent. It is also noted that during these same years the average annual percentage of immigrants in the building trades was 3.3 per cent ranging from a minimum of 3 per cent in 1909 to a maximum of 4 per cent for 1907 and 1911. These figures are reproduced in detail in Table III. From such figures

TABLE III—NUMBER IMMIGRANTS IN BUILDING TRADES ADMITTED DURING PERIOD 1907-1914, INCLUSIVE

	1907	1908	1909	1910	1911	1912	1913	1914
Carpenters	20,656	11,394	8,606	13,887	13,172	11,034	15,035	15,755
Engineers	1,464	1,438	826	1,695	1,638	1,331	1,594	1,684
Iron and Steel Workers	2,249	1,652	1,354	2,845	2,544	1,366	1,728	1,637
Machinists	2,224	2,045	1,831	3,336	2,902	2,098	2,725	2,676
Masons	11,308	4,589	3,860	6,257	5,728	4,555	7,377	7,772
Mechanics	1,745	1,325	644	1,449	1,536	1,342	1,853	1,954
Metal Workers	960	715	444	808	850	669	793	791
Painters	5,239	3,254	2,086	3,460	3,667	2,816	3,888	4,178
Plasterers	1,013	365	477	654	454	319	418	425
Plumbers	906	621	473	745	833	584	778	761
Stonecutters	2,052	1,166	1,337	1,491	1,204	972	1,111	1,036
Tinners	1,635	960	436	720	825	737	879	1,047
Totals	51,451	29,524	22,374	37,347	35,353	27,823	38,179	39,666
Per cent Immigration in Building Trades	4%	3.8%	3%	3.6%	4%	3.3%	3.2%	3.3%

it is seen that in pre-war years approximately the same character of immigrants were received from year to year. Comparing the character of immigration during 1918 with the pre-war years, it is found that 56.5 per cent of the total immigration reported no occupation. In the building trades, however, the same percentage was maintained, 3.2 per cent of the 1918 immigration being numbered in the building trades. Common labor fell off somewhat, only 13.3 per cent being classed as common labor.

Three facts are then noticeable in the foregoing review and comparison: (1) That immigration for the calendar year 1920 promises to eclipse any year since 1914; (2) that the percentage of immigrants counted in the building trades remains the same, and (3) that common labor has undergone an appreciable decrease.

FORECAST OF CONDITIONS

Besides the promise of a greatly increased immigration this year, analyses of available figures lead to various forecasts of conditions. What is evolved in the following paragraphs is of little value for present application, but it may be of value to furnish a basis for predicting the status of the construction industry as affected by immigration.

In the census of 1910 it is shown that there were in the building trades, excluding common labor, though including apprentices, 2,409,348 persons. In the same year the U. S. Geological Survey reported that 51 of the larger American cities had issued building permits aggregating in value $734,112,998. As little unemployment was noted in that year it can be taken as a normal one. Therefore, one can assume that all men in the building trades were actually employed that year. Although the men in the building trades, as reported in the 1910 census, were not all employed in the 51 named cities, apparently the cities are a fairly accurate barometer of building conditions throughout the United States at that time. It is possible to make a ratio between the number of men employed in the building trades in 1910 and the value of building construction reported by the 51 cities. This shows that in 1910 a building trades workman had a construction value of $305.

TABLE IV—COMPUTATION OF MEN IN BUILDING TRADES WITH KNOWN 1910 CENSUS DATA AS BASIS

	—Building Permits in 51 Cities—			
Year (1)	Reported Value (2)	Corrected Value (3)	Men in Bldg Trades (4)	Number Needed (5)
1910	$734,112,998	$734,112,998	2,409,348	2,409,348
1911	687,506,961	687,506,961	2,446,695	2,250,000
1912	738,989,710	738,989,710	2,482,045	2,420,000
1913	673,220,625	673,220,625	2,509,868	2,200,000
1914	619,752,354	619,752,354	2,548,047	2,025,000
1915	641,769,199	625,000,000	2,587,713	2,050,000
1916	780,183,970	710,[illegible],000	2,598,513	2,330,000
1917	512,576,744	394,000,000	2,608,413	1,290,000
1918	302,571,607	197,000,000	2,618,113	645,000

Maintaining this figure throughout the years, starting with 1910 as a base, the figures are tabulated in Table IV. This gives the permit values of the same 51 cities for 1910 to 1918, inclusive, and a column for corrected values, the latter being values with the changes in the value of a dollar taken into account. To convert from reported to corrected value, a mean between the index numbers given by the Bureau of Labor Statistics in its report upon the cost of 22 articles of food, and the index numbers given by the National Industrial Conference Board, is taken. Column four in Table IV begins with the number of men in the building trades as enumerated in the 1910 census. To that figure is added for the years 1911, 1912, 1913 and 1914 the actual number of immigrants listed in the building trades according to the figures of the Bureau of Immigration. From 1915 to 1919, inclusive, the percentage of 3.3 of the total immigration for that particular year is added. No account is taken of the number of men already citizens who enter the building trades. Dividing then the values of build-

ing construction, listed in column three, by the construction value of one man—$305—column five is made up.

The number of men enumerated in the building trades according to column four, as compared with the number of men actually needed to do the work reported by the the 51 cities, shows a considerable discrepancy, particularly beginning with the year 1913. However, it will be remembered that a period of unemployment began about that time and during the fall of 1914 and the spring of 1915, various surveys were made to determine, if possible the amount of unemployment in the various trades. Of these surveys the Bureau of Labor Statistics made perhaps the most authentic and exhaustive one. In its review of unemployment it was announced that an average of 20 per cent of all men in the building trades were unemployed during the latter part of 1914 and early in 1915. This average is taken by averaging the percentages reported from the following cities: Boston, Chicago, Philadelphia, Pittsburgh, St. Louis, Bridgeport, Cleveland, Duluth, Kansas City, Louisville, Milwaukee, Minneapolis, St. Paul, Springfield (Mo.), Toledo and Wilkesbarre. The minimum of these cities was 12.2 per cent and the maximum 27.7 per cent, the average being 20 per cent.

Unemployment Discount

Doubtless some unemployment existed during 1913, but as the survey was for 1914 and 1915 only, we can apply the percentages of unemployment during just those two years. If it be considered, therefore, that during 1914 and 1915 20 per cent of all men in the building trades were unemployed, we find that number to be approximately 500,000 in each year, the amount of the discrepancy between columns four and five.

This is as far as the analysis holds, because during succeeding years war disturbed the normal trend of things. Building construction cannot during the war be taken as representing the same percentage of total amount of money involved in construction work as before the war. In normal years this ratio of value of building permits in the 51 cities to the total amount of money in contracts awarded in the district north of the Ohio River and east of the Mississippi River was around 60 per cent.

While it is possible to make a very rough approximation of the shortage of building mechanics, using the data in column four, Table IV, and the various agency reports as a background, it is believed that the elements entering into even a rough approximation are so uncertain that it would be of little value. In the first place, if such a course be followed, several things are first to be considered. It is known that during the war the value of building permits reported by the 51 cities was far below a normal percent of the total amount of money involved in contracts. Then in the figures shown in Table IV no account is taken either of the adjustments made in wages and hours of labor, which must of necessity increase the number of laborers to do a particular job, nor of the reputed decrease in the efficiency of labor. Then the war induced many men in the builidng trades, drafted into service, to change their trades after being discharged. A tremendous impetus has been given industrial construction within the past few years, and this fact would no doubt materially decrease the percentage of total contracts awarded that the building permits recorded by the 51 cities represent.

Though of little present value, Table IV may serve students of the construction situation with some information upon which an approximation of labor shortages may be based in the future.

Recent Developments in the Manufacture of Cast-Iron Pipe

Abstract of Paper Read Before the New England Water Works Association, September, 1920.

SOME tentative new methods in the manufacture of cast-iron pipe were briefly mentioned in the report of the committee on standard specifications for cast-iron pipe, submitted to the recent convention of the New England Water Works Association by Frank McInnes, chairman, Boston, Mass. These methods were considered primarily in their possible relation to the question whether existing standard specifications shall be changed to require uniform outside diameter of pipe. The committee said:

One of these developments, the use of new methods of core making, where the thickness of material upon the core bar is reduced to a minimum, makes a uniform outside diameter less feasible than with the older methods. On the other hand, another company is producing a high tensile iron developed by high temperature on electric furnace and with this iron the range in thickness for different classes of pipe is so much reduced that the difficulty of obtaining a uniform outside diameter without too great multiplication of core bars, is, in great part, removed.

In one of the foundries of the United States Cast Iron Pipe & Foundry Co. the use of core bars was observed. The method is claimed to produce uniformly smooth inside walls and has been adopted for this reason. It is in line with the manufacturers' contention that with the greater thickness of material on the core bar, necessarily incidental to a uniform outside diameter, it will be difficult to make pipe with smooth interior surfaces. The product as observed was noticeably clean and smooth.

In the foundry of the American Cast Iron Pipe Co. iron with a tensile strength of 30,000 to 40,000 lb. per square inch was being used—made possible by high temperature treatment in an electric furnace of a metal partly taken direct from a blast furnace and partly from the foundry cupola.

The feasibility of using iron of greater tensile strength than in the past is a matter of general interest. The old line manufacturers say they have been all through this question and are convinced that high tensile iron and the resulting thinner pipe cannot be made a success. Such pipe are, however, being sold and, in this age of advancing freight rates, the possibility of reducing weight is becoming an important consideration.

Another interesting development in the making of pipe is the De Lavaud Centrifugal process in use at the plant of the National Iron Corporation, Toronto. By this method the iron is poured into a horizontal mould revolving at high speed which centrifuges the metal against the mould to the desired thickness. The pipe so made is said to have a tensile strength of 35,000 to 39,000 lb. per square inch. Obviously this method particularly lends itself to a uniform outside diameter.

Current American Shipbuilding

On Aug. 1, 1920, private American shipyards were building or under contract to build for private shipowners 389 steel vessels of 1,335,721 gross tons, compared with 334 vessels of 1,306,956 gross tons on July 1, 1920, according to a recent issue of *Commerce Reports*. These figures do not include Government ships building, or contracted for by the United States Shipping Board out of money voted by Congress.

Progress Toward Relief from Water Shortage at Salt Lake City

By SEPTEMBER Salt Lake City will be protected by the addition of a 40,000,000-gal. daily high-line conduit against a water shortage which has seriously restricted consumption during the past few irrigation seasons. The existing inadequacy of supply mains has become acute because of high per capita consumption and the growth of the city toward the eastern city limits requiring a supply at a high elevation. The average consumption in this semi-arid intermountain city is 203 gal. per capita, with a winter average of 160 gal. and a summer average of 250 gal. However, for one or two months the average consumption reaches 215 gal. and the peak load, lasting for 1 or 2 days, reaches 350 gal. per person daily.

During the early summer the supply comes mainly from City Creek which flows down a canyon immediately above the city. As the summer advances the City Creek flow diminishes materially and the supply must come largely from Big Cottonwood and Parley's creeks, mountain streams emerging from the mountains south and east of Salt Lake. It is to supplement the carrying capacity of the existing mains from these two supplies that the three miles of 48-in. reinforced-concrete conduit is now being rushed to completion from the mouth of Parley's canyon on a 0.15 per cent grade along the foot hill contours to a high point in the city distribution system. At the upper end the new conduit connects with an existing line by an 800-ft. inverted siphon of 42-in. riveted-steel pipe under a maximum head of 185 ft. At the lower end 1½ miles of 30-in. cast-iron pipe leads the water into the distribution system at several points.

Excavation for the cast-iron section in town as well as the laying of the pipe is being done by steam shovel. The concrete pipe is made at a point near the center of the conduit line, the pipe being transported to the trench by a two-wheeled cart hauled by a two-horse team.

The contractor, P. J. Moran, is laying from 275 to 300 ft. of pipe per day of eight hours. The total cost will be $385,000. Some of the unit prices bid are as follows: Earth, excavation and backfilling, $1.60 per yard; solid rock, excavation and backfill, $5; 42-in. steel pipe, laid, $15 per foot; 42-in. concrete pipe, laid, $6.25; 30-in. class A, cast-iron pipe, $13.90 per foot, 30-in. Class B, cast-iron pipe, $15.30.

All engineering and supervision are being handled under the direction of S. Q. Cannon, city engineer.

State of Missouri Plans 6,000-Mi. Highway System

PLANS are being made for the establishment of a 6,000-mi. system of state highways in Missouri, as provided by the McCullough-Morgan amendment to the Hawes road law which went into effect in March, 1919, and which required that this system be designated by the state highway engineer (subject to the approval of the state highway department), and be surveyed within three years.

This law provides that the roads are to be distributed among the 114 counties of the state in proportion to their areas and mileage of county roads. Due regard is to be given to directness and continuity of routes, low grades, economy of construction and maintenance and the needs of the people of the country, but no county is to have less than 50 mi. of state roads.

State or Federal aid to the extent of $1,200 per mile is made available for the purpose of road improvement, and of constructing culverts and bridges of 20-ft. span and under. Where the cost of grading and draining a road exceeds $1,200 per mile, or when a better road is desired, the law allows the additional amount to be shared equally by the local authorities and the Federal Government. Where the cost of grading and construction of culverts and bridges exceeds $1,200 per mile but the local authorities are unable or refuse to provide the necessary additional money, the law allows the state highway department to concentrate money due for these roads and to construct such mileage as is deemed advisable. Up to August, 1920, surveys had been made for over 4,000 mi., and complete plan submitted for 1,730 mi.

LAYING 30-IN. CAST-IRON PIPE WITH STEAM SHOVEL

Design of the 37,500-Hp. Turbines at Niagara

Hydraulic Features of the 100,000-Hp. Addition to the Hydro-Electric Power Plants on the American Side of the Great Falls—Designs of the Two Types of Turbines

The general features of the 100,000-hp. addition to the plant of the Niagara Falls Power Co. were given in an article in "Engineering News-Record," Sept. 23, 1920. In the following article the hydraulic design of the plant is treated by George R. Shepard and N. R. Gibson, engineers of the company, and W. M. White and Lewis F. Moody, engineers, respectively, for the two companies which designed and built the huge turbines, at this time the largest in the world.

Hydraulic Problems of the Design

By George R. Shepard and Norman R. Gibson
Assistant Chief Engineer Hydraulic Engineer
The Niagara Falls Power Co., Niagara Falls, N. Y.

EXPERIENCE of the power company in former developments at Niagara led to the adoption, in 1906, of the horizontal shaft units for the plant then being designed. However, in 1916, when most of the preliminary engineering on the extension to Station No. 3 was undertaken, the Kingsbury and General Electric thrust bearings had reached a stage of perfection that eliminated the engineering problem in connection with the supporting of the weight of the rotating parts of the unit. These mechanical difficulties having been eliminated, the efficiency of the unit became the deciding factor, and vertical units were used as offering the best opportunity for the development of a high efficiency. The surface elevation of the water in the lower river fluctuates through a vertical range of about 30 ft., so that the vertical unit offered the only means of getting the waterwheel runner low enough to get the full benefit of the low-water stages, and at the same time have the electrical machinery high enough to be safe from damage during high-water stages. The available head obtained by this arrangement varied from 210 to 220 ft., the mean being 215 ft.

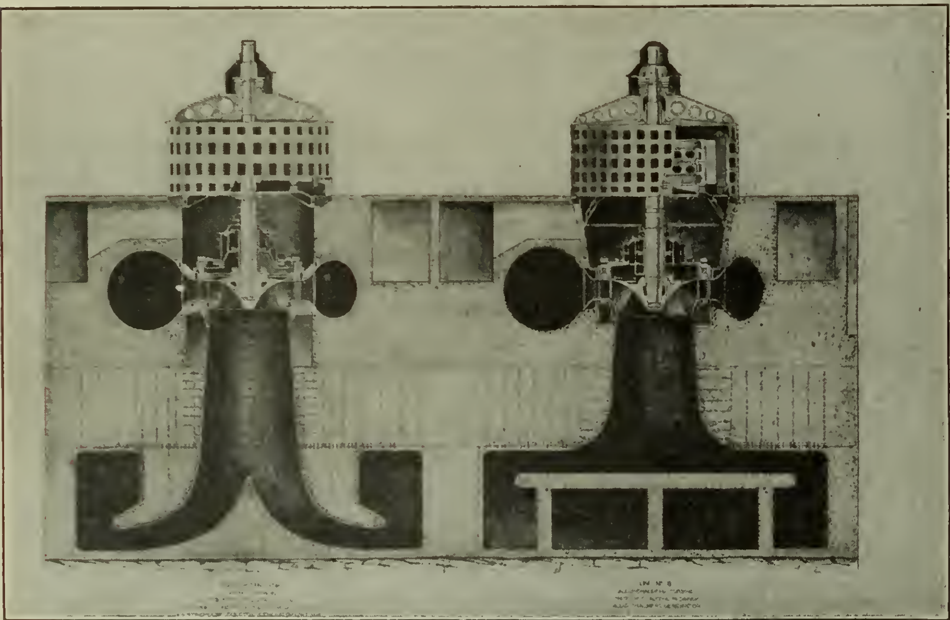


FIG. 1. SECTIONS THROUGH THE NEW NIAGARA TURBINES

Having determined the head, the maximum safe specific speed for the Francis type of runner was at once known, and gave a rough idea of the limitations of speed and load for each unit. There was available for development 4,400 sec.-ft., and the problem was to determine the number and size of units which would most efficiently develop that amount of water. Consideration of this feature and the rough limitations set by the specific speed, led to the selection of three units as the proper number to use. The fixed number of units led directly to the point of maximum efficiency for each single unit, which was set at the point of use of 1,500 sec.-ft. The experience of the waterwheel builders was that in order to arrive at this result it would be necessary to design the wheels for a maximum output of from 10 to 12 per cent in excess of the point of maximum efficiency. The builders further agreed that with the hydraulic efficiency naturally to be expected, this maximum output would be 37,500 hp. The combination of this maximum output with the specific speed and the periodicity of the current to be generated fixed the speed of the unit at 150 r.p.m.

Hydraulic Design and Efficiency

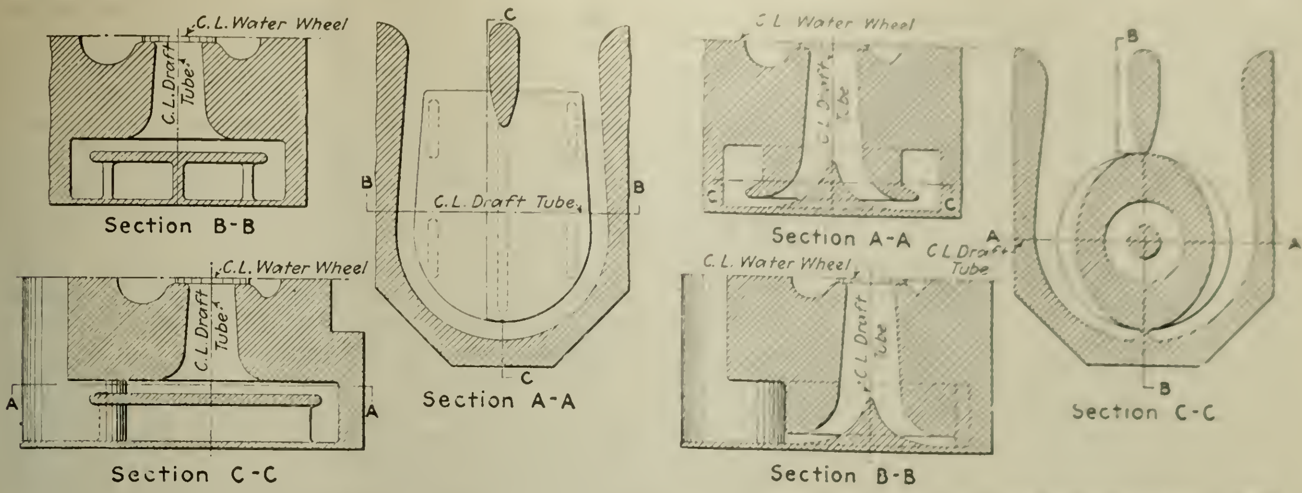
Efficiency was the underlying principle upon which the design was based, and to this end hydraulic losses were reduced to a minimum by providing large and easy waterways and by special attention to some details which frequently are not so carefully considered and which are treated more fully below.

The nominal velocities in the various waterways were as follows:

Canal	4.5 ft. per sec.
Forebay	1.5 ft. per sec.
Through tracks	1.8 ft. per sec.
Penstock entrances	3.0 ft. per sec.
Penstocks	8.0 ft. per sec.
Entrances to turbine gates	17.3 ft. per sec.
Top of draft tube	20.0 ft. per sec.
Exit from draft tube	5.0 ft. per sec.
Tailrace	3.5 to 4.5 ft. per sec.

The resulting hydraulic losses from head water to tail water, exclusive of turbine efficiency, has been found to be approximately 9.65 ft. at normal load, or 0.3 per cent of the total average head available. The net hydraulic efficiency of the plant, including turbines, is 92.5 per cent.

Having determined the over-all characteristics of the installation, the first minor problem to obtain consideration was that of the proper shape of the draft tube.



DETAILS OF WHITE'S HYDRAUCONE REGAINER (ON LEFT) AND (ON RIGHT) MOODY'S SPREADING DRAFT TUBE

The company's engineers had done considerable pioneer work along this line for a period of some twenty years, but neither their experience nor the literature on the subject appeared to point to the proper solution of the problem. The function of the draft tube is twofold; one, to utilize the static head between the bottom of the waterwheel runner and the surface elevation of the tailrace, and the other to regain as much of the discharge velocity head as is possible. Preliminary designs of the runner indicated a discharge velocity of between 18 and 20 ft. per sec., which represents a substantial part of the entire head.

Two Kinds of Draft Tube

The ideal draft tube would be a straight tube of uniformly enlarging cross-section, the expansion angle being in the neighborhood of 4 deg. This ideal shape is impracticable in most installations on account of the prohibitive cost of the excavation required. It was necessary, therefore, to determine some form of tube which would accomplish the same purpose in a much shorter vertical distance.

In collaboration with the designers of hydraulic turbines, considerable attention was given to the design of draft tubes, and after experimenting with about twenty-five draft-tube models of various designs, two types were finally adopted, and constructed in the power-house foundations. These are shown in Fig. 2, one being the hydraucone invented and patented by W. M. White, of Milwaukee, and the other the spreading draft tube patented by Lewis F. Moody, of Philadelphia. The efficiencies of these two tubes, as shown by Fig. 3, were practically the same, and both gave results which were far in excess of the efficiencies of any other model of equal dimensions.

The effect of these draft tubes is to maintain flow parallel to or radially from a central axis, with a gradual diminution of velocity until the velocity of discharge is finally reached. Such designs allow free play for the whirls in the water as it leaves the runner until the velocity of whirl has been greatly reduced. Large losses which occur when the direction of flow changes are thus prevented. The passages are also designed so that the hydraulic friction losses throughout the tube are reduced to a minimum.

As far as can be ascertained, the adoption of these draft tubes has been fully justified by the results attained, such as a direct gain in efficiency and the freedom from excessive vibration of the machinery.

The efficiencies of the hydraulic turbines were given particular consideration, but no guarantees were exacted from the manufacturers. Instead, each manufacturer agreed to furnish a turbine which would have the highest efficiency that it was possible to attain under the existing state of the art of turbine building. With this ideal before them, it is certain that each builder has put into his work the best design, material and workmanship of which he was capable.

New Method of Testing Wheels

Provision for testing these wheels in place was made by building a testing chamber so that pitot tubes and other equipment might be readily installed. It is expected that tests of the wheels may be made by using pitot tubes and chemical gagings, but up to the present, for various reasons, it has not been possible to have such tests carried out. Complete efficiency tests have been made, however, by a new indirect method recently invented by N. R. Gibson. This method, sometimes called the "pressure-time process" utilizes the principle governing the relation between velocity destroyed and rise of pressure, and by means of specially designed apparatus, patents for which have been applied for, there is produced a diagram, called the pressure-time diagram, from which the mean velocity in the conduit may be calculated. The apparatus is attached to a small piezometer tube tapped into the wall of the penstock at any convenient point, and records with respect to time, on a sensitized film or paper, the changes of pressure that occur in the penstock. The changes of pressure are produced by the simple process of closing the turbine gates, or, in this case, the Johnson valve.

The procedure for a test by this method may be briefly described as follows: The turbine gates are put on hand control, and steady conditions of load on the unit are maintained for several minutes until the flow in the penstock has become as uniform as possible. Readings of headwater and tailwater elevations are taken in the usual manner, and the pressure head at the entrance to the turbine gates is observed by gage or piezometer, so that allowances may be made for the loss of head in the penstock. Measurements of the generator output are taken by calibrated watt-

meter and auxiliary instruments, and, if the unit is separately excited, ammeter and voltmeter readings of the exciting current are also obtained. When conditions have been steady for several minutes, the turbine gates are closed gradually by operating the hand-control pilot valve. During the closure the load thrown off the generator is taken up by the other units operating in synchronism with it. At the same time the Gibson apparatus makes its record of the changes of pressure that occur in the penstock. From such a record may be calculated the mean velocity of the water in the penstock prior to the shutdown. Having determined the velocity, the discharge is readily computed, and after allowing for the known efficiency of the generator, the turbine efficiency is calculated in the usual manner.

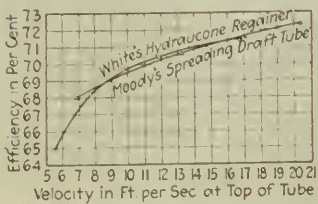


FIG. 3. EFFICIENCIES OF SPECIAL DRAFT TUBES

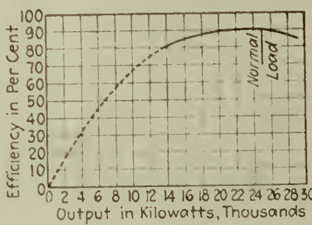


FIG. 4. EFFICIENCY DIAGRAM FOR STATION NO. 3

From these tests it has been determined that the turbine efficiencies are in excess of 80 per cent from half gate to full load, reaching in each case a maximum of 93 per cent. The average combined efficiency curve including losses in penstock, Johnson valve, turbine and generator, is shown in Fig. 4. From this curve it will be noted that at normal load the efficiency from forebay to switchboard is 90 per cent.

Details of the I. P. Morris Unit

By Lewis F. Moody

Assistant to Vice President and Consulting Engineer, William Cramp & Sons, S. & E. B. Co., Philadelphia, Pa.

Two of the three turbine units in this installation were furnished by the I. P. Morris Department of The William Cramp & Sons Ship & Engine Building Co. These units involve in their design the most recent developments in this field of engineering, and include a number of interesting departures from previous practice. Every effort has been made by the builders of the turbines to provide the greatest possible reliability in operation and maximum obtainable efficiency.

The turbines are of the vertical shaft single-runner type, having cast-iron volute casings imbedded in the concrete of the power-house substructure. They operate at 150 r.p.m., and are designed to develop maximum efficiency when operated under an effective head of 213.5 ft. and discharging 1,500 sec.-ft. of water.

Taking up first the hydraulic features, it may be noted that the engineers of the power company working in co-operation with the engineers of the turbine builder have exercised every care to provide an efficient water passage from the point of entrance from the forebay into the penstock to the final point of discharge of the draft tubes into the tailrace. Preliminary tests have shown a very small loss of head in the penstocks, and indicate that excellent hydraulic conditions have been secured at all points in the water passage.

Before entering the turbine the water passes through a large Johnson valve. In passing through this valve the velocity of the water is gradually increased, the penstock diameter being reduced at the outlet of the valve to a value equal to the diameter of the inlet to the turbine casing so that the velocity of discharge from the Johnson valve is maintained at a constant value between the valve and the turbine. Owing to the construction of the turbine casing of cast iron, it has been possible to preserve smooth surface contours for the internal surfaces of the casing and to avoid all local disturbances in the flow due to abrupt changes of direction or irregular surfaces.

The diameter of the intake to the turbine casing is 10 ft. 6 in., involving a velocity of 17.3 ft. per sec. and a velocity head of 4.66 ft., which represents 2.18 per cent of the effective head of the turbine. The casing is designed for a gradual acceleration of velocity as the water passes around the volute. The casing is stayed across the distributor by ten curved vanes cast integrally in a cast-steel speed ring forming a part separate from the casing and built in halves. The vanes of the speed ring line up with alternate guide vanes, when the guide vanes are in the normal gate position corresponding to maximum efficiency. There are twenty movable guide vanes or wicket gates.

Spreading Draft Tube

After passing through the runner, the water enters a straight conical draft tube of cast iron built in sections. From the lower end of the cast-iron section of draft tube the remainder of the tube is molded in the concrete substructure.

The draft tube is of a new type, the "spreading draft tube." The design of this tube has been carefully calculated and verified by many tests of experimental models both under conditions of smooth streamline flow in the water entering the tube and under the actual conditions of flow experienced when the discharge is received from a runner. In the design of this tube it has been the object to turn the water as smoothly as possible along paths of gradual curvature from the vertical to the horizontal direction, and to preserve symmetry about the turbine axis to a point where the velocity has been reduced to so low a value that only a small amount of velocity head remains in the water. Care has been taken to maintain a gradual decrease in the velocity by properly varying the transverse area of the passage at all points in the tube, in order under all conditions of operation to avoid the formation of eddies or disturbances at any point in the stream.

In many earlier installations under high and medium heads, particularly those involving long penstocks, the use of elbows in the draft tubes has resulted in severe vibration of the water column in the penstock and turbine. This vibration is believed to be due to the formation and breaking down of eddies in the draft tube. Another advantage of the form of tube used is the ability of such a draft tube to regain the energy of whirling components of velocity in the water leaving the runner. This property of the tube is of value in increasing the efficiency under partgate and overgate conditions, and in increasing the margin of power beyond the point of maximum efficiency of the turbine. Preliminary tests of the turbine indicate that both of

these advantages have been realized, and in actual operation the unit is remarkably free from vibration of any kind at all gate openings.

Cast-Iron Runners and Casing

The turbine runners are of cast iron, each one being in one piece. The runners are 10 ft. 6 in. in diameter in inflow. The specific speed of the runners is 158 metric or 35.5 in the foot-pound system. The throat of the runner or the diameter inside of the band is 9 ft. 10½ in. At normal discharge the corrected velocity of the water leaving the runner and entering the draft tube is 21.3 ft. per sec., corresponding to a velocity head of 7.0 ft., or 3.3 per cent of the effective head on the turbine.

Although the most valuable feature of the new draft tube is probably the elimination of vibration just mentioned, it is also estimated that this tube will improve the efficiency over that which could be obtained with tubes containing elbows by from 0.3 per cent to 0.4 per cent in the efficiency of the entire turbine under conditions of normal gate operation. The same type of draft tube when applied to turbines of high specific speed would, of course, be capable of producing much greater increases in efficiency than is possible in these turbines, which are of moderate specific speed. The final discharge velocity from the draft tube at normal gate is approximately 5 ft. per sec., corresponding to a velocity head of 0.175 per cent of the effective head on the turbine.

The turbine casing is of cast iron built in six sections. The use of a cast-iron casing, although involving a somewhat increased cost as compared to the use of plate steel, furnishes a superior design in the following repects: The casing is absolutely rigid and can be imbedded in the concrete so as to form a part of the substructure, and can be relied upon to transmit the loads imposed upon it without distortion. The resistance of cast iron to corrosion insures a long life for the casing, which is a matter of importance since the casing could never be replaced without dismantling all of the surrounding concrete substructure. The casing can be depended upon to be tight throughout the life of the plant, and there is not likelihood of local points of weakness being developed as in the case of a riveted structure. The casings have been subjected to hydrostatic pressure tests in the shops to a pressure of 120 lb. per square inch., which is well in excess of any presure to which the casings can be subjected in operation during a quick grate closure resulting in water hammer. Another advantage of a cast-iron casing is the ease and speed with which it can be erected in the field. The heaviest section of the casing weighs slightly less than 60,000 lb.

The movable guide vanes are of cast steel, cast integrally with their stems. The guide-vane stems turn in bronze bushed bearings in the distributor plates and head cover.

Operating and Lubricating Mechanism

The operating mechanism is unusually rugged throughout, the guide-vane stems being of large diameter, the cast-steel operating ring extremely rigid; and the levers and other parts of the mechanism being made sufficiently strong to render the failure of any portion of the mechanism an unusual occurrence even when trash becomes lodged between two guide vanes and the entire governor power is concentrated on two vanes. Renewable breaking links are provided to protect the other parts of the mechanism in case undue load should occur. The operating ring is supported on a ball bearing. It is turned by two operating cylinders which are bolted to pads or brackets cast on the turbine casing, thus making the entire operating mechanaism self-contained with the turbine. The connecting rods between the operating ring and pistons are provided with adjustable ends of similar design to the connecting-rod ends used in steam-engine practice so that any wear may be taken up and lost motion avoided in the operating mechanism. The piston rod is provided with a bronze sleeve where it passes through the stuffing box in the cylinder head, and the rod is guided by a bearing supported in a guide bracket bolted to the cylinder.

For the lubrication of the operating gear, the Taylor system of lubrication is used, consisting of a central grease gun supplying a system of piping leading to each individual bearing, so that the admission of grease or oil can be controlled to each bearing individually by turning a separate cock at each bearing, the lubricant being forced into the bearing by air pressure admitted to the grease gun.

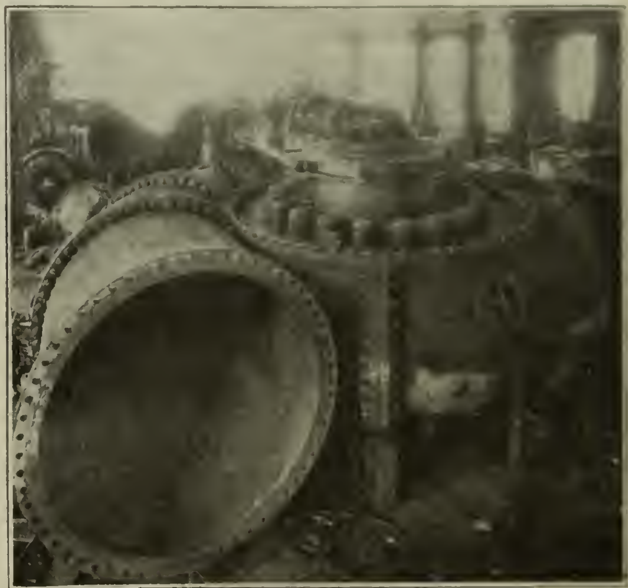


FIG. 5. I. P. MORRIS TURBINE ERECTED IN SHOP

A special design of runner seals have been used to reduce the leakage around the runner and to assist in making the thrust relief effective. The seals are of the multiple or labyrinth design in which a series of contractions are interposed in the path of the leakage water alternating with enlargements in which the velocity of the leakage flow produced eddies and reduces the quantity escaping. This provision although affecting only a small percentage of the total energy when the turbine is new will be of material advantage in preventing a serious deterioration in efficiency after the unit has been some time in operation. The leakage above the runner passes through a cored space in the turbine head cover and is vented through the runner hub, discharging into the center of the draft tube. The seals are formed in renewable wearing plates.

The distributor plates above and below the movable guide vanes are also renewable. At discharge from the runner the draft tube is lined with a renewable ring which may be replaced if corrosion should occur during the life of the unit.

The main shaft of the turbine is supported by a lignum-vitæ guide bearing in the turbine-head cover, and the shaft is provided with a renewable bronze sleeve where it passes through the bearing, seal and stuffing box. The bearing shell is split both horizontally and vertically to facilitate its removal. The equipment furnished with the turbine includes a set of brakes arranged to act upon the lower face of the generator rotor. These brakes consist of a series of shoes actuated by plungers, operated by air pressure. The operation of the brake is controlled from a cock mounted on the hand-control stand located close to the governor.

Governor Regulation

The turbine is regulated by a governor of the I. P. Morris double floating-lever type, belt driven from the main shaft of the turbine. The governor proper or the actuator and the separate hand-control stand are located on the gallery at the elevation of the thrust bearings mounted on top of the generators. The unit can therefore be operated from this point.

In order to avoid running a number of lines of the large governer piping from the operating cylinders up to the gallery with a consequent increase in the length of fluid column between the governor and the cylinders, resulting in increased inertia of this fluid column, the main governor valves are separate from the governor and placed on the level of the generator-room floor so that they are immediately above the operating cylinders.

The Taylor control system is used with these units. This involves the use of fluid-operated plunger valves of the Johnson type, by the operation of which the operating cylinders can be connected to either the governor or to the hand-control system. The plunger valves are located in a common casing with the main governor valve, which is located directly below the actuator, and the same casing supports a lower guide bearing for the governor spindle. All of the valves for shifting from governor to hand control and back again are controlled by a single lever mounted on the governor stand on the gallery. By a single throw of this lever a special control cock is operated which admits pressure to the plungers of the various Johnson valves and properly shifts the pressure and return connections from governor to hand control or vice versa. By this system, failure of the operators to manipulate the valves in proper sequence is avoided, thus avoiding loss of control of the unit between the time of its being taken off the governor and put on hand control. The entire operation can be carried out very quickly, which is frequently a matter of importance in station operation, and all loss of time required to open and close the series of valves by hand is avoided.

The separate hand control provided in addition to the governor contains separate valves and restoring mechanism by which the turbine gates can be operated through the pressure system, the gates being automatically maintained in any position corresponding to the setting of the hand wheel. By this means the unit can be operated on hand control with the governor and all of its valves thrown out of operation and made available for inspection and repair. A clutch is provided by which the governor head may be put out of operation without shutting down the unit so that all parts of the centrifugal mechanism can be made accessible. The centrifugal governor head is extremely powerful and is not influenced by slight changes of friction of the governor parts or other variation of conditions.

Among the members of the Cramp company's organization who have been responsible for the design of this turbine installation may be mentioned: H. Birchard Taylor, vice-president; John Overn, Jr., manager, I. P. Morris Department; Frank H. Rogers, hydraulic engineer; and R. E. Brunswick Sharp, assistant hydraulic engineer.

Design of the Allis-Chalmers Unit

By W. M. White
Manager and Chief Engineer, Hydraulic Dept., Allis-Chalmers Mfg. Co., Milwaukee, Wis.

THE hydraulic turbine forming Unit No. 16 of the extension to Station No. 3 is rated at 37,500 hp. when operating at the normal speed of 150 r.p.m. under the normal operating head of 214 ft. and is designed to use 1,500 sec.-ft. when operating at best efficiency. The unit has recently been put under full load and actually develops at normal head and speed a capacity of 40,000 hp.

Unit No. 16, which is the first one installed and the first placed in operation, was designed and built by the Allis-Chalmers Manufacturing Co. at Milwaukee, Wis. Since the design of the entire Allis-Chalmers hydro-electric unit was under the control of a single group of engineers it was possible to consider the structure properly as a homogeneous unit and correctly proportion and correlate the various elements. Such procedure was followed so that the completed machine possesses a unity not frequently met with in hydro-electric practice.

The design of the turbine embodies several new features of interest to water-power engineers, particularly the form of casing, governor, interconnecting barrel, brake support and draft tube used.

The water for the units in the new station is taken from the old Hydraulic Power Co. canal and is delivered to the unit through a 15½-ft. diameter penstock and controlled by Johnson valve located near the turbine. The discharge diameter of the Johnson valve is 10 ft. and to this is connected a short section of the feeder pipe which increases in diameter to 11 ft. at the entrance to the plate-steel circular section spiral casing surrounding the turbine and supplying water through guide vanes to the runner. The casing is made up of a multiplicity of conical sections of plate steel of gradually reducing cross-sectional area around the turbine. The plates are riveted to the flanges of a cast-steel speed ring which forms an integral part of the casing and the foundation of the turbine parts. The thickness of the plate steel of the casing at the 11 ft. diameter is ⅞ in. This thickness is reduced gradually to ½ in. at the smallest section of the casing. The roundabout seams of the casing are lap joint, double riveted and the longitudinal seams are lap joint, triple riveted, while the connection at the ends of the

plate to the cast-steel speed ring is made by a triple row of rivets. The rivets are countersunk on the inside.

Plate-Steel Casing

Fig. 6 gives a view of the casing as erected in power house. There are about six thousand rivets in the casing which were driven by a No. 90 air hammer. The heads were formed by 1⅛-in. by 1¾-in. snaps. The casing was calked inside and outside. It was concreted in without an hydrostatic test. No leaks of any kind have developed about the casing. Those who are familiar with plate-steel work will readily understand that plate thickness of 1¼ in. can be readily worked so that a casing substantially of the size shown could be designed and constructed for heads up to 350 ft. without unduly stressing the material or sacrificing tightness and without going beyond normal practice obtaining in plate work of this nature. Above all, however, all uncertainties as to casting strains are eliminated and only strictly dependable material used. On account of the simplicity of the construction and low cost relative to cast iron this casing was made larger in diameter so as to reduce losses due to friction, thereby tending toward higher turbine efficiency.

Water is controlled from the casing to the runner by means of twenty cast-steel guide vanes. Each vane has pivots on each end for the support of the vane and for controlling its position. Each vane is operated by means of a lever secured to the extended pivot through a link connecting to the shifting ring located on the outside of the turbine. Each guide vane is held in position by two thrust bearings, one supporting the weight and the other resisting the upward hydraulic thrust of the stem through the stuffing box when the unit is in operation.

The thrust bearings are so adjusted that the guide vane is held in a central position between the distributer plates with fixed and equal clearances on each end of the vane; consequently there is no friction and no wear between the ends of the vanes and the distributer plates.

A stuffing box is provided about each vane stem and water is thereby prevented from flowing through the bronze bearings supporting the vane—a specially desirable feature in that silt and sand which would tend to rapidly wear the main supporting journal is not carried between the surfaces by leakage. Levers are keyed to the vane stems and attached to the shifting ring through an adjustable connection and links having a cross-sectional area so proportioned as to fail before a guide vane or its stem is strained beyond its elastic limit should a guide-vane passage become obstructed. Heavy plate-steel wearing plates line the distributer plate at each end of the guide vanes. Wearing bushings are embodied on the upper and lower distributer plates opposite corresponding wearing rings placed on the upper crown plate and the lower band of the runner.

Runner of One Casting

The runner is of grey iron in one casting made by means of fitted cores and is bolted to a cast-iron hub which is keyed to the tapered end of the turbine shaft and held in place by ring, key and keeper. Either a taper connection as here used or a forged flange on the end of the shaft upon which the runner is mounted makes a good construction, but where a water bearing is used, with a bushing on the shaft, the construction here used is the better one, as it enables the bushing to be made solid and therefore of less thickness and results in the lower peripheral speed for a given unit. The diameter of the shaft at the turbine guide bearing is 28 in.

The turbine guide bearing consists of lignum vitae fitted into cast-iron blocks having the end grain of the lignum vitae toward the shaft. The bearing of this unit is 5 ft. in length and is made in two parts for convenience in dismantling and ease of handling. The bearing is lubricated by water supplied from the head race through fine strainers. Connection is also made

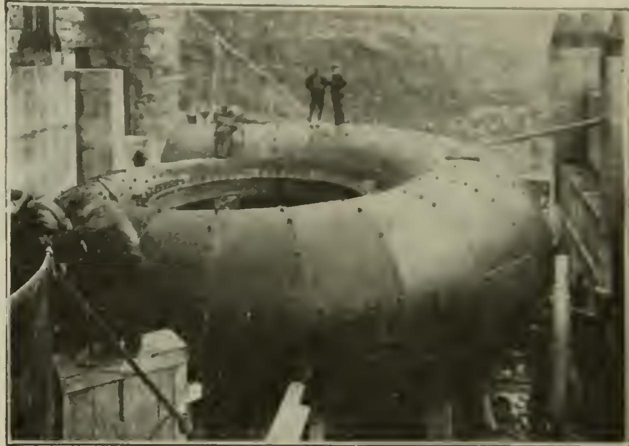


FIG. 6. ALLIS-CHALMERS TURBINE CASING ERECTED IN POWER HOUSE

to the city mains for use of filtered water during times when headrace water contains considerable silt and sand.

A feature which distinguishes Unit No. 16 from the other units is the cast-iron pit liner forming the turbine pit and transmitting the weight of the generator through this pit liner directly to the speed ring and through the vanes of the speed ring to the foundation. From a mechanical and design standpoint the value of this barrel can hardly be overestimated, tying together as it does all the major elements in which forces originate and from which they have to be transmitted. Interalignment of main working elements, i.e., generator, turbine and regulating cylinders, is permanently insured regardless of the behavior of the surrounding concrete.

The guide vanes of the turbine are controlled by means of water pressure on two pistons connecting to opposite sides of the shifting ring, inclosed by cylinders, mounted directly on the outside of the supporting barrel or pit liner. The mounting of the operating cylinders on the outside of the pit liner is unique and affords a clean design of the pit, as it keeps the governor pipes outside of the turbine chamber. This feature of design enables the cover-plate of the turbine to be removed by merely removing the pistons and crossheads and without disturbing the cylinders and governor piping.

An interesting feature of design is the governor equipment especially designed for this unit. The guide vanes are shaped to cause the smoothest flow from the casing to the runner and the position of the stems on the guide vane body is such that the vanes will be

in hydraulic balance when about one-third open. They will require considerable force to close the vanes from that point and considerable force to hold them in wide-open position under the high velocity of the water between the vanes, but both forces are minimized. The operating cylinders are 32 in. in diameter and the governor is designed for a normal operating pressure of 125 lb. so that the two pistons are capable of exerting 150,000 ft.-lb. when moved the full stroke from one end of the cylinder to the other. With a difference between the sides of the pistons equal to an operating pressure of 200 lb. and consequently by the usual method of rating governors, the governor of this unit has a capacity of 240,000 ft.-lb.

The operating pressure to the cylinders is controlled by means of a four-ported 12-in. diameter piston valve located in the governor stand. The pipe connecting the ports from the piston valve to the operating cylinders is 6 in. in diameter. This large diameter valve is necessary so that an axial motion of the valve of ½ in. will at normal pressure afford the area of opening required to pass sufficient water to force the operating pistons from one extreme to the other in two seconds of time. The main piston valve, above described, is moved axially by varying the pressure on each end of its body by means of another four-ported 3½-in. diameter piston valve and this piston valve in turn is moved axially by varying the pressure on each end of it by a ⅞-in. diameter pilot valve. By means of the smaller piston valve the size of the pilot valve and consequently the force to be exerted by the flyball is materially reduced over what it would have to be were the valve omitted.

The edges of the ports and the edges of the piston valves and the pilot valves are so carefully made that under normal operating pressure that is practically no lost motion between the axial motion of the pilot valve and the axial motion of the main piston valve. Under slow motion of the pilot valve the main piston valve will follow with a lag of less than 0.01 in. and under the axial movement of the pilot valve of ⅛ in. in 0.01 in a second the maximum lag of the main piston valve would not exceed 0.02 in. By thus reducing the size of the pilot valve the force required to move it has been reduced to such an amount that it does not exert sufficient force upon the flyball mechanism to prevent the flyballs taking up their exact position corresponding to the speed of the unit.

It was thought that a turbine of this magnitude should be equipped with a flyball mechanism steady, positive and as near frictionless as possible. The directly connected flyballs embodied in the design of this turbine have met these conditions. The flyball mechanism consists essentially of a fixed collar clamped around the main turbine shaft and a movable collar held in position and away from the shaft by four sets of ball-baring toggle joints located 90 deg. from each other. Two sets of toggle joints as incorporated in the design act as flyball weights. The outward motion of these sets is resisted by two adjustable springs being connected through ball bearings to each of the sets. Every toggle is fitted with a type of ball bearing preventing axial motion and consequently each set of toggles prevents endwise motion of the floating ring with respect to that set of toggles and as the two sets of toggles are at 90 deg. the movable collar is rigidly supported and prevented from moving in any direction except axially with respect to the main turbine shaft. It is a unique feature in governor flyball design that the floating collar has no support except through the motion giving mechanism. This design of flyball, therefore, affords a means of imparting to the pilot valve such motion as is caused in the flyball by the variation in speed of the main turbine shaft and thus is avoided the disturbing motion introduced by belts and gears when the usual type of flyball is used. The motion of the movable collar located around the main shaft is transmitted to the pilot valve by means of levers, reach rods through sliding shoes resting upon an oil-inclosed bearing surface at the upper side of the movable collar.

The governor has been adjusted to close the turbine gates from wide open to completely closed in three seconds of time and to open them from closed to wide-open position in four seconds of time. It is expected that the rise of speed with 40,000 hp. suddently thrown off the unit will not exceed 25 per cent. The regulation of the unit and the normal load conditions are remarkably steady and positive.

Hydraucone Draft Tube

The engineers of the Allis-Chalmers Manufacturing Co. at the time of first putting this unit into operation made a remarkable demonstration to show their confidence in the apparatus. The initial start of the unit was made solely from the station switchboard by closing the switch operating the control motor on the governor which moved the pilot valve causing the main turbine gates to open. This admitted water from the casing to the runner setting the unit in motion. When the unit had attained a speed of 90 r.p.m. the weights of the flyballs came into play and manipulated the pilot valve and regulated the unit perfectly at that speed. Without any adjustment in the governor being made the governor motor was manipulated from the switchboard and the unit brought up to a speed of 150 r.p.m. within ten minutes of the initial starting. The governor regulated the unit positively, steadily and perfectly under that speed.

One of the greatest losses in hydraulic turbines is in the energy discharged from the runner. Efforts have heretofore been made to utilize this energy by transforming the velocity into pressure for maintaining below the runner greater vacuum than would normally result due to the elevation of the runner above tail water level, and thus in effect increasing the effective head on the turbine. The size of units in water-power development have been increased until the diameter of the runner is large compared to the distance from the runner to the tail water level so that in large units it has not been found feasible to design the draft tube on account of the short radius of bend which will most efficiently utilize the energy discharge from the runner with an excavation of tailrace such as the owner is usually willing to make.

In Fig. 2 is an illustration of one form of "hydraucone regainer."

The word "hydraucone" has been coined to express the shape which a jet of water takes upon striking any given surface and includes the form from the point where this stream begins to make its turn to the end of the curvature. Consequently a hydraucone regainer

was used which is a chamber having a general form which the jet of water would take upon striking the impinging surface except that the capacity of the chamber is gradually greater in area in the direction of flow than that required to just close the hydraucone. The radially extending passage also affords a means of regaining for useful effect the whirl of the water as it leaves the runner at partial loads. It is not within the scope of this article to discuss at length the hydraucone.

This unit has not been in succesful operation for a sufficient length of time to show that all of the new elements embodied in its design are working as planned and that the complete unit is an unqualified success.

Crushing Strength of Southern Pine at Angles to Grain

By Q C. Ayres

Assistant Professor in Civil Engineering, University of Mississippi, Oxford

PRACTICALLY all designs in wood involve problems vitally dependent on the compressive strength of timber on surfaces oblique to the fibers. There is marked disagreement, however, as to the behavior of the wood under such compression. A series of tests recently conducted at the University of Mississippi on specimens of Southern pine gives data tending to clear up the existing uncertainties.

Southern yellow pine, or Southern pine, as it is called under the modern standard classification, includes the pines hitherto known as long leaf (*Pinus palustris*), short leaf (*Pinus echinata*), loblolly pine (*Pinus taeda*), Cuban pine (*Pinus heterophylla*), and pond pine (*Pinus aerotina*). The test specimens, cut from pieces selected from a dealer's stock, probably included wood from several of these species, but the consistency of the results obtained in the tests indicates that all Southern pines behave substantially alike in the matter of variation of crushing strength with direction of loading.

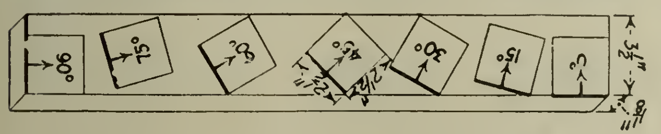


FIG. 1. CUTTING SEVEN TEST SPECIMENS FROM A STICK

Stock pieces were used for the tests in order to reproduce as nearly as possible conditions met in practice. From each stick, dressed to about $3\frac{1}{2}$ x $1\frac{1}{8}$ in., seven blocks $2\frac{1}{2}$ x $2\frac{1}{2}$ x $1\frac{1}{8}$ in. were cut as indicated in Fig. 1, each of the seven having its test axis at a different angle with the grain, these angles being 0°, 15°, 30°, 45°, 60°, 75° and 90°. The specimens were dressed on all four sides. The sticks from which they were cut rated 70 per cent heart and 30 per cent sapwood, were free from all visible defects, and were thoroughly air-seasoned. It was found that their average moisture content was 8.15 per cent, the weight of the wood 35 to 42 lb. per cubic foot, the density 7 to 14 rings per inch, and the percentage of springwood 70 to 90 per cent.

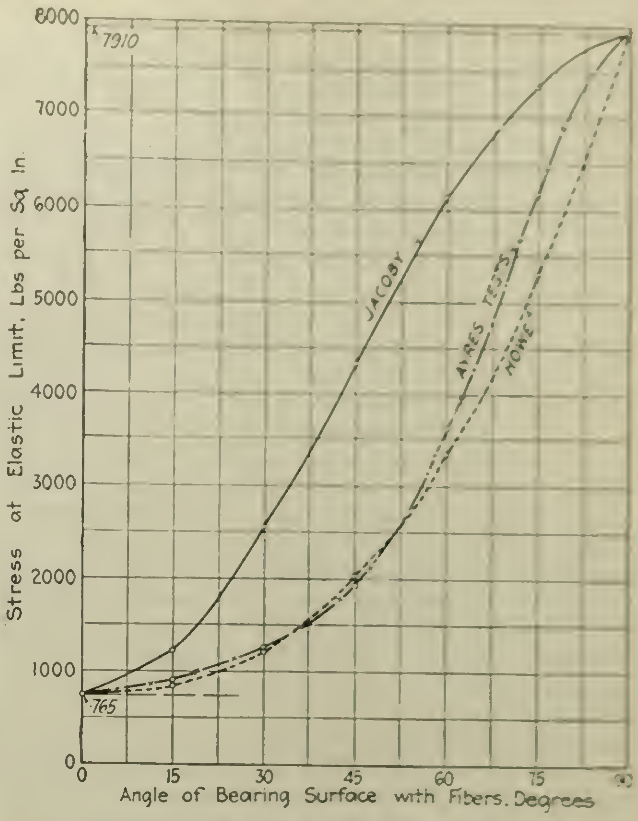


FIG. 2. RESULTS OF TESTS ON SOUTHERN PINE AND PLOT OF JACOBY AND HOWE FORMULAS FOR SAME TERMINAL VALUES

These test blocks were crushed in a 50,000-lb. Olsen hydraulic testing machine. Load was transmitted directly to the wood by the spherical bearing plate of the machine, and no deflectometer was used, as it was desired to avoid influencing the results by applying load over only part of the bearing face. The load at the elastic limit of the specimen was determined by observing the motion of the arrow on the dial of the testing machine. In each case the arrow responded to a uniform application of the load by a uniform advance on the dial until the wood began to yield, when it advanced fitfully (with more rapid application of the load) until final failure of the specimen. The value registered by the arrow at the point where its motion ceased to continue uniform was taken as the elastic limit load. These values are assembled in the accompanying table.

CRUSHING STRENGTH OF SOUTHERN PINE OBLIQUE TO THE GRAIN—AYRES

Angle of Surface with Fibers	Load at Elastic Limit—Pounds per Square Inch											Limiting Load by Formula	
	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8†	Set 9†	Set 10†	Mean	Jacoby	Howe
0°	694	703	742	731	721	654	700	1,023	806	873	765	(765)a	(765)a
15°	758	811	789	809	895	838	800	1,122	1,220	1,126	915	1,245	845
30°	937	1,102	1,011	987	1,219	1,176	1,067	1,557	1,714	1,818	1,260	2,550	1,235
45°	1,468	1,553	1,592	1,568	1,845	1,845	1,500	2,367	2,691	2,727	1,915	4,340	2,030
60°	3,717	3,425	3,678	3,048	3,905	3,412	2,881	3,491	4,275	4,296	3,615	6,125	3,360
75°	6,904	6,175	6,871	6,259	6,934	6,150	*	4,897	6,130	5,048	6,150	7,430	5,295
90°	7,908	7,718	7,922	7,710	8,448	8,664	*	7,636	6,580	8,582	7,910	(7,910)a	(7,910)a

* Results discarded; unreliable. † Sapwood. a Taken from test results and used as constants in the formula.

For the specimens tested parallel to the grain, the failure was by sliding along a plane oblique to the grain: *for all other specimens failure occurred by shear along a plane parallel to the fibers.*

Two formulas for the strength of wood oblique to the grain have been proposed, the first developed theoretically by Prof. H. S. Jacoby, the second derived empirically by Prof. M. A. Howe:

Jacoby, $n = p \sin^2\theta + q \cos^2\theta$

Howe, $n = q + (p - q)\left(\frac{\theta^\circ}{90^\circ}\right)^{5/2}$

where p = allowable intensity of stress in end bearing.

q = allowable intensity of stress in cross bearing.

n = allowable intensity of stress on a surface inclined at angle θ with the grain.

Values of n computed by these two formulas are appended to Table I. using average values of p and q as found from the tests (elastic-limit values). There is a fair agreement between the test values and those computed from the Howe formula, although the latter is based on load at a fixed deformation and not on elastic-limit load.

A better comparison of the test results and the formulas is presented by the curves, Fig. 2, representing the average values given in the table. It will be noted that Howe's formula gives values which err on the side of safety; in view of this fact, it may be considered the best and simplest expression that can be devised for Southern pine, and accordingly is recommended for use in dealing with that material.

At present working stresses of 350 lb. per square inch in cross bearing and 1,600 lb. per square inch in end bearing are commonly used. The present results would indicate that, pending further investigation, a decrease in the cross-bearing value and an increase in the end-bearing value are advisable, the amount of change depending on the factor of safety chosen.

Inclined-Bearing Tests on Douglas Fir and White Pine

By Thomas R. Simpson

Berkeley, Cal.

Because of the marked difference between the Jacoby and Howe formulas for permissible values of bearing pressure on wood when the surface is inclined to the grain, and because of divergences between the available test data, a new series of tests

FIG. 1. INCLINED BEARING AT TRUSS JOINTS

was made by the writer during the past year at the University of California. Douglas fir and California white pine were the materials. A rather remarkable result developed, namely, a close check with the Jacoby formula when the elastic-limit load was taken as criterion of permissible value, and approximate agreement with the Howe formula when a fixed depth of indentation was taken as criterion. The two woods behaved in substantially identical manner so far as the law of variation of load with angle of grain is concerned.

To indicate the importance of the subject, it may be remarked that the joint details of wooden trusses depend to a very great extent on the values adopted for inclined bearing pressure, as compared with those for end-grain and cross-grain compression. The formula of Prof. M. A. Howe, which incidentally is recommended in the latest edition of Kidder's Handbook, gives values considerably below those of Prof. H. S. Jacoby's formula, and in consequence some truss details are virtually impossible under the Howe formula, while they have satisfactory proportions under the Jacoby formula. Thus, referring to an end joint of the form sketched

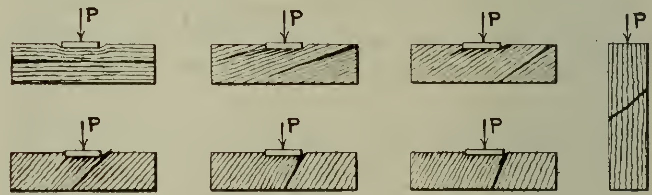


FIG. 2. MANNER OF FAILURE IN TESTS

in Fig. 1, with stresses as shown, each member made of an 8 x 8-in. stick, the depths of cut required under the Jacoby formula would be 4.87 in. in Type A and 3.86 in. in Type B; under the Howe formula, the depths of cut would be 8 in. and 5.23 in. respectively so that the proposed form of joint would simply not be feasible. There are other cases in which the formula used plays an almost equally important part, and in any event the design of washers, lugs, and other metal parts bearing on inclined surfaces is materially affected.

Referring to the origin of the two formulas, it should be said that the Jacoby formula was derived from theoretical considerations while Professor Howe derived his formula from tests, taking the values of loads giving a deformation of 0.03 in. However, in pure end-grain compression a load giving a deformation of 0.03 in. is considerably beyond the elastic limit for most woods, while in cross-bearing the load for 0.03-in. indentation is usually below the elastic limit.

To furnish a basis for choice between the two for-

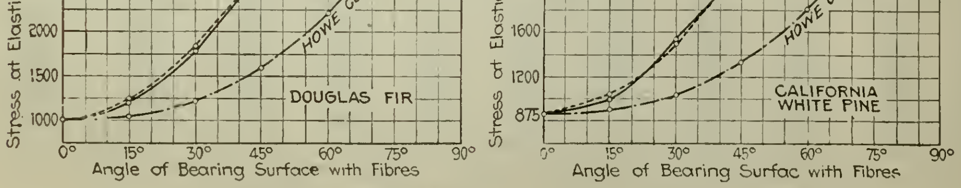


FIG. 3. ELASTIC LIMIT VALUES CHECK JACOBY'S FORMULA

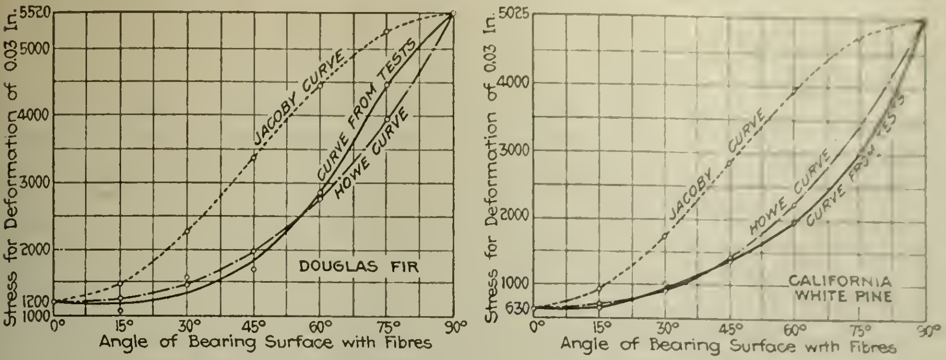


FIG. 4. CURVES FOR LOAD AT 0.03-IN. INDENTATION

mulas, specimens of douglas fir and of California white pine, 2 x 2 x 8 in., were used, all carefully selected for uniformity, and oven-dried for 24 hours to insure uniform moisture content. All wood was straight-grained and free from visible defects. Load was applied on the flat face of the specimen, but only over the middle 2 in. of length, the loading being done by a strip of ½-in. tool steel 2 x 12 in., laid across the specimen, directly under the pulling head of the machine. Thus an area of 4 sq.in. (out of 16 sq.in.) was loaded. Deformations were measured by a compressometer for the specimens in end bearing, and by a multiple-lever deflectometer in the other cases.

Stress-strain curves were plotted from the results of the tests, and the loads at elastic limit were obtained from these curves. Very satisfactory straight lines up to the elastic limit or yield point were obtained in practically all of the tests. Readings being taken at intervals of about 500 lb. load increment, the load for a deformation of 0.03 in. could also be read off accurately. Both resulting values are given in the tables herewith. Five specimens were tested for each angle of bearing, and the mean values are given; the variations recorded within any set of five were relatively small.

INCLINED-BEARING TESTS OF DOUGLAS FIR AND CALIFORNIA WHITE PINE

DOUGLAS FIR

Angle of Surface with Fibers	Mean Load at Elastic Limit, Lb. per Sq.In.	Allowable by Jacoby Formula	Allowable Load by Howe Formula	Mean Load for 0.03-In. Indentation, Lb. per Sq.In.	Allowable by Jacoby Formula	Allowable Load by Howe Formula
0°	1,010	1,010	1,010	1,200	1,200	1,200
15°	1,205	1,230	1,050	1,058	1,480	1,249
30°	1,785	1,835	1,220	1,572	2,280	1,475
45°	2,670	2,665	1,595	1,695	3,360	1,965
60°	3,440	3,495	2,210	2,840	4,440	2,765
75°	4,015	4,115	3,120	4,465	5,250	3,950
90°	4,325	4,325	4,325	5,520	5,520	5,520

CALIFORNIA WHITE PINE

Angle of Surface with Fibers	Mean Load at Elastic Limit, Lb per Sq.In.	Allowable by Jacoby Formula	Allowable Load by Howe Formula	Mean Load for 0.03-In. Indentation, Lb. per Sq.In.	Allowable by Jacoby Formula	Allowable Load by Howe Formula
0°	875	875	875	630	630	630
15°	1,000	1,050	905	653	926	680
30°	1,540	1,500	1,040	1,010	1,728	910
45°	2,160	2,175	1,335	1,378	2,828	1,305
60°	2,750	2,825	1,815	1,965	3,926	2,220
75°	3,110	3,310	2,520	3,005	4,755	3,420
90°	3,475	3,475	3,475	5,025	5,025	5,025

The initial failure of all specimens was in crushing of the fibers, while final failure took the form of shear along the fibers except in the end-bearing specimens.

In the accompanying Figs. 3 and 4 the results of the tests are plotted, both elastic-limit values and values at 0.03-in. indentation. Together with these test curves are plotted the Jacoby and the Howe formulas, using terminal values corresponding to those given by the tests.

Conclusions—The loads for 0.03-in. indentation correspond closely with the Howe curve. Since such load is usually well above the elastic limit in end bearing, and below the elastic limit in cross-bearing, it would seem good practice to base the allowable bearing stress in engineering design upon the loads at the elastic limit. These latter correspond remarkably with Jacoby's theoretical formula.

As a result it is believed that while the mathematical analysis offered by Jacoby for the proof of his formula is not altogether satisfactory, yet the formula appears to express the proper relation between load and angle of grain, and should be used.

Use of Clinker Asphalt in England Lowers Paving Costs

THOUGH asphaltic concrete with clinker as coarse aggregate was used to some extent in England prior to the war, only recently, says *The Surveyor*, has the manufacture of clinker asphalt approached commercial perfection. The Borough of Hornsey is recognized as the leader in clinker-asphalt production, the special interest in the Hornsey material being the fact that it is composed entirely of clinkers derived from the borough dust destructor, which, after preparation to meet varied requirements of grading, is mixed with pure bitumen. Large areas of this clinker asphalt were laid in the Borough of Hornsey in 1914, but owing to war conditions the plant used was of a somewhat crude character, comprising open-hearth driers and a mixer driven by a small gasoline engine. Even during the war this method of manufacture was continued, but since the war certain changes in plant and methods have resulted in a considerable decrease in the amount of labor needed, and a noticeable increase in output.

It is pointed out that a conspicuous feature of clinker-asphalt road construction is the comparative freedom from waves which are so pronounced in certain bituminous construction. Lack of waving in clinker asphalt is no doubt due largely to the interlocking and absorptive character of the particles formed in the aggregate used.

The Surveyor further says: "In the earlier years the work was carried on at about half the cost of ordinary bituminous construction, and notwithstanding the enhanced cost of labor and materials it still shows a saving of upwards of 10s. per super yard as compared with other bituminous construction of not superior traffic-resisting qualities."

Utility of Hardwoods for Paving Shown in Comparative Tests

Relative Insusceptibility to Expansion Through Water Absorption, and Greater Strength Recommend Oaks and Hickory

By E. E. Butterfield
In Charge of Tests, Office of the President, Borough of Queens, New York City

Difficulty in obtaining a reasonably uniform quality of creosoted pine paving blocks in 1918 led to an investigation of the physical properties of some American hardwoods with reference to their possible utility for wood block pavements. The widespread failure of creosoted pine pavements during and following the rainy spell in the summer of 1919 led to further examination of the physical properties of creosoted pine paving blocks for purposes of comparison with the hardwoods, as well as for the purpose of obtaining as much information as possible which would throw light on the causes and character of failure of the creosoted pine block pavements.

The 1918 specifications of the Borough of Queens called for creosoted pine paving blocks to comply with the following requirements:

Annual rings, per inch, average	Not less than 6
Oil, lb. per cu.ft	Not less than 20
Water absorption, 24 hr. at 100° F. followed by 24 hr. immersion in water, gain in weight	Not more than 5%

Samples from four deliveries under contract gave the following results:

	1	2	3	4
Oil, lb. per cu ft	14 8	18 3	13 7	18 9
Water absorption	5 5	5 0	16 7	5 8

The contractor made a request for re-sample and re-test and a representative of the manufacturer was permitted to inspect the material and to select samples at the various points of delivery. The results of the tests on these samples were as follows:

Rings per Inch	Water Absorption, per Cent	Rings per Inch	Oil Lb. per Cu.Ft.
5	8.2	4	21.2
6	9.0	5 4	19.3
6.1	7.0	5.4	18.1
10.4	11.0	6.6	18.4
15.3	4.6	6.6	18.7
20.2	6.9	9.0	15.5
	..	9.0	18.0
	..	10.0	17.7
		10.2	21.2
		10.5	18.7
		12.5	19.4
		16.0	17 0
		16.6	11.5
		18.0	17.3
		21.1	20 4

Other blocks from the same deliveries showed water absorption varying from 5.9 per cent to 34.7 per cent.

It was impossible to arrive at a logical basis for appraising the value of the blocks for paving purposes inasmuch as none of the customary tests had any direct bearing on the strength, wearing qualities or durability of the material. Plans were therefore formulated for a series of physical tests such as are made on structural timbers with necessary modifications for the size, shape and function of wood paving block.

While this investigation was in progress numerous and widespread failures of creosoted pine block pavements occurred in the Borough of Queens, in January, 1919, and during the prolonged rainy season of the summer of 1919 and again during the period December 1919-February 1920. According to seasons and climatic conditions there were two different types of failure.

The winter failures occurred during a sudden drop in temperature to below the freezing point of water, which was preceded by a period of moderately warm damp weather. It would seem that the winter failures are due to the sudden expansion of water into ice, either water infiltrated beneath the blocks or water absorbed by them.

The other type of failure occurred at summer temperatures following prolonged rains. Failures of this type occurred on Jackson Ave., Long Island City, at many other points in the Borough of Queens, and in other cities throughout the East during the rainy spell in the summer of 1919. The summer failures occur at high temperatures under conditions favoring a maximum saturation of the blocks with water. Under such conditions the forces of expansion of the wood, of the oil and absorbed water are all acting in the same direction.

In both winter and summer failures the end result is the same, although produced suddenly at the low temperatures and occurring gradually at elevated temperatures during or following rainy spells. There are local areas of bulging, arching of the affected pavements, accompanied or followed by fracture of the blocks. On closer examination many of the fractured blocks present the appearance of having been sheared along the grain.

Failures of existing creosoted pine block pavements, laid under rigid specifications and with utmost care, following closely on our experience with the lack of uniformity of the available materials in 1918 gave rise to reasonable doubt as to the effectiveness of prevailing specifications and methods of tests in insuring satisfactory results with wood block pavements. Consequently, an attempt was made to select tests which would furnish more direct evidence of the wearing qualities and durability of the wood.

Selection of Tests

Laboratory tests on paving materials should conform as closely as possible to the practical working conditions to which the pavement will be subjected in actual service. It is not to be expected that there will be a direct relation or a parallelism between the results of laboratory tests and the results of practical service. The most that can be attained is an approximation, yet this approximation should be made as close as possible. The tests should represent essential independent variables. Irrelevant tests should be avoided, as should also tests which may tend to confuse issues by expressing similar results in different terms. The tests should imitate the forces or conditions to which the pavement will be exposed in service. The principal forces to which a pavement is subjected are compression, abrasion, impact and shear from traffic, externally, and compression and shear from expansion, internally. Tests to determine shearing strength, impact, and water absorption were selected as the most significant, important and practicable. Compressive strength along the grain is of little practical value inasmuch as a pavement is rarely, if ever, subjected to a static load of the magnitude of the compressive strength of wood.

In expansion, a wood block pavement is subjected to compression on all sides in a series of horizontal planes.

When slight arching of a row or a stretch of blocks exists, the direction of the grain forms an acute angle with the perpendicular, and the horizontal force may be resolved into rectangular components, one acting in the direction of the grain and the other across the grain. According to the numerical values of the horizontal force and its components with and across the grain, the blocks may fail in shear along the grain or in compression across the grain. Blocks taken from areas of failure previously mentioned exhibited a clean shear along the grain, regardless of the season of failure, whether winter or summer. If the pavement becomes raised from the foundation either from bulging and arching or from existing irregularities or depressions in the foundation, then the impact of traffic would also tend to produce a mechanical shear in the unsupported areas.

The tests for shearing strength were made on specimens prepared in the same manner as for tests of single shear on structural timbers and as described by Samuel J. Record in "Mechanical Properties of Wood," 1914 Edition, p. 107.

Impact Tests

To test for impact in the laboratory the blows are delivered by a hammer which strikes the same spot repeatedly until failure occurs. In actual service the blows are delivered by the wheel of a rapidly moving vehicle so that, in addition to the simple impact delivered from varying heights according to smoothness of the pavement, there is the important factor of velocity. The laboratory impact test is a rather feeble substitute for the glancing blow delivered by a 14-ton truck traveling at from 15 to 30 mi. an hour. The impact tests were made on cylindrical cores 2.5 cm. in diameter by 2.5 cm. in height, of the same form and size as cores of granite block or broken stone selected for the toughness or impact test. The cores were tested in an impact machine with a 2-kilogram hammer raised 1 cm. each blow. The figures represent the number of blows as well as the height of the hammer at which failure occurred. The impact test performed in this way is not the same as the method of testing impact on structural timbers but it is adequate for comparative purposes and possesses the advantage of permitting a comparison between the impact or toughness values of wood and stone blocks.

Tests for water absorption are important not so much for the purpose of fixing an arbitrary value for the permissible absorption of water as for the purpose of taking into account the expansion caused by the absorption of water. In order to obtain some information on the magnitude of the expansion caused by water absorption three creosoted pine paving blacks, 8 in. x 3 in. x 3 in., were maintained in an atmosphere saturated with water vapor for one year, measured accurately in three dimensions at room temperature, dried in a vacuum at 140 deg. F. to constant weight, cooled to room temperature, and again measured. The blocks were at no time in contact with or immersed in water and the changes in volume represent the changes produced by the absorption of water vapor at constant temperature. Tests upon these three blocks gave the following results:

Moisture Content (Loss in Weight), per Cent	Change: Length, In.	Change: Width, In.	Change: Depth, In.
12	0.234	0.077	0.000
14.8	0.496	0.200	0.004
14.9	0.367	0.112	0.005

A change in length of 0.234 and 0.496 in. in an 8 in. x 3 in. paving block is equivalent to 36 and 82 in. per 100 lin. ft., and a change of 0.077 and 0.2 in. in width is equivalent to 32 and 85 in. per 100 lin. ft. Changes of such magnitude are astonishing when one considers that they were due solely to differences in water content at constant temperature and that consequently the results are not in any way related to the expansion of the wood at different temperatures. The coefficient of expansion of wood across the grain, that is in the length and width of wood paving blocks, is 0.0000544 per degree Fahrenheit, according to Record, or 0.6528 inches per 100 deg. F. per 100 lin. ft. The coefficient of expansion (cubical) of creosoting oils is 0.00044 per degree Fahrenheit, or about 4 times the coefficient of expansion of water. While there is no known law by which the expansion of absorbed water, the expansion of the wood, and the expansion of the oil may be computed, it is readily conceivable that these three factors working in the same direction may give rise to forces far in excess of the crushing strength of the wood across the grain. In the future, figures for water absorption should be supplemented by the measurement of the expansion produced by the water absorption.

In the following series of tests the water absorption was determined by 24 hours' immersion, preceded by a period of drying at 100 deg. F. for 24 hours. The figures in the table represent percent gain in weight.

TABLE 1.

Kind of Wood	Shearing Strength Lb. per Sq.In.	Impact (Toughness)	Water Absorption, per Cent	Linear Expansion Across the Grain, Accompanying Water Absorption, in per ft.
White Oak	1,620	36	6.0	0.03[illegible]
Red oak	1,158 radial	36	18.8	0.254
Chestnut Oak	1,364 tangential; 1,598 radial	40	8.2	0.193
Post Oak	1,230 radial	41	8.6	0.162
Hickory	1,465 tangential; 1,481 radial	46	8.4	0.219
Maple	1,163 radial	49	13.6	0.330
Yellow Birch	1,183	37	12.3	0.223
Red Birch	999	37	13.5	0.225
Southern Pine, untreated	1,258 tangential; 1,666 radial	22	11.2	0.23[illegible]
Southern Pine, creosoted	1,237 radial	13	10.2	0.15[illegible]

All of the hardwoods tested appear stronger on impact than creosoted pine. Untreated pine is much more resistant to shear and impact than creosoted pine, which is more or less to be expected when one considers the treatment to which the wood is subjected in the creosoting process. (See in this connection the conclusion of W. K. Hatt in Circular 39, Forest Service Experiments on the Strength of Treated Timbers.)

The water absorption is not diminished or appreciably affected by the creosoting process. On prolonged immersion the following results were obtained:

	Water Absorption Per Cent: Untreated Pine	Creosoted Pine	Creosoted Pine	White Oak
3 days' immersion	21.5	23.0	27.0	15.2
7 days' immersion	28.8	26.6	34.1	20.4

These absorption tests on the untreated pine and creosoted pine were made on samples of presumably selected materials which were submitted by bidders on a construction contract.

The samples of creosoted pine from which specimens for test were selected represented contract deliveries of

material for repair work and bidders' samples for construction contracts. The untreated pine blocks were bidders' samples submitted at the same time with the creosoted pine blocks for construction contracts. The samples of white oak represented deliveries of blocks for experimental purposes and for repair work in 1919. The samples of the other hardwoods were sent in as sections of logs from which pieces of the dimensions of paving blocks were cut.

There is nothing new in the use of hard wood for paving blocks. Hard wood pavements have been used successfully in Australia, England, Scotland, and on the continent of Europe. In Australia, karri, jarrah, blackbutt, tallow wood, mahogany and many other varieties of native hard woods have been used. In England and Scotland karri, jarrah and oak have been used. In Australia, England and Scotland hard wood has been used for straight paving from curb to curb, while on the continent it has been used chiefly for special work such as paving in the street railway area and bridge approaches. The Australian hard wood pavements are noted for their endurance, their life having been estimated at 21 years. It is significant that the only disadvantage attributed to pavements of dense hard woods is the tendency of the blocks to wear round at the edges.

In the United States there has been no systematic trial or use of the dense hard woods for paving purposes. White oak in the form of a wedge-shaped block has been laid between alternating rows of granite block in the franchise area of one of the traction companies in New York City. This type of construction consisting of about one-half white oak surface has been used for over 6 years in the railway area at intersections subjected to particularly heavy traffic.

The greater strength and relative insusceptibility to expansion from water absorption of the dense hard woods, such as white oak, chestnut oak and hickory would seem to merit a more extended trial for paving purposes where a wood block pavement is desired.

Earthwork Balancing on Road Work

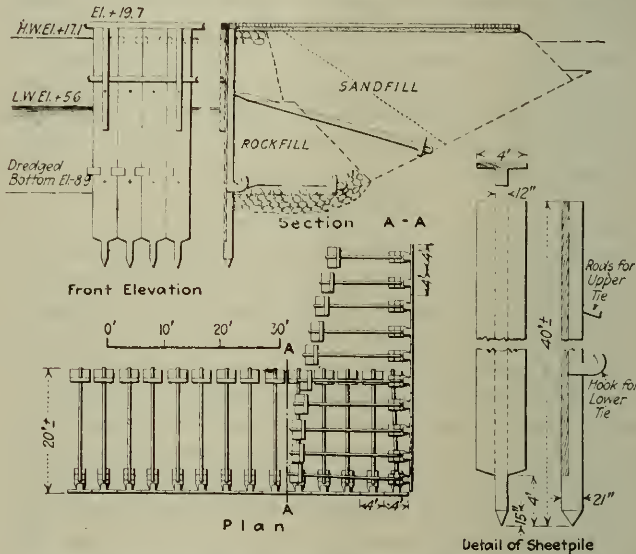
In order to insure sufficient material being provided in a given section of road to make the embankment in that section without waste, the Missouri State Highway Department has issued rules for balancing earthwork which rules also cover shrinkage allowance. It is provided that earthwork is to be balanced to show the disposal of excavation and the method of obtaining material for embankment and to assist in determining economical grade line. As a free haul of 1,000 ft. is specified, the earthwork should balance in sections of not over 1,000 ft. and as much less distance as is practicable. Steepness, irregular profile and fixed points of the grade line may require the sections to be over 1,000 ft. Careful study should be made to determine when it is more economical to borrow, waste or overhaul and at the same time secure a good grade line. The rule for shrinkage is as follows:

> Since earth when placed in embankment becomes more dense, occupying less space than it did originally, and since most highway earthwork contains a great amount of vegetable matter, the yardage of excavation should exceed the yardage of embankment. Where excavation averages 100 cu.yd. or more per station, allow 15 to 20 per cent of excess cut over fill. Where excavation averages less than 100 cu.yd. per station allow 20 to 25 per cent excess of cut over fill. Swell should be allowed on rock.

Special Quay Wall for Shores Which Require Filling

Precast Concrete Piles Form Face Wall With Precast Concrete Ties to Hold Them Against Shore Fill

PRECAST reinforced-concrete sheetpiles with specially designed hooked ties are the basis of a new type of quay wall which has been devised by a French engineer, Louis Ravier, of Paris, which has been used in its latest development in the construction of a quay at Kenitra, in French Morocco. The basic idea of the system is the use of a T-shaped sheetpile which is



DETAILS OF SPECIAL PRECAST PILE AND TIE QUAY WALL AT KENITRA, MOROCCO, DEVISED BY LOUIS RAVIER

driven in the water and which is held in place against the subsequently placed fill by special ties, the lower one of which is also placed under water before filling is commenced. Afterward the fill is carried from the line of sheetpiles back to the old shore line, and is paved for a solid quay wall.

The T-shaped sheetpile has a main stem 12 x 17 in. in section and in the Morocco wall about 40 ft. long. To this is joined integrally a 4-in. faceplate 4 ft. wide, a thorough connection being made in the reinforcement. This faceplate, however, stops about 4 ft.

VIEW OF THE TIES IN THE CASTING YARD

SHEETPILES WITH HOOKS IN CASTING YARD

above the point of the main shaft of the pile. At a distance of about 12 ft. above this point there is cast integral with the main shaft a heavy concrete hook extending backward from the face of the pile, and at a point about 12 ft. from the top of the pile reinforcing rods are left protruding in the back of the shaft for the future connection of the upper tie rods.

The lower ties consist of precast concrete sections about 12 in. square and 12 ft. long, with eye ends, as shown in the view. The upper tie rods are of not quite as large sections, but are longer and have an eye only at one end, the upper end being left with protruding rods to connect with the rods already left in the sheetpiles.

In construction the sheetpiles are driven in line

CASTING THE SHEETPILES WITH THE HOOKS

through the water to the proper depth, which is not necessarily refusal but is governed by the required elevation of the quay and the pre-ascertained condition of the soil in which the piles are driven. This height is such that the lower hook is just above the bottom of the harbor. The lower tie is then placed under water engaging the hook on the sheetpile by means of a solid concrete cylinder which passes through the eye of the tie and the curve of the hook. The rear end of the tie is held by a reinforced-concrete plate about 4 ft. square kept in place by a concrete block threaded through the rear eye of the tie.

A filling of rock is then dumped into the water to water level, at which height the upper tie rod is placed, in open air, the tie to the sheetpile being made by joining the reinforcing together and pouring the concrete around it. The lower end of the upper tie has a deadman similar to that used in the lower tie. Rock fill is then continued as shown in the cross-section to the top of the quay and the final fill made with sand. The sheetpile is capped with a concrete cap and the quay wall paved as shown.

Progress on Proposed American Falls Dam

ONE of the irrigation projects visited by the Appropriation Committee of Congress this summer and the one seemingly the most likely to be developed soon is the American Falls Dam in Idaho on the Snake River. It would have a storage capacity of 3,000,0000 acre-ft. and would be capable of supplying 1,300,000 acres already irrigated with a safe and reliable supply. In addition it would take care of new land amounting to 400,000 or 450,000 acres.

Prof. W. O. Crosby reported Jan 15, 1920, favorable geological conditions. I. W. McConnell, consulting engineer, New York, headed a board of engineers, selected jointly by the U. S. Reclamation Service and the State of Idaho, and reported April 10, 1920, favorably on the construction of the reservoir. In the fall of 1919 a mass meeting to inquire into the storage needs of the various canal companies brought application for 550,000 acre-ft. of storage. These various interests through a storage committee negotiated with the Reclamation Service for a form of contract providing for Federal construction of the dam with the understanding that the various organizations desiring storage would advance the money for their proportionate share of this reservoir, while Congress would be asked to appropriate money to provide for the storage for lands held in public ownership. Contracts have been signed for 335,170 acre-ft. of storage and the first payment of money has been deposited with the Reclamation Service. The signed contracts are with 31 canals and individuals representing 500,000 acres. Other lands already in cultivation need 550,000 acre-ft. additional. The North Side Pumping Unit of the Minidoka Project (U. S.R.S.) will require 520,000 acre-ft., making a total of 1,400,000 acre-ft. for which there is immediate need.

A 43-ft. dam holding 600,000 acre-ft. can be built for \$8.83 per acre-ft., a 64-ft. dam with a capacity of 1,500,000 acre-ft. for \$5.73 and the full capacity, 3,000,-000 acre-ft. can be obtained with an 89-ft. dam 5,000 ft. long at a cost of \$4.50 per acre-ft. of storage. For the full development Congress would have to appropriate \$9,370,000 and the land owners \$3,090,000. For the 1921 expenditures Congress is asked for \$370,000 and the land owners will supply \$670,000.

Ohio's 1919 Typhoid Rate Lowest of Record

In 1919 Ohio had a typhoid fever death rate of 8.6 per 100,000 population, the lowest of record. In 1918 it was 14.6, a figure about the average for the three years previous to 1918.

Increasing the Efficiency of Three Pumping Plants

Water Department of Lynn, Mass., Rebuilds Two Low-Lift Plants and Changes from Coal to Oil at Main Pumping Station

RADICAL CHANGES in three pumping stations of the water-works of Lynn, Mass., have been made within the past two years to keep abreast of the times and to get a proper plant efficiency, said Reeves J. Newsom, commissioner of water, in a paper read before the New England Water Works Association at its recent convention in Holyoke. As a result two outlying low-lift stations now have complete equipments of motor-driven pumps of much increased efficiency that may be operated "24 hours a day for weeks at a time practically without attendance," while the main pumping station has had its steam boilers converted for the use of oil instead of coal for fuel, at great reduction in fuel cost.

One of the outlying stations had been equipped with a 15,000,000-gal. centrifugal pump no longer ago than 1912. All this equipment went to the junk heap, including a priming pump of the ordinary reciprocating type. This pumping plant was operated six years without knowledge of its efficiency. In 1918 Mr. Newsom found by tests that when pumping from 12,750,000 to 16,750,000 gal. a day under heads from 10.9 to 27 ft. the efficiency of the combined plant varied from 26 to 47 per cent. The acceptance test of the new plant showed an efficiency of 74.5 per cent. At both of the new outlying stations the priming pumps, Mr. Newsom states, "are novel adaptations of a direct-connected motor-driven hydro-turbine vacuum pump and, complete, occupy a space only 20 x 40 in.

Oil Substituted for Coal

At the main station, where oil has been substituted for coal as fuel, the steam-driven pumps have their steam supplied from two 175-hp. boilers. The reasons for changing to oil, the nature of the contract for oil, the oil equipment and a summary of the advantages of using oil at Lynn are set forth by Mr. Newsom as follows:

The coal problem has become very serious in two ways. At times coal is scarcely obtainable and last winter for several weeks we had to depend on trucks coming through the deep snows from a city twenty miles distant to keep our pumps going. Then, too, the quality of the coal now on the market has made its use very uneconomical. The station duty has dropped as much as 30 per cent at times, and in order to keep up steam there has had to be wasted unburned, through the ash pit, 18 to 20 per cent on the average, and at times as high as 28 per cent of the coal fired. Combined with these facts has been the ever rising price of coal from around $4 per ton to $16.50 at the present time.

We have made a contract for oil at the equivalent of about $9 per ton for coal, and the price is guaranteed for two and one-half years, and the delivery of the oil for five years. This contract is backed by a $10,000 bond, which is two-thirds of the cost of the oil-burning apparatus, and the amount to be saved is such that if the oil company delivers oil for only a few months we can change back to coal without loss.

The oil situation appears to be pretty stable, however, when it is remembered that enormous royalties are paid to the Mexican government on the output of oil and it is therefore vitally interested in keeping them in operation, and further any interference with the oil output would not be tolerated by the British and American navies. The company that delivers the oil in trucks from storage tanks in Chelsea, Mass., owns also the wells, the pipe lines, and the tank steamers which bring it to this country, so that transportation difficulties would seem to be minimized.

The oil burning apparatus which is being installed consists of three principal elements—the storage tank, the combined pump and heater, and the burners, with connecting piping and auxiliaries.

The storage tank is of reinforced concrete, built in two separate compartments with a total capacity of 35,000 gal., or about three week's supply. A suction pipe comes from each compartment of the tank and runs to the pump inside the boiler room. These pipes are surrounded near the end by steam jackets which heat the heavy fuel oil so that it will flow. Pipes extending to the bottom enter the tank at the same points to which ejectors can be attached for removing water which may collect from time to time.

Equipment Details

The pump to which the suction pipes are attached is of the double duplex direct-acting type, mounted above the heater, which is cylindrical in shape, the whole thing being a small compact unit. The heater is constructed like a surface condenser, the steam being inside the tubes and the oil flowing around them. In this heater the temperature of the oil is raised to about 130 deg. F.

From the heater the oil is pumped to the boiler front, where it passes through an auxiliary heater composed of another steam jacketed section of pipe which is used to heat the oil beyond the pump when the boilers have been banked, or when for any reason the main heater does not function properly. The piping is so arranged that all exhaust steam from heaters and pump returns to the boilers.

The oil then passes through a regulator and to the burners, where it is atomized by steam and mixed with air. The burners are placed just below the location of the coal grates, the pipes coming in through the ash doors which are entirely bricked up except for the requisite air slots.

The regulator is actuated by changes in steam pressure and controls the flow of oil to the burners. The supply of air is controlled by the position of the chimney drafts. It is possible to obtain a regulator which will also control the air, but a centrifugal pump load is so steady that practically no change is required in the amount of air needed, once it has been set to meet the atmospheric conditions for the day's run, and the complication of such a regulator is not, therefore, justified in our installation.

We use both boilers ordinarily to carry the load and to prevent its unequal distribution and the overloading of either of the boilers. Steam flow meters are being installed to show the respective outputs.

The dangers in the use of oil are two—having too hot a fire, and having the fire too concentrated. The limit to which an oil fire can be forced is usually beyond the safety point of the boiler, and so the output must be watched. If the burners are too close to the boilers the flame may be so concentrated that the rivets in the shell will melt. A boiler setting built especially for oil is usually very high, but a coal installation can in most cases be adapted to oil by removing the grates and putting the burners in the top of the ash pits.

The principal advantages which will in our case be derived from the use of oil are as follows: (1) Oil is cheaper than coal; (2) it can be burned more efficiently than coal; (3) greater boiler capacity can be developed; (4) coal and ash handling charges will be eliminated; (5) variation in quality will be minimized; (6) banking of fires can be done very much more economically; (7) neater and cleaner and better working conditions will be obtained.

The burning of oil seems to solve our problem in this station, temporarily at least, and perhaps until such time as the eventual solution, the development of available water power will be consummated.

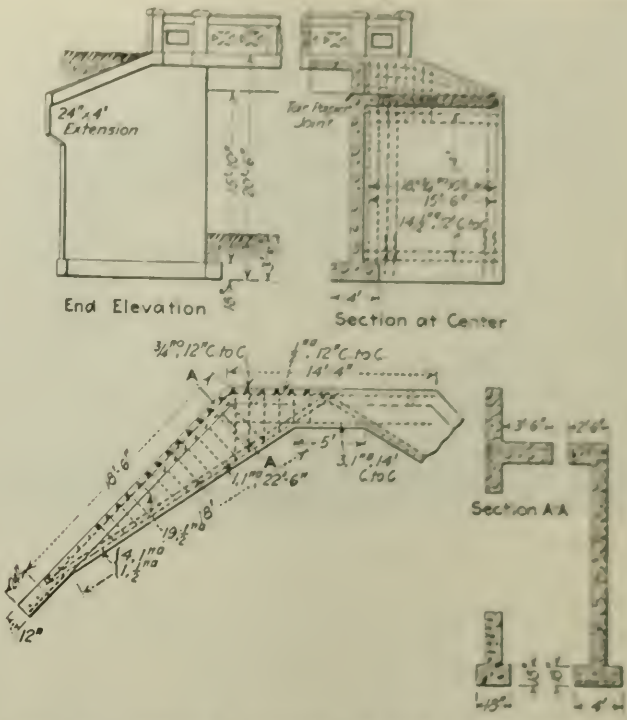
Concrete Abutment of Thin Walls Tied by Diaphragm

Special Design Used in Illinois Highway Viaduct Saves Material and Insures Coaction of Wings and Face Wall

FOR the abutments of the New Athens Viaduct, a concrete beam-and-slab highway bridge for St. Clair County, Illinois, a special type of wing-wall abutment was designed and used by A. P. Poirot, of Bellville, Ill., who built the bridge. Comparatively thin wing and face walls were used, but were tied together near the top by a horizontal diphragm spanning the juncture angle.

The viaduct consist of 20 spans of 40 ft. and two spans of 37 ft. 9½ in. The roadway, 19 ft. wide, is carried on a 7-in. slab with three longitudinal 16 x 26 in. stringers, which are supported on three-column bents. Except that every other bent is of the split-column type for expansion, as shown in the view herewith, the design follows ordinary practice.

A detail and a view of the wing-wall abutment are also shown. The abutment consists of a face wall 14 ft. 4 in. long and 20 ft. 6 in. high, which is 12 in. thick in its main section, with a 4 ft. base and a 2 ft. 6 in. corbeled top. Joined to this at a 45 deg. angle are 18 ft. 6 in. wings also 12 in. thick but extending up higher, at the face, than the face wall. Joining the three walls at the elevation of the face-wall corbel is the 16 in. horizontal diaphragm, of the shape and reinforcement shown in drawing. The advantages claimed for this type of construction by the designer are as follows:



DETAILS OF DIAPHRAGM ABUTMENT OF NEW ATHENS VIADUCT, ST. CLAIR COUNTY, ILLINOIS

SPLIT EXPANSION COLUMN BENT ON NEW ATHENS VIADUCT

Details of diaphragm abutment of New Athens viaduct, Clair County, Illinois.

(1) It permits the use of comparatively small sections for the wings and face wall and no footings need be provided under the wings further than those required to carry the deadload of the wings themselves.

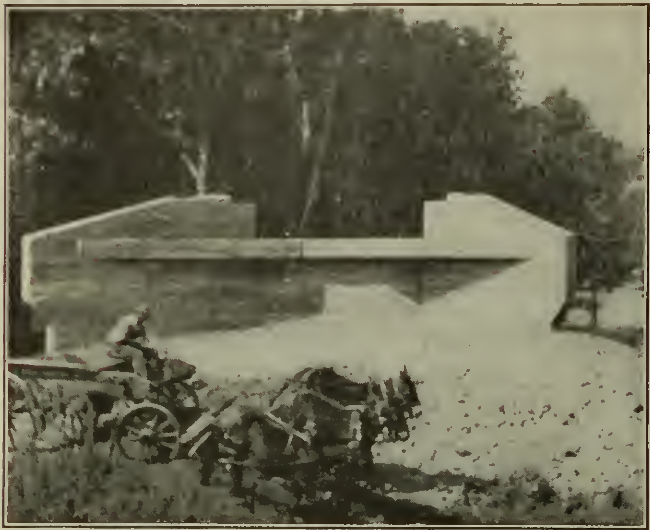
(2) The location of the diaphragm is such that it can be built strictly according to the plans with ease. The steel can be properly placed and the concrete properly formed and worked, thus assuring good construction at the critical part. This is often not the case in other types of design. For instance, in the cantilever type the critical part of the wings is usually below the stream bed immediately above the footing, at a point where form construction for the wing wall makes it almost impossible to keep a thin layer of dirt from separating the wall from the footing course, thus providing a chance for corrosion of the rods where it is least desired, and consequently a lessening of the value of the structure.

(3) The base can not be broken when back filling is being done, as is often observed when ties are used that extend underneath the roadway from the end of one wing to the end of the other.

The wing walls and the face wall are designed, so far as the earth pressure in back of them is concerned, as slabs supported at the top and bottom. The earth in front of the footings and the friction on the earth underneath provide the bottom support, and the diaphragm brace, shown above, provides the means whereby the wings and the wall mutually support each other at the top.

The base is designed to resist bending moment at any section caused by the tendency of the wings to spread and also to resist the moment caused by the direct dead- and live-load from the top.

As a test, the back filling of one abutment was made shortly after it was completed and before the superstructure was placed. This remained for about eight



INSIDE OF WING-WALL ABUTMENT WITH CONNECTING DIAPHRAGM

months, after which the last span was put in place. Careful measurements revealed no movement and no signs of insufficient strength were found.

D. O. Thomas is county superintendent of highways of St. Clair County and Ben A. Gundland was in charge as superintendent of construction.

Methods of Increasing Efficiency of Track Labor

Cost Records Necessary—Permanent Employment With Good Pay and Housing Help To Secure Better Men and Better Work

UNDER present conditions of labor and wages the railways have a very practical interest in increasing the efficiency and economy of track work. New methods and better management will be necessary to obtain this result. The situation was reviewed by F. G. Jonah, chief engineer of the St. Louis-San Francisco Ry., in an address delivered at the recent annual meeting of the Roadmasters and Maintenance of Way Association, an abstract of which follows:

Formerly, when labor for track work was abundant and cheap, there was little check on its performance or economic results. In considering the efficiency of workmen the first thing necessary is to know accurately what they are doing now and what they are capable of doing. This means putting the work on the basis of unit costs. In the past, there have been records only of the total expenditure for various subdivisions of track work, comparatively little being known of the amount of work performed for this expenditure. In the transportation department the whole efficiency of the organization is judged by statistical information, based on the unit cost of moving a ton of freight one mile or carrying a passenger one mile; the mileage of engines per ton of coal; the movement of loaded cars per day, the terminal expense of handling cars and engines. The information shows at a glance whether the railway's business is being handled economically.

It is possible to measure in the same way results of the work of track gangs, so that various railroads are beginning to undertake the collection of such data. The system introduced on the St. Louis-San Francisco Ry. is found to be well worth its cost, and is giving some definite results. The basis of this system is the time book. Heretofore, track foremen have reported the amount of time put in on different kinds of work, but have said nothing about the quantity of work done. The new time book provides for such a record. When the cost of work is known, steps can be taken to keep up a good average or to raise a low one.

Motor cars for section forces were introduced by many railways a few years ago, but on the assumption that a man could then cover more territory, they lengthened the sections and eliminated a few foremen, apparently trying to figure sufficient saving in wages to pay for the motor cars. This was at a time when men worked ten hours per day. With the eight-hour day now general, the long section is a mistake, as too large a percentage of time is taken up in moving to and from work. Further, increased traffic, with increased number and weight of trains, demands more intensive work and supervision, so that many sections should be shortened, instead of lengthened. But the motor car will be economical even on short sections. Power appliances should be used whenever possible and manual labor reduced to a minimum.

With increased wages, a better personnel can be secured. All sections should be allowed to carry a permanent force of at least a foreman and four men, expanding to a greater number at times in the summer. Steady employment the year round will hold good men on the sections, and give the railway a chance to develop good foremen for section gangs and extra gangs. Consideration should be given to proper housing facilities. The time for box car bodies as houses for families is past, and the day of the hobo is past. Clean, efficient labor demands comfortable, commodious, healthful domiciles. It will pay to establish these. There is no reason why the section foreman should not be one of the substantial citizens of the community in which he lives. His pay now compares favorably with that of the village school teacher, and the railways will expect their men to measure up to a higher standard than has prevailed in the past.

Extra gangs should be housed in clean bunk cars and the train should carry a car equipped with shower bath. Cars should be screened and a good commissary maintained. In the days of the hobo camp, few could blame the man who put in a month at one and then took the first opportunity (at pay day) of going off on a drunk to forget his misery. He drifted back to camp only because he had no other place to go. Labor cannot be held under conditions that prevailed in the past. The road that will get the best results is the one that provides the best housing conditions and has the best personnel; and the latter depends largely upon the former.

After good men have been secured, they must be fully equipped with tools, so that they can undertake any kind of work at any time. Ample material must be supplied also, for money is wasted if extra gangs and section gangs are kept waiting for material. It is unwise to undertake too much work by doubling up section gangs, for the morale of a section foreman is destroyed by frequently taking him off his own territory to help another foreman. The practice should be resorted to only in such emergencies as wrecks and washouts, for it is far better to organize extra gangs to do extra work. If three or four section gangs are worked together, at the present pay of section foremen, the overhead expense is much more than the salary of a good extra-gang foreman.

Dallas Has Aërial Photo Map

Dallas, Texas, is one of the few cities in the country that possess a complete aerial photographic map. It was made last spring by army aviators at the request of Mayor Wozencraft and now hangs in the Mayor's office. Three hundred seventy-eight plates were exposed at an altitude of 6,000 ft. from a former bombing plane flying along parallels. Later these pictures had to be cut and carefully fitted together, making a mosaic 5 x 8 ft. in size. This map will be of service in planning Greater Dallas.

Am. Soc. C. E. Arguments for and Against Federation

Membership Receives Presentation of Opposing Views Prior to Voting on Question of Joining the New Organization

In accordance with the action of the Board of Direction of the American Society of Civil Engineers at a meeting held in Portland, Ore., Aug. 12, there has been sent to the corporate membership of the society ballots calling for a vote on the question of joining the Federated American Engineering Societies, together with a pamphlet containing arguments pro and con, prepared by committees of three consisting of Edward E. Wall, David C. Henny and John C. Hoyt, who present the case in favor of joining the federation, and George H. Pegram, John W. Alvord and Arthur S. Tuttle, who oppose it. The arguments are reprinted in full below:

Arguments for Joining Federation

As Prepared by Edward E. Wall, David C. Henny, and John C. Hoyt.

On June 18, 1918, the Board of Direction of the American Society of Civil Engineers adopted resolutions creating a Committee on Development. About the same time similar committees were created by the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. In order to correlate the work of these committees so far as it pertained to matters of common interest to the engineering profession, especially to matters of public welfare that involved engineering training and technical experience, these committees appointed from their membership a general committee, known as the Joint Conference Committee, consisting of fourteen members. Three members of this committee were also members of the Engineering Council.

The Joint Conference Committee, after considering various plans for providing an agency through which the engineers of the country could speak and act as a unit for the engineering and allied professions, was unanimously of the opinion that to establish such an agency some comprehensive organization other than Engineering Council was necessary—that an organization was needed which should be thoroughly representative and democratic and which should be formed from the bottom up and not from the top down. This committee submitted a unanimous report which contained a general plan for such an organization based on the following principles:

1.—Non-interference with interrelations of organizations with respect to technical matters, and maintenance of the autonomy, functions, and operations of each organization.

2.—Local affiliation of existing groups of engineers in order to facilitate united action on local questions of public welfare and other matters of common interest.

3.—National association of engineering organizations by means of a national council composed of representatives widely chosen by local affiliations or organizations and by national organizations, the council to meet annually and to act through an executive board.

4.—Financial support of such an association by contribution from all participating organizations on a basis of membership.

5.—A form of organization which will permit expansion and development.

The report of the Joint Conference Committee was considered by Engineering Council at its meeting in October, 1919, and the general principles therein stated were endorsed. The report was also presented to the four Founder Societies and it was considered at a joint meeting of the governing boards of these societies held Jan. 23, 1920, together with the governing boards of the American Society for Testing Materials and of the United Engineering Society and with members of Engineering Council. At this meeting resolutions were unanimously adopted requesting the Joint Conference Committee to call, without delay, a conference of national, local, state, and regional engineering organizations and affiliations for the purpose of forming the comprehensive organization of engineers recommended. In compliance with this request a call was issued to about 110 engineering and allied technical societies not organized for commercial purposes, but devoted chiefly to the advancement of engineering and allied technical arts, to send representatives to an organizing conference to be held in Washington, D. C., June 3-4, 1920. There were in attendance at this conference 140 men, representing 71 societies having an aggregate membership of over 110,000, or 80 per cent of the membership of the organizations which were invited to send representatives to the conference.

The conference was, therefore, in every way thoroughly representative, the delegates coming from all parts of the United States and representing national, local, state, and regional engineering organizations and affiliations. Its outstanding feature was the unanimity of opinion that a comprehensive body to speak for allied and technical organizations was necessary. Without a single dissenting vote the Federated American Engineering Societies, the management of which shall be vested in a body known as the American Engineering Council, was formed. A constitution and by-laws were adopted (see accompanying copy) and the Joint Conference Committee was instructed to act as the ad interim committee between the adjournment of the conference and the convening of the American Engineering Council on Nov. 10, 1920.

Engineering Council, at its meeting on June 17, 1920 unanimously endorsed the Federated American Engineering Societies and its governing body, the American Engineering Council, and authorized "its executive committee to offer such assistance as may be practicable in completing the work of the Organizing Conference of the Joint Conference Committee of the Founder Societies in establishing the American Engineering Council."

The chairman of Engineering Council, under date of July 12, 1920, stated:

"I am sure that, as chairman, I voice the opinion of Engineering Council when I state it will do everything in its power to advance the organization of the new council, to act in the interim, and to facilitate a smooth transfer of activities from the old to the new council."

From this it is quite evident that Engineering Council will go out of existence when American Engineering Council is prepared to take up its work, about Jan. 1, 1921.

The Federated American Engineering Societies has now a membership consisting of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Detroit Engineering Society, the Dallas Technical Club, and the Cleveland Engineering Society. The sentiment expressed by delegates at the organizing conference indicates that other societies to whom invitations to become members have been extended will be added to the list as soon as the question can be considered by their governing boards and presented to their membership, so that without a doubt the Federated American Engineering Societies when completely formed will speak for a body of over 100,000 engineers and allied technologists and will be prepared to perform a real function as a medium of the engineering and allied technical professions in their relation to the public.

The new organization is no mushroom. It has not grown in a night. It is not a dream of one or of a few men. It is the mature result of months of hard thought and days of intense conference by many broad-minded engineers from all quarters of our land, gathered day after day.

The following events indicate that now is the psycho-

logical time for establishing a comprehensive organization to represent engineering and allied technical interests, and that this new organization is to be the Federated American Engineering Societies with a governing body to be known as the American Engineering Council.

1.—On Sept. 17, 1919, the Joint Conference Committee of the four Founder Societies unanimously recommended this comprehensive organization.

2.—In October, 1919, Engineering Council unanimously endorsed this recommendation in principle.

3.—On Jan. 23, 1920, the governing boards of the Founder Societies, of the American Society for Testing Materials, and of the United Engineering Society and the members of the Engineering Council unanimously endorsed the recommendation of the Joint Conference Committee in principle, and requested the committee to call, without delay, a conference of representatives of national, local, state, and regional organizations and affiliations, for bringing into existence the comprehensive organization recommended by the Joint Conference Committee.

4.—This conference met in Washington, June 3-4, 1920, and unanimously voted in favor of the comprehensive organization recommended by the Joint Conference Committee.

5.—Engineering Council, at its meeting on June 17, 1920, unanimously endorsed the formation of the Federated American Engineering Societies and the American Engineering Council and instructed its executive committee to proffer and perform every possible service in bringing it into existence.

6.—The technical papers of the country have been unanimous in their endorsement of the action of the Washington Organizing Conference and in their expressions that the step taken was the most important in the history of the engineering profession.

The American Society of Civil Engineers recognized the need of a general organization to represent the engineering and allied technical professions when it joined in the creation of Engineering Council. The American Engineering Council is a similar organization made more democratic by including in its membership local as well as national societies, and it is obvious that any organization representing many societies in different parts of the country must have greater potential effect that one representing only a few.

The American Society of Civil Engineers has given financial support and in every way fostered Engineering Council; and there is no reason why it should not lend the same support to the American Engineering Council, which will succeed Engineering Council and carry on its work in a more representative way and on a more comprehensive scale.

The statement has been made that the proposed plan for financing the American Engineering Council will not provide adequate funds. Engineering Council has done a large amount of work under appropriations from its five member societies, never exceeding $22,000 per annum. It has, of course, always had need of more money, but that is a need of any live organization. The proposed budget for the American Engineering Council is several times that heretofore allotted for Engineering Council and is considered ample to provide both for its successful organization and for carrying on a large amount of useful work.

One of the fundamental principles of the Federated American Engineering Societies is "non-interference with the interrelations with respect to technical matters and the maintenance of the autonomy, functions, and operations of individual organization"; therefore, the American Society of Civil Engineers will lose nothing by becoming a charter member of the Federated American Engineering Societies, and its traditions and achievements, together with its high standing in the engineering profession, will be strengthened through its hearty support of the movement. In fact, the American Society of Civil Engineers cannot afford to refuse to be identified with the movement.

On April 14, 1920, the questionnaire ballots of the members of the American Society of Civil Engineers on the report of the development committee were canvassed, with the following results:

Question A-1: "Shall the American Society of Civil Engineers 'adopt the principle of becoming an active national force in economic, industrial, and civic affairs'?" Carried by a vote of 2,889 to 910, the percentage of affirmative votes being 76 per cent of those who voted on the question.

Question A-2: "Shall the society actively co-operate with other engineering and allied technical associations in promoting the welfare of the engineering profession?" Carried by a vote of 3,115 to 685, the corresponding percentage of affirmatives being 82 per cent.

It is evident that the sentiment of the society is strongly in favor of these policies, but it was also evident that at that time many members felt that it would be unwise for the society to join any federation which did not grant the national organizations the same representation accorded to local, state or regional organizations. At the organizing conference of the Federation of Engineering Societies, held at Washington, D. C., June 3-4, 1920, this defect in the original plan was remedied and this action, it is believed, removed the only objection that can be consistently urged as a reason why the American Society of Civil Engineers should not join the new federation.

The question now before the membership of the American Society of Civil Engineers is whether the society shall join this organization in its formative state and thus be in a position to play an active part in developing its policies, or whether it shall lag behind and permit other organizations to perform this work, remaining aloof until others have done the construction and then apply for membership.

It is pertinent to refer to the parallel case illustrated by the United Engineering Societies Building on West 39th St., New York City. Every member of some years' standing will recall that at the time of Mr. Carnegie's gift the American Society of Civil Engineers had an opportunity to enter the engineering building along with the other national societies, and that, owing to the influence of the ultra-conservative element in the society, it did not avail itself of this opportunity; after several years elapsed wiser counsel prevailed and the society took the step which it should have taken in the first place. Shall the members of the society be contented to repeat a mistake of this kind?

The American Society of Civil Engineers should be a leader in this movement, and the vote in favor of its becoming a charter member of the Federated American Engineering Societies should be overwhelmingly in the affirmative.

Arguments Against Joining Federation

As Prepared by George H. Pegram, John W. Alvord, and Arthur S. Tuttle.

1. The federation is identical in principle with the federation plan which was disapproved by the society as Question No. 3 of the questionnaire voted on early this year.

The reasons which then demanded its disapproval still obtain.

2. The purposes of the federation are vague and ambiguous. Advocacy of the plan has relied more upon rhetorical persuasion than upon definite and clean-cut statement as to what is to be done and how it is to be accomplished.

3. Because of the vagueness of purpose it is impossible for any one to draw reasonable conclusions as to whether the work of the federation will justify either its creation or the heavy expense it will inevitably entail.

4. The American Society of Civil Engineers is representative and democratic in organization.

The federation is neither representative nor democratic. Its management is vested in a council composed of representatives of constituent societies, who are not necessarily elected by the members of those societies. This council would be in the nature of an autocracy without the usual restraints to the pursuit of political and personal ends.

5. The requirements of membership in the American Society of Civil Engineers demand high personal, technical, and executive qualifications, and are rigidly enforced.

The absence of qualifications for membership in the fed-

eration lets down the bars to almost any society that may incorporate the word "engineer" in its title. This diversity of standards and interests will prevent the federation from becoming in any sense a representative body.

To carry weight, engineering prestige must rest on professional attainment and standing rather than on bulk of numbers. The federation stes up no profesisonal standards whatever. Its one standard is bulk.

6. The representation of the American Society of Civil Engineers in the council and executive board would be in an insignificant minority, careful estimates indicating that on the basis of the Washington conference, this representation would be less than 8 per cent. The society would be simply lending its prestige for exploitation and both the society and the engineering profesison would suffer by such a sacrifice.

7. The American Society of Civil Engineers has never yielded control of its actions or policies to others. The nearest approach is in its connection with the Engineering Council, which, however, can take no action from which the representatives of the society dissent.

Should the society join the federation, it would, in the estimation of the public, cease to function as the leading engineering organization, as it has done for sixty-eight years.

8. The revenues of the society even if its dues are increased as proposed under the amendment about to be voted upon, are not adequate to permit the society to maintain membership in the federation without serious curtailment of its technical activities and the entire abandonment of the proposed plan for strengthening the local sections.

9. The experience of the American Association of Engineers demonstrates the impossibility of doing effective "welfare" work with the funds that will be available under the federation scale of membership fees.

10. "Welfare" work in general is of local or regional interest. It can be handled most effectively by local or regional bodies which would be inspired by a genuine community of interest.

When a "welfare" matter demands broader consideration than can be obtained through local or regional organizations, it can and should be made the subject of the co-operative action of interested organization in which this society should take a leading part, the funds for such purposes being raised by special contribution. This will insure the needful community of interest in each instance, and will avoid the wasteful expense arising from the permanent maintenance of the elaborate and costly overhead of a national federation.

11. If the membership of the society, upon further consideration, elect to stand by their previously expressed determination to remain out of such a one-sided and unrepresentative combination in which there interests and rights have been needlessly sacrificed, the society's prestige will not thereby be diminished, but, on the contrary, will be enhanced.

Public Water Supplies in Quebec

Of 230 towns and villages having 500 population or more in the Province of Quebec, 192 with a total population of 1,383,700 have water-works, but all told there are some 440 separate water supplies in the province, if those are included that serve only a few houses. The foregoing figures are from a paper by T. J. LaFreniere before the recent Montreal Convention of the American Water-works Association. Of the 192 works named, 97 take water from rivers. These works serve a population of 1,192,512, or 86.2 per cent of the total supplied by the 192 plants. Of the remaining works, 20 supply lake water to 3.8 per cent of the total population involved, and 75 supply water from springs and wells to 10 per cent of the population supplied by the 192 works.

Quays vs. Piers for Ports

COMPARING the virtues of the quay system with the pier system for shipping ports, Capt. F. T. Chambers, U. S. N., of the U. S. Shipping Board Port Facilities Commission, in an article in *Engineering News-Record*, Sept. 16, 1920, p. 556, showed the same

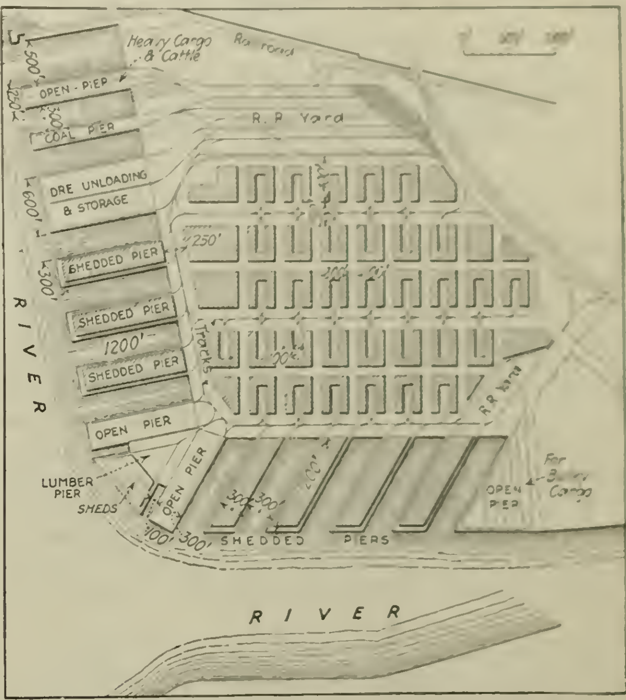


FIG. 1. PIER LAYOUT FOR A PORT AT JUNCTION OF TWO RIVERS

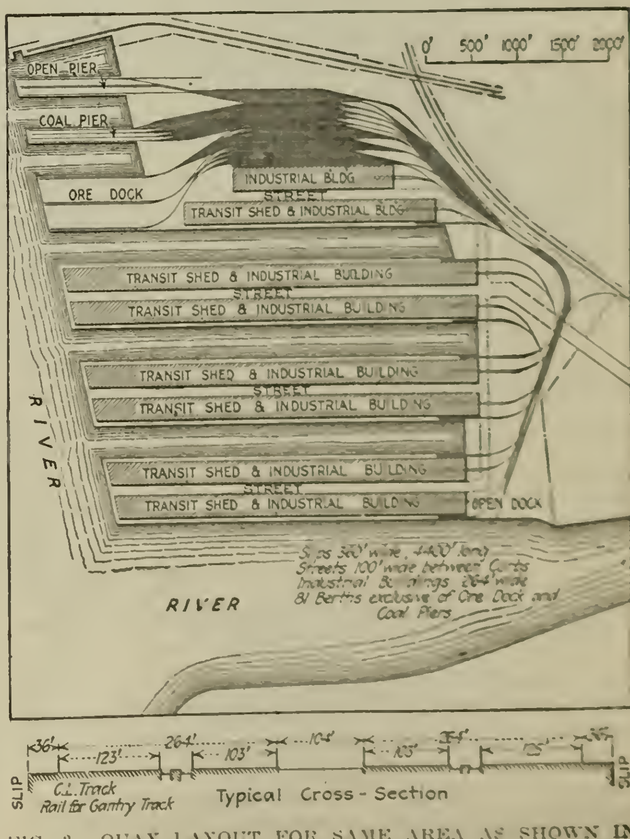


FIG. 2. QUAY LAYOUT FOR SAME AREA AS SHOWN IN FIG. 1

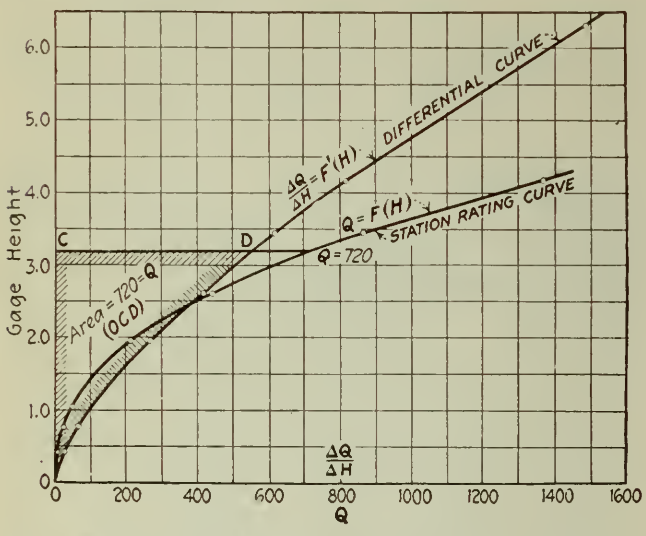
area as developed for the two types. By an error in make up the layout for the quay system was omitted and as Fig. 2 of the article was given the plan of the layout given in cross-section in Fig. 3. There are reproduced herewith, therefore, the two layouts for the same area, as intended in the original article. It is the contention of Captain Chambers that the quay layout, shown as Fig. 2, is much the better from every standpoint.

Differential Method for Drawing Stream Rating Curves

By C. C. Jacob

Federal Court Water Commissioner, Assistant Professor of Civil Engineering, University of Utah, Myton, Utah.

To OBTAIN a continuous record of the flow of water in a stream or over a weir it is first necessary to obtain the functional relation between the gage height and discharge, or the rating curve. In the case of river gaging stations the ordinary method is to make current meter measurements of discharge at various observed gage heights. For weirs we rely upon the formulas and tables published by various experimenters, selecting the particular formula that best fits the case in hand. Very often, however, the hydraulic engineer must determine the flow of a stream which cannot be directly measured, or the discharge over a dam or weir of such size or shape that no experimental



STREAM RATING CURVE DRAWN BY DIFFERENTIAL METHOD

ΔQ	ΔH	$\frac{\Delta Q}{\Delta H}$	H	Q
5.6	0.20	28	0.42	4.76
10.8	0.18	67	0.76	20.6
15.9	0.15	106	1.04	44.6
37.4	0.14	267	1.95	211
58.0	0.14	414	2.63	442
92.0	0.15	617	3.45	862
122.0	0.15	813	4.16	1,370
179.0	0.12	1,490	6.30	3,810

NOTE—For any gage height, the area *OCD* between the differential curve and the *H* axis is equal to the discharge for that gage height.

data applicable to the problem are available. The following indirect method was developed by the writer in an attempt to rate a gaging station on a rough mountain stream where no satisfactory measuring section could be found. The accompanying curves and table illustrate the method which was developed theoretically as follows:

Consider a stream or weir whose discharge, Q, cannot be directly measured, on account of unfavorable channel conditions or for any other reason. To apply the differential method it must be possible to discharge into the stream above the gage a comparatively small stream which has been accurately measured. Call this smalll stream, or increment of discharge, ΔQ. It will produce a certain increase, ΔH in the gage height, H, at the main stream gaging station, which can be accurately observed with a hook gage. Several values of ΔQ and ΔH are obtained for various stages of the stream. From these data a curve is plotted with values of $\Delta Q \div \Delta H$ as absissæ and corresponding values of H as ordinates. This is obviously the differential curve of the station rating curve required, expressed as $\Delta Q \div \Delta H = F'(H)$, $Q = F(H)$ being the general expression for the rating curve. The rating curve, being the integral of the curve plotted from the observed data, is obtained from the latter by measuring the successive areas between the curve and the H axis by means of a planimeter or simply by "counting the squares." This is, of course, equivalent to integrating the equation

$$\int^{Q} \Delta Q = \int_{0}^{H} F'(H)\, \Delta H \text{ or } Q = F(H)$$

Any convenient stream which can be diverted temporarily around the gaging station and accurately measured with a current meter or standard weir can be used as the "increment stream." It must be of sufficient size to give a measureable increase in the station gage height, the error in the rating curve derived by this method being proportional to the error in the observed gage height increment. The "stage of zero flow" should be determined if practicable, but this can be obtained indirectly by taking advantage of the fact that the rating curve for open channel sections as well as weirs has the parabolic form $Q = CH^n$, and the differential curve will give a straight line graph on logarithmic paper.

Figures on Sale of Rhone Power

Some of the transpositions of power costs from French to American currency were erroneously stated in the article "French Government to Regulate River Rhone" by Thorndike Saville, in *Engineering News-Record*, Aug. 26, 1920, p. 396. The last paragraph of the first column on p. 398 should have read as follows:

Under these conditions, if during the first period of ten years it is possible to sell 300 million kw.-hr. at 0.05 fr. (0.96c.) and 330 million kw.-hr. at 0.03 fr. (0.58c.) there will be, after payment of interest on stock and bonds, an income of 1,000,000 fr. ($193,000) during each of the first ten years. During the second period of forty years, in the course of which the bonds would be retired, it will be sufficient to sell 800 million kw.-hr. at 0.04 fr. (0.78c.) and 550 million kw.-hr. at 0.015 fr. (0.29c.) for the annual net income to be two million francs ($386,000). During the third period of twenty-five years, in the course of which the stock will be retired, it would be sufficient to sell 1,000 million kw.-hr. at 0.03 fr. (0.58c.) and 800 million kw.-hr. at 0.01 fr. (0.19c.) to give a net annual income of twenty-one million francs ($4,050,000). At the expiration of the concession it should be possible to sell 1,000 million kw.-hr. at 0.02 fr. (0.39c.) and 800 million kw.-hr. at 0.01 fr. (0.19c.), and there would be an annual income of sixteen million francs ($3,086,000).

Pennsylvania and Rhode Island Traffic Counts Compared

MAIN line highways leading north and south from Providence, R. I., show as much, or greater, passenger-car and commercial motor-truck traffic than at any of nine points along the Lincoln Highway in Pennsylvania, or than at two points on the William Penn Highway, also in Pennsylvania, according to traffic censuses made during July. Traffic counts were begun upon the Rhode Island and Pennsylvania roads upon the same day—July 25. The Rhode Island counts continued during the ensuing week ending Sunday, Aug. 1. The counts in Pennsylvania were taken for July 25 and 26 only. Counts were made in Pennsylvania beginning at 6 a.m. and ending at 6 p.m., while those in Rhode Island were taken during the 18-hr. interval from 6 a.m. to midnight.

Traffic Count Point	Passenger Cars	Trucks
Post Road, Camp Ave., North Kingston	13,723	1,125
Post Road, Matunoc	5,789	448
West Shore Road, Warwick, Conimicut	20,162	3,427
Nooseneck Hill Road, Spring Lake	2,502	376
Plainfield Street, Providence City Line	5,454	2,285
Hartford Pike, Oak Swamp Reservoir	3,893	700
Putnam Pike, Barnes Hill	8,539	1,247
Taunton Ave., West of Pawtucket Ave	13,316	2,003
Waterman Ave., West of Pawtucket Ave	11,070	2,404
Pawtucket Ave., Brightridge School	25,182	4,398
Nayatt Point Road, West Barrington	13,376	1,437
Child St., Warren	10,119	1,733
Warren-Bristol Road, Town Line	7,087	2,238
Fall River to Tiverton, Anthony Hill	13,104	1,765
Sakonett Point Road, Lafayette Road	2,266	490
Main Road, Portsmouth Town Hall	7,944	1,094
New London Turnpike, Emery Park	7,960	1,385

TABLE I. TRAFFIC COUNT ON NINE SECTIONS OF THE LINCOLN HIGHWAY, PENNSYLVANIA—6 A.M. TO 6 P.M.

Point Taken	Kind of Traffic	July 25	July 26
Coatesville-Downington	Passenger cars	3,877	2,307
	Motor trucks	82	1,013
	Motorcycles	125	43
	Teams	33	74
	Total	4,117	3,437
Philadelphia-Morrisville	Passenger cars	2,647	922
	Motor trucks	265	546
	Motorcycles	(a)	.....
	Teams	54	117
	Total	2,966	1,585
Allegheny Co.—Greensburg	Passenger cars	2,147	920
	Motor trucks	37	188
	Motorcycles	.....	.....
	Teams	1	5
	Total	2,185	1,113
Greensburg-Westmoreland Co.	Passenger cars	2,027	644
	Motor trucks	32	103
	Motorcycles	149	33
	Teams	22	20
	Total	2,230	800
Bedford-Fulton Co.	Passenger cars	690	285
	Motor trucks	51	101
	Motorcycles	28	11
	Teams	17	47
	Total	786	444
Bedford-Somerset Co.	Passenger cars	845	475
	Motor trucks	29	19
	Motorcycles	41	13
	Teams	6	....
	Total	921	507
Columbia-Lancaster	Passenger cars	1,722	460
	Motor trucks	44	115
	Motorcycles	76	22
	Teams	22	26
	Total	1,864	623
Lancaster-Chester Co.	Passenger cars	1,356	560
	Motor trucks	31	57
	Motorcycles	70	32
	Teams	34	13
	Total	1,491	662
Philadelphia-Paoli	Passenger cars	1,303	507
	Motor trucks	33	226
	Motorcycles	79	42
	Teams	11	9
	Total	1,426	784

(a) Number motorcycles for the two days—343.

TABLE II. TRAFFIC COUNT ON TWO SECTIONS OF THE WILLIAM PENN HIGHWAY, PENNSYLVANIA—6 A.M. TO 6 P.M.

Point Taken	Kind of Vehicle	July 25	July 26
Bethlehem-Easton	Passenger car	3,243	1,002
	Motor truck	75	270
	Motorcycle	159	60
	Team	8	25
	Total	3,485	1,357
Lebanon-Reading	Passenger car	1,431	431
	Motor truck	34	105
	Motorcycle	148	23
	Team	30	73
	Total	1,643	632

On the Post Road leading into Providence from the south, account made at Norwood showed a total number of vehicles—automobiles, motorcycles, auto trucks and heavy and light wagons—of 8,141 on July 25. The total number of vehicles on Monday, July 26, decreased to 3,902, and the number of auto trucks increased from 293 on Sunday to 583 the following day. Upon the Mendon Road leading into Providence from the north, a total of 4,542 vehicles was counted July 25. This number decreased to 2,864 on Monday, July 26, though the number of trucks jumped from 151 on July 25 to 671 on Monday, July 26.

TABLE III. COUNTS ON MAIN LINES LEADING NORTH AND SOUTH FROM PROVIDENCE, R. I., 6 A.M. TO 12 P.M.

Point Taken	Post Road—Austins Corners—Norwood								
	Sun.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.	
	July 25	July 26	July 27	July 28	July 29	July 30	July 31	Aug. 1	Weekly Totals Sundays, Averaged
Automobiles	7,522	3,129	3,207	3,689	3,687	3,331	4,114	6,274	23,055
Motorcycles	297	140	117	126	117	114	193	237	1,074
Auto trucks	293	583	620	628	710	840	508	331	4,201
Heavy wagons	20	22	13	14	16	14	21	1	111
Light wagons	9	28	24	21	19	26	29	24	163
Totals	8,141	3,902	3,981	4,478	4,549	4,325	4,865	6,867	33,604

Point Taken	Mendon Road—Berkeley								
	Sun.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.	
	July 25	July 26	July 27	July 28	July 29	July 30	July 31	Aug. 1	Weekly Totals Sundays, Averaged
Automobiles	4,152	2,047	1,872	2,055	2,074	2,036	2,432	4,376	16,780
Motorcycles	200	61	71	33	66	56	100	175	575
Auto trucks	151	671	554	661	602	658	642	253	3,990
Heavy wagons	2	46	22	33	23	21	32	6	181
Light wagons	37	39	43	33	24	25	49	15	239
Totals	4,542	2,864	2,562	2,815	2,789	2,797	3,255	4,725	21,765

The heaviest traffic in Pennsylvania was found to be traveling the Chester County section of the Lincoln Highway between Coatesville and Downingtown. On Sunday, July 26, 3,877 pasenger cars were counted on this thoroughfare, while the number of trucks was 82. The next day, Monday, the number of passenger cars decreased to 2,307, while the truck total jumped to 1,013. The total number of vehicles counted on this section of road on Sunday was 4,117, and on Monday, 3,437. The heaviest traffic on the William Penn Highway was found on the section between Bethlehem and Easton. On Sunday, July 25, 3,485 vehicles traversed this section of the highway, 3,243 being passenger cars and 159 trucks. The following day there was a total of but 1,357 vehicles, 1,002 being passenger cars and 270 being motor trucks.

Inasmuch as an average was taken of the two Sunday counts the figures given above represent but seven days traffic.

In all counts made in both states the week-day passenger vehicle traffic approximated 50 per cent of that on Sunday, while the week-day truck traffic was generally from three to six times that reported on Sunday.

Counts were made at 19 points in Rhode Island, in all cases the census extending over an 8-day period. Counts upon two of these sections are given in detail in an accompanying table. Sundays being averaged, the 8-day period reveals the passage of the foregoing number of passenger cars and auto trucks at the points indicated in Table IV.

Worcester's Water-Works Pipe Trenching Machine

THE trenching machine bought by the Water Department of Worcester, Mass., in 1913, continues to give good service according to a paper by George W. Batchelder, water commissioner, read before the New England Water Works Association at the recent Holyoke convention. Besides being used in Worcester whenever practicable the machine has been rented for use in Hartford, Conn., and Quincy, Dartmouth and Auburn, Mass. The rentals thus far total $9,011, not including work now in progress at Auburn.

The machine is a model O Austin, and cost $6,650 in 1913. It has buckets 18, 24, 30 and 36 in. wide, with teeth projecting 3 in. on each side so that cuts 6 in. wider are made. By barring down material on both sides of the trench it is possible to make still wider cuts.

The total cost of repairs and replacements thus far has been $3,864 and the machine is apparently good for many more years' service, Mr. Batchelder states.

When rented out the city charges 7.55c. per cubic yard for the use of the machine.

	Length of Trench Dug, Ft.	Hours Work
Aug. 18—Very coarse gravel	410	8
Aug. 19—Loam, hardpan and gravel	250	5
Aug. 20—Hardpan, clay and sand	380	6½
Aug. 21—Sand and fine gravel	165	3
Aug. 23—Filled land, very rocky	384	6½
Aug. 24—Coarse gravel and sand	438	8
Aug. 25—Very rocky and wet	445	8½
Aug. 26—Fine gravel and hardpan	295	5½
Aug. 27—Gravel, clay and hardpan	472	8
Aug. 28—Filled land, rocky	180	3½

The above table is the record for the machine on trenches 2 ft. wide and 5 ft. deep at Auburn, Mass., in August, 1920.

Tree Planting Along California Highways

Tree planting along the highways in California, when the trees are of a kind approved by the state forester, is favored by the state highway commission and "where planted in accordance with the terms prescribed in the permits, will be maintained by the commission." When the commission receives inquiries about tree planting on the highways an application for a permit is supplied. When this application is filled out and returned a field investigation is made by the commission and if this results favorably a permit is issued. This permit prescribes the kind and size of trees, exact location, size of holes to be dug, replacing of earth and protection to be given, etc. The commission is planning the establishment of a nursery in conjunction with the California State Board of Forestry.

LETTERS TO THE EDITOR

Pro-Federation Arguments Attacked

Sir—A reading of the arguments that accompany the Am. Soc. C. E. ballot on the question of that society entering the new Federation of Engineering Societies brings out two facts:

First: There is no essential difference between the present proposal and that which was defeated by the society last spring.

Second: No positive and definite reasons for entering the Federation have been advanced in these arguments.

The plea for a "Yes" vote reveals the same vagueness as to aims and purposes that brought about the earlier defeat of the proposal, and its resubmission at this time falls little short of being an affront to the intelligence of the society.

The chief argument and in fact the basis of the entire plea for the Am. Soc. C. E. entering the Federation is that "everybody is doing it." As a matter of fact only five of the seventy-one societies represented at the Washington conference have as yet joined the new Federation.

On the other hand the American Chemical Society has refused to join and the American Association of Engineers has indicated that it will do likewise. It appears, then, that the unanimity of which so much is made by the advocates of the Federation is not in accordance with the facts.

In becoming a part of the Federation the Am. Soc. C. E. has nothing to gain and everything to lose. The inequitable organization of the Federation, its hazy purposes, its vague promises, and the utter lack of positive and convincing argument in its support, all demonstrate that it offers no benefits to the profession at large that can possibly justify the sacrifices the Am. Soc. C. E. is called on to make.

JOHN P. HOGAN,
CLIFFORD M. HOLLAND,
FREDERICK C. NOBLE.

New York City, Sept. 27.

Shrinkage of Earthwork

Sir—For the information of your readers who are interested in the shrinkage of earthwork the requirements contained in the specifications of the Mississippi River Commission for levee work is given as follows:

"*Shrinkage.*—The allowance for settling or shrinkage of embankment will be 15 per cent of the net fill for scraper work, 20 per cent for wagon work, and 25 per cent for other methods including dragline and other machine scrapers regardless of the material used; and no embankment that is not carried up as above specified will be paid for. The allowance for shrinkage or settling must be so disposed on top and slopes as to give the required width of crown, and to fill out the slopes so as to make plane surfaces from edge of crown to base of levee after shrinkage has practically ceased. The contents of the levee, computed to the established net grade only, will be paid for.

"*Settlement of Foundation.*—Should the contractor desire payment for restoration of yardage due to settling of foundation, he must apply to the contracting officer for instructions regarding the erection of structures for the determination thereof, in advance of any work on sections on which such payment may be made, and he must erect at his own expense, prior to any work thereon, such structures as may then be required by the contracting officer. Should these requirements be fulfilled the contractor will be paid for the restoration of yardage due to settlement of foundation at the same rate as the other embankment, but he will receive no compensation for such restoration unless the instructions of the contracting officer in regard to the determination of quantities shall have been fully complied with."

These requirements have been adopted after a great many years of experience in levee construction work and have

fairly met the general conditions under which these levees are built. The varying character of the soil or earth borrowed, the time required for and the weather conditions during construction, as well as the method of construction, are largely the controlling factors of shrinkage. The settlement of the foundation of levees and embankments is usual and in some cases very considerable and this should not be attributed to or confused with the shrinkage of the borrowed earth. In levee work measurements are usually made in embankment.

H. N. PHARR, Chief Engineer,
St. Francis Levee District.

Bridge Junction, Ark., Sept. 22.

Sir—The theories advanced by Charles Prelini in support of his contention that earthwork does not shrink, *Engineering News-Record*, Sept. 2, p. 475, are exceedingly ingenious but, unfortunately, they appear to be lacking in facts for a foundation.

In the writer's letter, published in your issue of Aug. 19, descriptive of work on the Yale Bowl, it was stated that "The embankment was mostly formed from material scraped from the enclosed area." Consequently, all of the material which was spilled from the scrapers fell where it was picked up by subsequent passages of that machine, and there was absolutely no waste in transportation.

The same is true as regards material lost by erosion. In ordinary storms the water was readily absorbed by the embankment and it was only in rainfalls of exceptional severity that any of the sand was displaced. The small amount of material which was eroded was either washed down into the cut, from where it was subsequently replaced, or else caught and retained on the embankment by the concrete wall which surrounds the Bowl at the foot of the outer slope.

A theory to account for the difference in volume of excavation and embankment, in the case of the Yale Bowl, must be other than that due to loss of material either in transportation or by erosion.

CHARLES A. FERRY,
Engineer, Yale Bowl.

New Haven, Conn., Sept. 14.

Venturi Tube Suggested for Holding Vacuum in Siphon

Sir—The writer was much interested in a short article in the Sept. 16 issue of *Engineering News-Record*, p. 541, in which the use of a true siphon on a main supply pipe was described. The conditions in this case were comparable to those encountered by the writer about fourteen years ago where it was desired that a 16-in. riveted steel pipe line should be placed temporarily in service pending the completion of a pumping plant. A long crest with a maximum height of about 6 ft. above hydraulic gradient began a short distance from the intake of the pipe line and it occurred to the writer that it would be possible to siphon the water across this crest. With this end in view, a connection at the highest point in the line was provided, above which was placed an air chamber about 2 ft. diameter and 3 ft. high. A gage glass was placed on the side of the air chamber, near the bottom, so that the attendant could see when the surface of the water in the chamber approached the level of the top of the 16-inch. pipe.

When the chamber was pretty well filled with air, work was started with a hand-operated air pump (as I remember it, one of the same type generally used in garages years ago before the advent of the power-operated tire-pump) and by this rather laborious means the air would be cleared from the chamber. Of course, so long as the level of the water in the chamber was above the connection with the line the flow would be complete.

The only trouble we had in this case was the difficulty in preventing leakage of air into the riveted pipe line, as it didn't take much to keep the air pump at work pretty constantly. With this exception, however, the scheme was a success.

It has occurred to the writer, however, that in such cases as this, or the one described by Mr. Braun and Mr. Sherman, it would be easily possible to keep the air chamber clear of air by installing a venturi tube just below the hydraulic gradient beyond the crest (toward the discharge end of the line) and connecting the throat with the air chamber with the small tube. In the case described in the articles referred to a venturi tube for this 6-in. pipe, having a 2-in. throat, should, with a velocity through the full section of the pipe of 2 ft. per second, give a differential head more than sufficient to keep the chamber clear. This would mean a rate of discharge of but 175 gal. per minute. As a matter of fact, if the crest is but 3 ft. above the hydraulic gradient, it would be found that the required degree of vacuum would be about balanced by the throat velocity due to a discharge of about 90 gal. per minute.

While the use of the siphon has been very generally avoided in the past for very obvious reasons, in such cases as those referred to above the writer believes that it would be easily possible to adapt the venturi tube to the work of holding the required vacuum and offers the suggestion for what it may be worth.

GEORGE SYDNEY BINCKLEY.

New York City, Sept. 27.

Engineers in Public Service Would Gain by Uniform Classification

Sir—Engineering Council's proposed classification and compensation of engineers in federal, state, county and railway service is to my mind one of the most important movements recently put forth to bring about a higher state of efficiency in the engineering service of our public and semi-public institutions. I believe the same inducements should be offered to men entering the above branches of engineering as are offered to those entering private fields; namely, chances for continuous promotion based on the individual's ability and efforts.

At the present time the engineering field in public service is extremely limited. The engineer of ambition in a small town has very little hope after he reaches a high position there of advancing to a more responsible position in the larger town or city, for the reason that local civil service rules form a barrier through which he cannot pass without starting in the lower grades and working up in the particular town or community in which these rules are operating.

The universal adoption of a standard classification and compensation of engineers, such as proposed by Engineering Council, would be the first step forward by which the present complicated and inconsistent civil service grading might be abolished and in its stead a uniform system of grading and compensation established throughout the country. This would be a most important advance step, as it would pave the way for making engineering in the public service one large field where the engineer might start in Oshkosh as a "junior aid" or "junior assistant engineer" and work up through the various grades, ultimately reaching the larger and more important organizations in our larger municipalities or in the federal, state or county service.

It requires no unusual range of vision to picture a crying need for competent engineers who have been trained in the public service to properly and efficiently design, construct and maintain public works and to manage many of our cities. Every effort should be made now to lay a substantial foundation on which this important service to the community may be built. Every engineer and every technical society, whether it be an association, an organization or a union, should agree upon and get behind some such classification and compensation of engineers, as proposed by Engineering Council. When we have agreed upon this—and I think we have pretty nearly agreed now, at least in so far as the proposed classification is concerned—let publicity work begin. Let us go at this publicity work in an engineering-like manner, organizing in every town, city and state where engineers are employed on public work. Let us get to the newspapers, magazines, etc., and through them show the public in their own language the community value they will derive from making federal, state, county,

municipal and possibly railway engineering service one big field within which the best engineers will gravitate to the top if they are offered the same incentive as now exists in private fields, in addition to that very strong incentive for public service.

This is not an impossible dream; it is a worthy object in which the entire engineering profession should be interested, interested enough to make the public interested. It's part of our job to educate the public to the benefits that may be derived from the adoption of improved methods in handling public affairs. It's time, anyhow, that we began to talk non-technical language so some one besides engineers will clearly understand the importance of our economic and social functions.

Let's begin now! HARRY W. LEVY,
Department of Public Works, Borough of Manhattan.
New York City, Sept. 7.

Smooth Approaches and Floors Will Reduce Highway Bridge Impact

Sir—I read the editorial in your Sept. 7 issue regarding the necessity for a study of impact and its benefit on highway bridges. I think all highway engineers thoroughly appreciate the importance of this subject, for at the present time there is no information which would allow us to arrive at the result of the amount of stress generated by a moving load striking a bridge. There are so many factors that enter into this proposition that it seems to me it would be an extremely difficult and complicated matter to secure any formulas which would apply.

For practical purposes, it is my opinion that highway bridge engineers at the present time should take every possible precaution to make the approaches to bridges smooth, so that the impact from a load striking a bridge will be at the minimum. They should also see that the floors of bridges are laid properly and maintained in such shape that they may not be rough and uneven. In this way we can immediately preserve to the public the service of certain bridges which otherwise might be wrecked due to impact stresses.

It is my opinion, based on some practical experiences, that there are bridges which might fail if the floors are left uneven and rough, but which might easily carry the loads to which they are subjected if the floors are properly maintained, so that during the time that we are making investigations of theories, we should see that what we have is properly taken care of. C. J. BENNETT,
State Highway Commissioner.
Hartford, Conn., Sept. 14.

What Is Art?

Sir—Referring to the letter of John C. Trautwine, Jr., in the issue of Sept. 23, p. 619, under your heading "What Is Art?" I beg to subscribe to his statements and to the quotation from President Charles MacDonald's address at the Denver convention of the American Society of Civil Engineers in 1908.

When writing my thesis over 53 years ago, I selected the subject: "Aesthetics Applied to Bridge Design." A proposition was set forth therein, based largely on Greek and Roman art, that the lines and forms which appeared most beautiful to us were those which would most faithfully represent the internal stresses caused by the external forces acting upon the structure, with the least amount of material and arranged in the most economical way.

The internal forces result from the resistance of the material and the external forces from the loads upon the structure, both static and dynamic and from the wind, rain, and extremes of temperature. The measurements and the proportioning of all these forces are purely scientific, but form the artistic foundation.

To restate, the greatest beauty of form in a structure and its parts is secured by giving the required resistance to every attacking force with the least amount of material, and in the simplest and most direct way.

As a monstrous example of the combination of architecture and engineering in bridge construction, visitors to the Philadelphia World's Fair in 1876 may remember the double-decked bridge across the Schuylkill River of 400-ft. span. It is a double-intersection Pratt truss, which was then artistically (?) decorated on both sides by a sham face plating of cast iron ⅛ to ¼ in. thick, intended to resemble a roman arcade crossing the river. The columns enclosed the posts and rested on pedestals joined by a balustrade, all resting upon the lower chord. The columns were joined at the top by semi-circular arches just below the upper chord. The arcade rested on air and the diagonal tie-rods were in full view between the columns!

Fortunately, both for art and engineering, the weather soon rusted the thin iron sham and boys finished the job by practicing football against the corroding balustrade. Since removing the iron sham work the whole truss creditably and artistically shows what it is, without architectural embellishment, which, I feel sure, the Romans would never have endorsed and Americans will never repeat.

RUDOLPH HERING,
Consulting Engineer.
New York, Sept. 25, 1920.

Effect of Illumination on Two-Photograph Method of Detecting Motion

Sir—In your issue of Aug. 26, 1920, page 409, there is an article under the title "Changes in Configuration Revealed by Superposing Photographs." It is mentioned in the article that, to make effective this method of detecting changes in configuration by the superposition of positive and negative plates, the photographs must be taken from the same position, and the same camera and kind of plates should be used.

Another very important element to make this method successful would be that the exposures be taken under about the same direction of illumination. The method depends essentially on the comparison of lights and shadows, and it is apparent that the lights and shadows on a panorama taken with the sun in the east would be very different from the same view taken with the sun in the south or with the sun in the west. The effect of direction of illumination is very marked in the illumination of ornamentation on a building or other artistic objects due to the movement of lights and shadows under the different directions of illumination. It would appear to have an important bearing on the method outlined in the article. S. H. GRAUTEN,
Electrical Engineer, Kansas City Railways Co.
Kansas City, Mo., Sept. 2.

Dry Out Sweating Vault

Sir—The letter in the *Engineering News-Record*, Sept. 9, p. 521, in reference to the sweating of the concrete vault, is very interesting to us for the reason that we have had somewhat similar experiences in the past.

We do not know all of the conditions surrounding the construction of the vault but we are inclined to believe that a large part of the trouble is due to the fact that it has never been dried out, and we feel that the sweating would be materially reduced if the vault had once been dried out by the application of heat.

We have also conferred with an architect who has had a very extensive experience in the construction of banks and he advises us that he has never succeeded in constructing a vault below grade which did not sweat. This architect states that he has constructed a great many vaults which were waterproofed but on account of the difference in temperature between the walls and the interiors of the buildings the vaults continued to sweat. His practice, where a dry vault is needed, is to install a small electrical heater and an expeller fan; then every few days the heater is turned on to raise the temperature and the fan is started and the vault dried out. As soon as any noticeable amount of moisture collects again the process is repeated.

CHARLES F. DINGMAN,
Engineer, Flynt Building Construction Co.
Palmer, Mass., Sept. 16.

News of the Week

New York, September 30, 1920

Local Financing in South America Noted by S. T. Henry

Before the war South America depended largely on European capital to finance engineering work, but during the time that funds from foreign sources have not been available the plan of raising money locally has succeeded in many instances. This departure from precedent was observed by S. T. Henry, vice-president of the Allied Machinery Co. of America, who has just returned to this country after a six months' trip through South America and who, last week, described his experiences at a meeting in New York City of the members of the Allied organization.

If local financing can be further stimulated, as now appears probable, Mr. Henry believes that South America will afford many opportunities for contrators with modern construction equipment. The increased cost of labor has emphasized the value of mechanical plant, especially in view of the fact that the Latin American worker is combining a decreased efficiency with insistence on an 8-hour day. Under such conditions local contractors are realizing that the use of modern, labor-saving equipment is essential to the making of profits.

Five-Inch Pavement, Reinforced, Now California Minimum

At a recent meeting of the California Highway Commission it was voted that "hereafter, because of the rapidly increasing volume and intensity of the traffic over the state highways, no concrete base shall be laid on any state highway a lesser thickness than 5 in. and all concrete bases are to be reinforced with steel."

The instructions as to the method of placing the steel and its dimensions as explained by A. B. Fletcher, state highway engineer, are as follows:

"On all future day labor authorizations and contracts for the construction of concrete bases and for concrete shoulders the outer edges shall be reinforced by ½-in. square deformed steel bars placed longitudinally along the edges, centered in the depth of the slab and placed 2 in. from the outer edges. Such longitudinal bars shall be lapped 12 in. for bond. At intervals not greater than 30 ft. the bars shall be butted and not lapped. Transverse reinforcement shall consist of ⅜-in. square deformed steel bars placed transversely on 18-in. centers, such transverse bars being hooked over the longitudinal bars and securely wired thereto."

No Increased Expense from Amendments, Says President Davis

Arthur P. Davis, president of the American Society of Civil Engineers, has sent to *Engineering News-Record* the following reply to the communication by Willard T. Chevalier, published as a letter to the editor in last week's issue:

"Replying to the communication of W. T. Chevalier in your issue of Sept. 23, p. 617, the proposed amendments to the constitution would not commit the society to additional expense because the expenses of the Nominating Committee are paid now. If the new committee is larger this is more than offset by the reduction in the Board of Direction, which meets eight times a year to once for the Nominating Committee. The amendment provides for payment of expenses for only one delegate from each section, and that only once a year. This might slightly increase expenses if amendment F is defeated but not otherwise. I am informed that of the five members of the Northwestern Section who signed the "Appeal" four will vote for the amendments criticized after having studied them further. A similar proportion will probably obtain in other regions."

State Highway Officials to Meet

The American Association of State Highway Officials will meet in Washington Dec. 6 for a four-day convention. The decision to call this meeting was reached at a session of the executive committee of the association which met in Washington Sept. 21.

The executive committee conferred at length with Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads. They also had a round table discussion with the representatives of a number of manufacturers of motor trucks. The truck manufacturers advanced the suggestion that an educational campaign should be conducted among the users of trucks as to just what they should do to avoid damaging highways. If owners of trucks would do all in their power to reduce to a minimum the chance that their truck may damage a roadway, it is believed that they will be spared many burdensome regulations which are believed certain to come unless prompt steps are taken to reduce the amount of damage being caused by trucks. During the course of the conference a visit was paid to the experimental station of the Bureau of Public Roads at Arlington.

Urge Am. Soc. C. E. Members To Vote "Yes"

Proposed Amendments to Constitution of Society Endorsed in Printed Appeal Signed by 362 Men

Arguments in favor of the proposed amendments to the constitution of the American Society of Civil Engineers, which are before the members in the form of a referendum to be canvassed Oct. 6, are being distributed as a printed 4-page pamphlet addressed to corporate members and carrying 362 signatures. The communication follows:

The undersigned who are working for a really progressive policy in the society, inspired with a desire to add to the traditions and advance the ideals of the society, have followed the work of its Committee on Development with the deepest interest and are looking forward to the adoption of the proposed amendments, which are based upon its recommendations, as a proper means for advancing the professional standing and increasing the prestige of the society.

We appeal to the pride and deliberate judgment of the corporate members who desire a progressive policy that is in keeping with the time to weigh the facts carefully, believing it is their wish overwhelmingly expressed by the questionnaire ballot, canvassed April 14, 1920, that the society shall become "an active national force in economic, industrial and civic affairs"; and that the directors in each geographical district shall be nominated and elected by vote of the corporate members resident therein.

With the object of clarifying the present situation the following facts are set forth:

The Board of Direction submitted to the society amendments "A," "B," "C" and the substance of amendment "G" which had been reported by its special committee with the following comment:

"In preparing the proposals for amendments to the constitution submitted herewith, the special committee appointed by the Board of Direction has thought it best that the changes in the constitution of the society be limited at this time to those necessary to make effective the recommendations of the Committee on Development specifically approved by vote of April 14, 1920, upon the questionnaire."

Amendment A—It is urged as a reason for the defeat of this amendment that the society by undertaking "to co-operate in important economic, industrial, and civic movements," would cease to be a purely technical society and would thus be liable to taxation. A recent legal opinion, which the Board of Direction can confirm, shows that this statement is not true.

Amendment B—This amendment is verbatim as submitted by the Board of Direction. This proposal to assign all members of the society to local sections was approved by a $2\frac{1}{3}$ to 1 vote of the society, April 14. 1920.

Amendment F—This amendment remedies a great injustice. The constitution provides that there shall be included in District No. 1 the corporate members resident in the territory within fifty miles of the Post Office in New York City, or according to the latest year book, 1,248 members. Notwithstanding this fact there are included in District No. 1, 933 corporate members living outside of North America, making the total membership included in District No. 1, 2,181. District No. 1 now has a minimum representation on the Board of Direction of 30 per cent of the board's membership for 15 per cent of The corporate membership of the society resident in the district. In other districts the proportionate representation is much less. For example, in District No. 5 for over $9\frac{1}{2}$ per cent of the corporate membership there is a minimum representation on the Board of $3\frac{1}{3}$ percent. The proposed amendment reduces the minimum representation of District No. 1 on the board to $16\frac{2}{3}$ per cent for 15 per cent of the corporate membership.

It frequently happens that District No. 1 has a president, two vice-presidents and two or more past-presidents and then its representation exceeds 40 per cent of the membership of the board for 15 per cent of the corporate membership. The New York District, because of this excessive representation, has been able to control the policies of the society. It is contended that this amendment is in conflict with the constitution, which provides that members of the society shall be elected by at least 25 members of the board, whereas the proposed amendment provides only 24 members. The proposed amendment provides that all officers of the society at the time of its adoption shall serve to the end of the terms of office for which they were elected. For the year 1921 there will, therefore, be 26 members on the board; 25 in 1922; and 24 members in 1923. The proposed amendment provides the requisite number of directors for the election of members for more than two years, which gives ample time to further revise the present constitution.

Amendment G—Article VII, Section 2, differs in details as to the form of procedure as submitted by the Board of Direction. The election of the directors by the corporate membership of the geographical districts which they are to represent was recommended by the Conference of Presidents of Local Associations in 1915, was approved by a more than 4 to 1 vote of the society canvassed by the board in 1916, and by a $5\frac{1}{2}$ to 1 vote of the society canvassed April 14, 1920.

Section 3 of Article VII and Section 8 of Article VIII, providing for an Annual Conference of the representatives of local Sections as recommended by the Committee on Development, were approved by a $2\frac{1}{3}$ to 1 vote of the society April 14, 1920.

Sections 4, 5 and 6 are substantially the same as those in the present Constitution.

Amendments "A," "B" and "G" are based upon the recommendations of the Committee on Development which were approved by a 3 to 1 vote of the 1920 Annual Meeting of the society, by a minimum $2\frac{1}{3}$ to 1 ballot canvassed April 14, 1920, and by the 1920 Annual Convention by a vote of nearly 6 to 1. Those who have controlled the government of the society for the past twenty-five years now seek to defeat the expressed wishes of the society through unfavorable sentiment for the proposed amendments backed by arguments unsupported by facts and at variance with the spirit of these amendments.

"An Appeal for a Progressive as Against a Radical Policy" is in reality an entreaty to the membership to defeat the amendments and thus allow the present objectionable status to continue. It is stated: "These amendments are not those formulated by the committee of the Board of Direction appointed for that purpose. They are almost entirely the product of the radical faction of the society." On the contrary, one-half of the amendments the members are asked to vote against were prepared by a special committee of the Board of Direction. These amendments instead of establishing a political machine embody changes which are intended to democratize the society, and decentralize authority. The recommendations of the Committee on Development were accompanied by a budget, the result of careful study made after consultation with the secretary of the society; this budget showed that an increase of \$5 per annum in the dues of non-resident corporate members would provide sufficient funds to cover the increased expense resulting from putting its recommendations into effect.

It has been stated that it might cost \$16,000 a year for the expenses of delegates to the annual conference of representatives of local sections, on the basis of 80 sections. This statement does not seem warranted in view of the following facts:

1. The society is now liable for the expenses of 19 members of the Committee on Nomination.

2. There are 25 local sections in the society.

3. The budget, accompanying the report of the Committee on Development, contained an estimate of \$3,520 for the expenses of the delegates of 40 sections; from this amount was deducted the expenses of the members of the Committee on Nominations making a net increased expense of \$1,848 for an Annual Conference of the delegates of 40 sections.

4. The American Society of Mechanical Engineers, with over 12,000 members, had 38 sections represented at its last annual meeting and the cost was about \$1,500; \$3,500 is the estimated expense for the next annual meeting. Present allowance 10 cents per mile and \$4 per day at the meeting.

5. The American Institute of Electrical Engineers, with over 11,000 members, has 36 sections and the expense of the 30 delegates to the annual convention, June 29 to July 2, 1920, was \$2,500. Allowance railroad and Pullman fares and meals en route.

The proposed amendments provide a definite recognition for local sections—which they do not now enjoy. The details of administration are left to the Board of Direction, where they customarily belong.

The special committee authorized by the Portland Convention was not created for the purpose of making a general revision of the constitution, or to employ counsel to pass upon the legality of the amendments, but merely to report upon certain specific amendments considered by the convention and which are not involved in the present ballot.

The progressive development of the society must be accomplished step by step. The vote on the questionnaire April 14, 1920, emphatically indicated that the corporate membership of the society approved the progressive policy recommended by the Committee on Development. The proposed amendments are the next step in carrying out this progressive policy. Do not be induced by any appeal to vote against these amendments. Their defeat will indefinitely delay this progressive movement.

Every corporate member of the society should read President Arthur P. Davis' letter in Sept. 16, 1920 issue, *Engineering News-Record* (pp. 570 and 573).

If you have already voted you may withdraw your vote by dating, and endorsing over your own signature (handwritten not typewritten or printed) on the outer envelope in which you mail your latest ballot "Destroy previous ballot"; the ballot should be mailed not later than Sept. 30, 1920.

On behalf of real progress in the society the undersigned appeal to you, to vote *Yes* for the proposed amendments:

E. L. Adams, Louis J. Affelder, J. C. Akers, T. D. Allin, J. C. Allison, George G. Anderson, J. H. M. Andrews, H. C. Ash, Richard I. D. Ashbridge, Lionel Ayres.

Percival S. Baker, H. G. Balcom, Walter F. Ballinger, A. F. Barnard, E. C. Barnard, W. K. Barnard, Francis Bates, George L. Bean, F. Phillips Best, Thomas B. Blackburn, Louis P. Blum, C. K. Bowen, E. R. Bowen, S. W. Bowen, A. W. Bowie, Baxter L. Brown, Norman F. Brown, George Bryan, Jr., Morton Burden, C. A. Burnette, George W. Burpee, W. J. Burton, A. D. Butler, Gordon Butler.

H. F. Cameron, Charles C. Campbell, John F. Campbell, Horace T. Campion, C. M. Canady, John Carson, A. A. Casani, F. D. Cefalu, E. C. Chamberlin, Ralph H. Chambers, C. T. Chenery, J. N. Chester, William H. Chorlton, C. D. Christie, George L. Christie, H. L. Christie, F. B. Church, Leland Clapper, Edwin Clark, W. A. Clark, Francis A. Cokefair, E. H. Coleman, R. S. Colnon, William H. Connell, John S. Conway, William H. Crawford, E. W. Crellin.

C. M. Daily, A. M. Danzilli, J. H. Darling, A. L. Davis, C. E. Davis, D. E. Davis, Edwin F. Dawson, E. F. Delery, F. E. Dempsey, C. M. Denise, H. W. Dennis, F. G. Dessery, Richard G. Develin, James L.

de Vou, E. C. Dicke, O. H. Dickerson, Clark Dillenbeck, E. C. Dilworth, H. J. Doolittle, W. S. Doyle, E. H. Dresser, F. L. Dudley, Arthur J. Dyer.

William Easby, Jr., Samuel Eckles, J. H. Elder.

Edward B. Fay, F. H. Finck, Wager Fisher, G. C. Fitzgerald, Edwin J. Fitzmaurice, J. C. Fowler, Benjamin Franklin, Francis E. Freeland, Charles Frommer, George S. Frost, William C. Furber.

B. J. Garnett, J. T. Garrett, R. P. Garrett, O. H. Gentner, Jr., Elmer A. Gibbs, W. Herbert Gibson, Frank Gillelen, Irving D. Goodwin, A. E. Goodwin, R. R. Gould, R. R. Graham, William H. Gravell, F. W. Green, A. P. Greensfelder, William B. Gregory, Charles F. Gross, William G. Grove, N. C. Grover.

Albert B. Hager, John P. Hallahan, Milo C. Halsey, T. R. Halsey, John W. Hamilton, Charles Hansel, Andrew B. Hargis, C. H. Harlan, George R. Harlow, E. L. Harman, Stephen Harris, O. F. Harting, F. A. Hastings, Harry Hawgood, William E. Hawley, F. Henderson, V. K. Hendricks, Clemens Herschel, Harry A. Hickman, Louis C. Hill, Arthur Hirst, L. R. Hjorth, W. W. Horner, A. H. Horton, F. E. House, John J. L. Houston, Otis E. Hovey, R. H. Howard, John C. Hoyt, William H. Hoyt, Richard L. Humphrey, A. M. Hunt.

J. Granberry Jackson, Nathan B. Jacobs, Reginald H. James, Edwin S. Jarrett, A. N. Johnson, Alfred Jones, H. L. Jones, S. A. Jubb.

Alfred L. Kehoe, E. W. Kelly, Richard Khuen, Jr., G. W. Kinne, B. H. Klyce, Morris Knowles, William J. Kupec.

John F. Laboon, C. G. Emil Larsson, Harrison W. Latta, Ralph J. Lawrence, J. A. Lewrie, A. L. Lee, Marshall O. Leighton, S. H. Leister, Horace G. Leng, J. B. Leeper, W. I. Lex, A. R. Lindsay, C. E. Long, F. W. Lyon.

I. W. McConnell, H. E. McCool, Hunter McDonald, Morton Macartney, Charles MacDonald, John MacMillan, L. T. Maenner, R. G. Manning, Charles W. Martin, John Meigs, O. C. Merrill, William F. Miller, J. H. Miner, W. S. Mitchell, Frederic A. Molitor, Carl deMoll, Charles E. Mollard, Burdett Moody, F. C. Moore, Walter Moore, Jr., S. B. Morris, John F. Murray, William S. Nichols, C. W. Ogden, Ole K. Olson, F. H. Olmstead, William P. Parker, W. B. Patton, Walter Pearl, Emile G. Perrot, Arthur I. Perry, J. L. Pickles, Henry S. Prichard, B. B. Priest, Charles F. Puff, Jr., Marshall R. Pugh, C. D. Purdon, Clyde B. Pyle.

Earl Querback, Henry H. Quimby.

J. C. Ralston, R. J. Reed, P. J. Reich, John M. Rice, H. Ridgway, John E. Rockhold, W. E. Rolfe, Alstin O. Rose, George F. Rowell, J. W. Rowland, E. J. Ruff, S. Bent Russell.

C. W. S. Sammelman, Maurice R. Scharff, Nathan Schein, G. M. Schofield, H. H. Sears, H. J. Sharp, A. M. Shaw, William J. Shea, E. G. Sheibley, H. T. Shelley, E. H. Shipman, L. H. Shoemaker, Joseph G. Shryock, Joseph W. Silliman, J. W. Skelly, Joseph M. Slater, S. A. Sloan, C. E. Smith, Henry C. Smith, Pemberton Smith, Stanley Smith, A. L. Sonderegger, Ellis C. Soper, W. H. Spear, T. Nelson Spencer, N. S. Sprague, Herman Stabler, J. R. Stack, Norman L. Stamm, F. Charles Starr, Herbert H. Starr, Edward B. Stearns, F. LeRoy Stearns, Charles H. Stevens, John D. Stevenson, H. C. Stowe, H. Struckmann, J. T. Stuart, C. R. Sumner, S. M. Swaab.

E. G. Taber, C. M. Talbert, G. A. Taylor, G. Lewis Taylor, E. B. Temple, J. Hermon Terry, Franklin Thomas, C. J. Tilden, F. E. Trask, A. J. Turner, Daniel L. Turner.

J. H. Van Wagenen, Paul Voorhees, C. B. Voynow, R. E. Wachter, J. E. Wadsworth, Joseph C. Wagner, Samuel T. Wagner, O. A. Walt, J. J. Walker, J. S. Walker, Edward E. Wall, Albert K. Warren, C. L. Warwick, L. C. Wason, George S. Webster, Maurice A. Webster, William A. Weldin, R. C. White, W. M. White, W. E. Whittier, E. H. Wilcox, Frank L. Wilcox, T. J. Wilkerson, Marshall Williams, W. H. Williams, C. B. Wilson, D. R. Wilson, Percy H. Wilson, Lef. Winship, Francis P. Witmer, F. C. Woermann, J. W. Woermann, S. L. Wonson, W. H. Woodbury, Wilkie Woodward, Robert B. Woodworth, J. C. Wright, S. H. Wright, Alfred M. Wyman.

Walter G. Zimmermann.

A supplementary list of names received too late for printing in the foregoing pamphlet has been sent to *Engineering News-Record*. It follows:

A. L. Ackhart, Willard Beahan, John Boldt, C. P. Bower, J. H. Brillhart, Wendell P. Brown.

William J. Carter, H. W. Dimer, Charles Y. Dixon.

J. G. Esch, H. H. Esselstyn, P. P. Evans, Herman Fougner, Harry Fuller.

F. L. Gorman, L. M. Gram, Bernard L. Green.

R. L. Harding, R. Husselman, Edward Hutchins.

Theodore A. Lelsen, A. G. Levy, John E. A. Linders.

Philip O. Macqueen, W. M. Mitchell, J. E. A. Moore, Edgar B. Morris, David W. Morrow.

K. H. Osborn, R. B. Perrine.

Frederick D. Richards, James Ritchie, A. V. Ruggles.

James C. F. Shafer, Huntington Smith, F. H. Stephenson, D. Y. Swaty.

George H. Tinker, F. J. Van Hook.

E. M. Walker, W. J. Watson, D. R. Wells.

Am. Soc. C. E. Amendments Supported

In addition to the pamphlet urging the adoption of the constitutional amendments of the American Society of Civil Engineers, published in another column, the following communication has been sent in printed form to the corporate membership:

Amendments A, B, C and G to the constitution of our society, now before the membership, are the first step in carrying out those recommendations of the Committee on Development which were unanimously adopted after two years of study and debate by its members and which have been approved by the vote on the Questionnaire canvassed April 14, 1920.

Amendment A is covered by Question A1, which was approved by a vote of 2,889 to 910.

Amendment B is covered by Question B2, which was approved by a vote of 2,854 to 831.

Amendment C is covered by Question B6, which was approved by a vote of 2,583 to 1,149.

Amendment G is covered by Questions B3 and B5, which were approved by votes of 3,176 to 567 and 2,613 to 1,091, respectively.

Amendment F reduces the number of directors from 18 to 15 by reducing the representation of District No. 1 from 6 to 3; removes the secretary from membership on the Board of Direction; reduces the number of past presidents on the board from 5 to 3; and eliminates the requirement that at least one vice-president shall be a resident of District No. 1.

It brings squarely before the membership the question of whether in the future it shall be possible that District No. 1 with a resident corporate membership of 1,248 shall have as heretofore 12 votes out of 30 on the Board of Direction, giving it practically 1 for each 100 members as against 18 votes for 6,965 non-resident members, or less than 1 for each 380 thereof.

The question may be stated thus: Shall a small minority in New York City have, as in the past, virtual control of the affairs of a society having 85 per cent of its membership outside of that city, or shall the representation be so readjusted that the New York membership of the Board will be at least four, or one for every 316 members against a possible maximum of twenty for the non-resident members or one for each 364 on the basis of present numbers, and the governing body of the society become thereby truly national in its makeup?

Prof. Ira O. Baker, Mortimer G. Barnes, Prof. John H Bateman, Prof Arthur H. Blanchard, J H Brillhart, H. R. Buck, A. D. Butler.

John F. Coleman, Edward H Connor, Mortimer E. Cooley.

William L. Darling.

John Ericson.

William M. Gardner, John E Greiner

H. L. Haehl, John L. Hall, Charles Hansel, E. E. Haskell, John B. Hawley, W. H. Hoyt, Maj. W. C. Hoad, Clarence W. Hubbell.

Prof. Clarence T. Johnston.

Richard Khuen, Jr.

Maj. Theodore A. Lelsen.

Hunter McDonald, George C. Mason David A. Molitor.

Frank C. Osborn.

Arthur Pew, George S. Pierson.

J. C. Ralston, Prof. Henry E. Riggs.

E. C. Shankland, F. H. Stephenson.

E. B. Thomas, Prof. C. J. Tilden.

E. M. Walker, E. E. Wall, Dalton R. Wells, Gardner S. Williams, George M Wisner.

New Signatures to Supplementary Appeal Total 33

The following 33 additional signatures to the supplementary "Appeal" for administrative reforms in the American Society of Civil Engineers, as published in *Engineering News-Record*, Sept. 23, p. 617, have been received, this making a total of 115 names. This journal is informed that some of the names on the original "Appeal" are not on the supplementary circular because the subject is now under discussion in the local section to which the signers belong. Other signers, it is said, are not wholly in sympathy with the reforms advocated. The claim is made that many more have not responded because of the time limit that was set for the receipt of replies.

S. Barfoed, E. I. Clawiter, M. C. Couchot, Charles Derleth, Jr., E. C. Hutchinson, F. R. Muhs, M. M. O'Shaughnessy, S. B. Smith, J. J. Walsh, C. F. Loweth, W. L. Breckenridge, D. G. Brumley, C. B. Burdick, C. F. W. Felt, A. W. Newton, R. I. Randolph,

L. K. Sherman, C. L. Strobel, D. H. Maury, Elbert Reichmann, Edwin C. Finley, E. M. Hoopes, F. W. Cappelen, J. D. Wardle, R. T. Hartman, A. R. Swem, H. R. Green, J. R. Worcester, C. T. Main, F. M. Gunby, F. H. Fay, C. M. Spofford, C. R. Gow.

Ventilating Shaft Contract Awarded to Bryson

The first construction contract on the Hudson River vehicular tunnel, involving two ventilating shafts at the New York City end of the tubes, as described in this journal Sept. 23, p. 623, has been awarded to Thomas B. Bryson, whose bid of $650,802 was the lowest of the five opened Sept. 21.

Barber Asphalt Plant Burns

Fire, the origin of which as yet is undetermined, destroyed the Barber Asphalt Paving Company's plant at Maurer, near Perth Amboy, N. J., Sept. 26, causing damage which a preliminary estimate places in excess of $2,000,000. The fire spread over an area of six acres and, due to the dense smoke, caused from the explosions of oil tank cars, with difficulty was kept from spreading to adjoining manufacturing establishments, firemen being aided in fighting flames with searchlights.

Program Issued for Municipal Improvements Convention

The program has been issued for the 26th annual convention of the American Society for Municipal Improvements, to be held at the Planters Hotel, St. Louis, Mo., Oct. 12-15. The first day will be devoted to meetings of committees on specifications, to the reports of the officers of the society and to committee reports of a technical nature, such as water-works, street cleaning, etc. There is also scheduled for Oct. 12, a round-table luncheon discussion of the society's activities. The plan is for groups interested in certain subjects to gather about assigned tables, each of which will be in charge of a chairman.

A heavy schedule of technical papers and committee reports is planned for the remaining days of the convention. On the night of Oct. 14, the "Engineer Players," a group of members of the Engineers' Club of St. Louis, will present the morality play "Every Engineer." Other entertainment features include a golf tournament on Oct. 11, a reception and dance on Oct. 12, and an automobile sight-seeing trip.

Testing Material Standards Adopted

By letter ballot canvassed Sept. 1, 1920, the 23 tentative standards of the American Society for Testing Materials, accepted at the annual meeting in June, were adopted as standard. In addition the letter ballot was favorable to the revision in the Standard Specifications and Tests for Portland Cement providing for a 78 per cent fineness through a 200-mesh sieve. This becomes effective Jan. 1, 1921. The maximum vote cast for any standard was 158 and the maximum against 12, although the membership of the society is now well over 2800.

Belle Isle Bridge Plans Adopted

Detailed plans for the Belle Isle bridge, prepared by Esselstyn, Murphy & Hanford, engineers, have been adopted by the Detroit city council and it is intended to advertise for bids to be opened about Oct. 22 or Nov. 1. The engineers believe that if bids are opened before Nov. 1 it will be possible for contractors to have the work on the piers well under way before cold weather, and if the winter is an ordinary one it will be possible to continue work on the piers and foundations all winter. By the end of 1921 the piers should be ready for the steelwork and the bridge could then be completed by 1923, or even sooner if the conditions governing the supply of building materials should improve.

The bridge will be approximately 2,200 ft. long, comprising 20 spans 74 ft. to 135 long. The total width will be 88 ft., with 59 ft. roadway (asphalt pavement) for six lines of traffic and two 12-ft. sidewalks. No drawspan is contemplated, but the structure will afford an underclearance of 30 ft., sufficient for fire boats and pleasure vessels.

The detail plans have been made from the general designs submitted by a bridge commission made up of M. E. Cooley, University of Michigan, chairman; Prof. Emil Lorch, Prof. H. E. Riggs, Francis McMath, and William Kales. Prof. L. M. Gram was engineer for the commission. The cost of the structure is estimated at $2,000,000.

Board of Engineers to Report on Delaware River Bridge

A board of three engineers to make a traffic, location and design survey and report on a highway bridge over the Delaware River at Philadelphia was appointed on Sept. 23 by the interstate bridge and tunnel commissions of New Jersey and Pennsylvania in joint session. The board is composed of Ralph Modjeski, consulting engineer, New York; George S. Webster, chief of the Bureau of Surveys, Philadelphia; and L. A. Ball, consulting engineer, New York. Mr. Ball, a resident of East Orange, N. J., was selected by the New Jersey authorities to represent that state. Mr. Modjeski is named chairman of the board, at a fee of $20,000, while the other two members are to receive $15,000. It is not required that the members give their full time to the work.

For the survey and report an appropriation of $100,000 has been made by the commissions, this sum including the fees of the board members. In prior meetings the commissions received offers from various engineers in private practice to make such a survey and report thereon for approximately the amount stated, as reported in our issue of Aug. 19, 1920, p. 383. It is expected that the report will be completed within six or eight months. Three sites are to be investigated, one located south of Market St., the other two north of Market. Borings to disclose the foundation material, studies of property values and an estimate of the cost of the bridge are to be included in the report.

Declare Molasses Tank Safe; Dynamite Suspected

(Special Correspondence)

Expert witnesses testifying for the defense in the trial of damage claims against the United States Industrial Alcohol Co. for the deaths and injuries from the collapse of a large molasses tank in Boston on Jan. 15, 1919, have declared that the tank was safe although subjected to stresses of about 30,000 lb. per sq.in., that numerous other molasses tanks of the company along the Atlantic seaboard are more highly stressed and yet stand, and that all appearances suggest that a dynamite explosion wrecked the tank. F. E. Sherry, Prof. George F. Swain, Prof. George E. Russell, and L. E. Moore have testified for the defense. The defendant corporation has pleaded in defense of the damage suits that the failure was due to conditions beyond its power to control.

According to the testimony of the expert witnesses the tank, although stressed higher than might be desirable, was not stressed to the elastic limit of the material. From tests made on specimens of the material, the ultimate strength was found to be 55,000 lb. per sq.in., the elastic limit 33,000. The stress near a manhole where a vertical crack was found after the accident, was set by Prof. Swain and Prof. Russell at between 28,000 and 29,000 lb. per sq.in. Slightly higher stress existed at some other points. Metallurgists for the defense testify that the steel shows signs of severe shock and has no indications of a gradual drawing out and thinning down of the material. One witness living near the site of the tank testified to seeing a light smoke rise from the ventilator at the top of the tank a few minutes previous to the accident. Experts testify that this smoke can be explained only by the presence of a burning fuse.

Price Trend and Supply in the Cement Industry

By Owen M. Fox
Construction News Department,
Engineering News-Record

In view of the severe shrinkage in the construction industry many cement users have been led to the belief that shortage conditions prevailing for some months past should soon be overcome and that possibly lower prices might be imminent. Inquiry in the industry does not bear out this idea.

While it is true that construction is at a low mark all over the country it should be remembered that a larger proportion of cement is used in construction now than formerly. The greatest pressure of demand, however, comes from dealers supplying rural communities and agricultural districts. In such territory, small jobs which have been deferred for long periods on account of either war restrictions or, prior to the war, lack of money, are now going ahead, and these consuming units, small individually, form an enormous total.

These reasons explain why although production is now on a greater scale than it was last year, it is below demand. Car supply, so great a factor in the past, is gradually improving, but other obstructions, such as uncertain coal supply or inefficiency or scarcity of labor, still tend to keep most plants running with an output below capacity.

Prices have recently advanced to cover the increase in freight rates, effective Aug. 26, and the outlook gives no indication of an early reduction. Certain producers are paying from 75 to 85 per cent more for their coal, on contract, than formerly. In many instances only a fraction, approximately one-third, of their need is being supplied under contract and to supply this deficiency coal has been purchased in

the open market in competition with speculators and manufacturers of long-profit lines, at an advance over contract price of from \$3 to \$8 per ton. Furthermore, such open market purchases are frequently below the requirements in B.t.u. for the proper burning of cement to such an extent that 25 or even 50 per cent more coal is required to produce a specific quantity of finished product. Taking into consideration the fact that every dollar added to the cost per ton of coal increases the actual cost of cement five cents per barrel, it is seen that this cost has been materially raised by the prevailing coal hysteria.

Other features also add to the production cost. Car shortage means that producers must ship in whatever rolling stock is available. Much cement has been shipped in privately owned refrigerator cars, at a minimum freight charge of 50,000 lb., when the actual capacity of the car is much less, and at the expense of a stiff rental paid to the car owners. Cases are frequent of such excess charges amounting to \$25 or more on a car load, all of which must be added to the cost of cement to the ultimate consumer. Large sums have been spent in labor cost for cleaning stock cars which have been assigned by the railroads to cement hauling and the already troublesome labor factor has been intensified by men being required to perform this unpleasant and unexpected work.

We entered the building season this spring with reserve stocks far below normal and a multiplicity of factors have kept plants running at less than capacity so that there has been no chance to overcome the deficiency. Effort is being centered now on securing quantity production rather than economy. Should we pass the next six months with fuel, transportation and labor suffering no serious derangement, the 1921 season will open with ample stocks and some possibility of lowered prices. For the present each week sees some improvement in the car situation. Each week brings us nearer to a return to reason as regards coal prices. Each week therefore sees a slight improvement in the cement situation. But we have a long road to travel before supply equals demand and before any downward revision of price scales can be expected.

\$60,000,000 Needed for River and Harbor Work

Government river and harbor improvement work now is being carried forward at the rate of \$3,500,000 monthly. This is exclusive of the Wilson Dam, where the monthly expenditure is \$700,000.

Since the next appropriation bill will have to cover a period of 16 months, and as it is considered desirable to continue work at the present rate, it is expected that the next Congress will be asked to appropriate some \$60,000,000 for river and harbor improvements.

Edwin Thacher

Edwin Thacher, one of the pioneers of reinforced concrete in America, former chief engineer of the Keystone Bridge Co., known the world over as originator of the Thacher slide rule, inventor of the Thacher truss, the first deformed reinforcing bar, and an improved system of arch reinforcement, died Sept. 21, 1920, in New York City, at the age of eighty-one. He passed practically his entire professional life in bridge engineering, the earlier half in iron bridge construction and the later half in reinforced concrete. The

EDWIN THACHER

most notable achievements of his career were those of the former period; they include, besides the development of the slide rule and the truss which bear his name, a study of column strength leading to the deduction of the straight-line formula (in the publication of which, however, he was anticipated by Thomas H. Johnson, who had been independently studying the subject at the same time as Mr. Thacher), the preparation of extensive tables of stress coefficients for bridges, and the aggressive advocacy of rational detailing in iron bridge construction. Particularly through his stand for good details of design, including opposition to the then prevailing practice of using eccentric connections such as top-chord pin connections at mid-depth of a U-chord, Mr. Thacher exerted a strong and lasting influence on the development of bridge designing practice in the United States. His influence upon the younger men who worked with him was heightened by a generous and human disposition and a high character.

Born Oct. 12, 1839, at DeKalb, N. Y., Edwin Thacher obtained the degree of civil engineer at Rensselaer Polytechnic Institute in 1863. During the next five years he was successively assistant engineer of the Cedar Rapids & Missouri River R.R., of the U. S. Military Railroads, and of the Louisville, Cincinnati & Lexington R.R. Entering then the field of iron bridge building, he remained in this activity for more than thirty years. After two years as resident engineer of the Ohio River bridge at Louisville (recently rebuilt), he went to the Louisville Bridge & Iron Co (1870-80), became calculating engineer for the Keystone Bridge Co., of Pittsburgh (1880-83), and rose to the position of chief engineer of the company. In 1887 he left Keystone to become chief engineer of a bridge works at Decatur, Ala., which however failed soon afterward. Returning to Louisville he practised for five years as consulting engineer and bridge contractor (1889-94) and then formed a partnership with Henry Keepers, of Detroit, for similar practice (1894-99). During this period Mr. Thacher became interested in the Melan system of reinforced concrete arch construction, then being introduced by F. von Emperger, and took up the representation of this system in the West. In this capacity he developed the final designs for the Topeka reinforced-concrete arch bridge, a structure which as the largest of its type in the world marked an epoch in the development of concrete construction; and the firm of Keepers & Thacher secured the contract for the bridge and built it. From 1899 to 1901 as member of the firm Thacher & Conners he built two important bridges for the United Sates military government in Porto Rico. In 1901 he combined with William Mueser as the Concrete Steel Engineering Co., to develop jointly the Melan, von Emperger and Thacher methods of reinforced-concrete arch construction. He continued actively in this firm until 1912, since which time he has done only occasional professional work, finally retiring two years ago.

The widely used multiscale cylindrical slide-rule, with double 30-ft. scale, was devised by Mr. Thacher during or shortly after his Louisville period (being patented Nov. 1 1881). Some years later he developed a 24-in. flat rule with improved scale arrangement to keep the result on the rule at all times. While still at Louisville prior to 1880 he had begun the calculation of tables of stress coefficients for all current forms and proportions of bridge truss, including both iron, wood and combination. As finally used these tables included the Thacher truss, developed while he was at Keystone; it was a highly efficient form of partly single and partly double intersection truss, adapted particularly to combination wood and iron construction and considered to be largely free from thermal stresses. The Thacher reinforcing system for concrete arches was devised about the time he first interested himself in the Melan system, and his deformed bar was invented some years later. Mr. Thacher's work for the improvement of bridge design methods was at its height during his service at Keystone. His influence on this establishment contributed in a significant way to bringing the art to its present-day excellence of practice.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Valparaiso, Ind.; St. Louis, Oct. 12-15.
AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION, Chicago; Atlanta, Ga., Oct. 26-28.
NATIONAL DRAINAGE CONGRESS, Chicago; Atlanta, Ga., Nov. 10-12.

The Brooklyn Engineers' Club held a a special meeting Sept. 23 for the purpose of discussing the invitation extended the club by the Joint Conference Committee to become a charter member of the Federated American Engineering Societies. Richard L. Humphrey, chairman of the committee, was present and addressed the members.

The Rochester (N. Y.) Engineering Society, at its first fall meeting, Sept. 10, was addressed by Col. Samuel P. Moulthrop, whose subject was "Indian Life In and Around Rochester." The talk was illustrated with colored slides and dwelt particularly on the various trails passing through or near the city, as the Indian was the forerunner of the engineer in establishing lines of communication. The following officers have been elected for the coming season: President, Henry L. Howe, engineer in charge of city testing laboratory; first vice-president, Harold O. Stewart, production engineer for Max Lowenthal & Son; second vice-president, Charles C. Evans, architect; secretary, Joseph W. Ward, works engineer, Taylor Instrument Co.; treasurer, Louis J. Summerhays, of William Summerhays & Son.

The Engineering Society of Buffalo, including its affiliated bodies, on Sept. 21 unanimously voted to become a charter member of the Federated American Engineering Societies. Members of the Automotive Engineers Society, the American Steel Treaters Society, American Institute of Architects, American Chemical Society, American Society of Mechanical Engineers and the Electrical Engineers Society were present at the meeting. A project was discussed to incorporate the Engineering Society of Buffalo for the purpose of organizing the members of the various affiliated bodies on a united front for the discussion and solution of important engineering problems confronting the city and the western district of New York. Dexter S. Kimball, dean of the engineering school of Cornell University, and Richard L. Humphrey, consulting engineer, Philadelphia, and chairman of the Joint Conference Committee, addressed the meeting on the subject of the federation. Among the topics to be discussed during the fall and winter are the Niagara Falls hydro-electric development.

Personal Notes

PROF. FREDERICK H. NEWELL, head of the department of civil engineering, University of Illinois, and formerly director of the U. S. Reclamation Service, has resigned his position. Professor Newell was president of the American Association of Engineers last year and this summer acted as director of the field forces.

GEORGE C. BUNKER, in charge of water supplies on the Canal Zone, is now in the United States. He has recently visited Bogota, Colombia, where typhoid is endemic, to investigate the water supply for the board of sanitation, and in November will return to that city to install ten water sterilizing outfits.

WILLIAM EARL RUSS & CO. is the name of a new firm of architects and engineers organized, at Indianapolis, by William Earl Russ, architect, of that city, formerly with Frank M. Andrews of New York; Walter H. Scales, formerly chief designing engineer with the Lackawanna Bridge Co., at Buffalo, for the past year associated with Mr. Russ as chief of engineering and construction; and Ralph J. Batchelder, formerly with Allen & Collens, Boston, and Holabird & Roach, Chicago.

A. R. JONES, supervisor of tracks, New York Central Lines East of Buffalo, with headquarters at Clearfield, Pa., has been made division engineer of the St. Lawrence Division, at Watertown, N. Y., succeeding P. H. Winchester, transferred.

MERVIN E. LYLE, formerly assistant to the president of the Columbia Graphaphone Co. and for a number of years manager of the company's Bridgeport, Conn., factories, is now associated with Willard C. Brinton, consulting engineer, of New York, and has been appointed assistant to the president, Terminal Engineering Co., Inc., of which Mr. Brinton is president.

OSCAR ZOLOAGA, hydraulic engineer, of Venezuela, who is at present in the United States, recently inspected the Miami Conservancy District, at Dayton, Ohio. Mr. Zoloaga is constructing several dams in his country.

E. J. STEPHENSON, of Minneapolis, has been appointed civil engineer for the United Light & Railways Co., Davenport, Iowa.

WOUTER COOL, civil engineer, of Rotterdam, Holland, and Batavia, Dutch East Indies, is visiting the United States, on his way from Batavia to Holland, with a view to studying the dock and wharf facilities of this country. He has examined the waterfronts of San Francisco, Seattle, Vancouver and Portland and expects to make similar studies at New York and Boston. For the past five years Mr. Cool has been general harbor advisor to the Netherlands East India Government. Upon his return to Java, it is announced, he will be also director-general of the East Indies railroads. Mr. Cool is accompanied by U. DE RONDE BRESSER, dredging expert and general contractor, who constructed the harbor works at Soerabaja, and has handled several other large government contracts.

LLOYD ALDRICH, recently tendered his resignation as engineer of Sonoma County, Cal., effective Oct. 31.

F. C. FINKLE, consulting engineer, Los Angeles, has been appointed consulting engineer for the Victor Valley Irrigation District, comprising more than 70,000 acres in San Bernardino County, Cal., to supervise the design of an irrigation system for the district.

R. E. SPEAR, formerly engineer accountant for the Illinois Central R.R. Co. in the bridge, building and waterworks department, has accepted the position of borough engineer of Ambridge, Pa., which is operating under the city manager form of government with W. M. Cotton as borough manager.

ARTHUR M. SHAW, consulting engineer, New Orleans, will have general direction of the newly established civil engineering department of Loyola University in that city. He will also continue his office for private practice.

Obituary

JULIUS REICHEL, formerly civil engineer in the Carbondale, Ill., office of the Illinois State Highway Department, died recently at Havana, Ill.

CAPTAIN WALTER C. PATON, Corps of Engineers, U. S. A., formerly city engineer of Excelsior Springs, Mo., died in that city Sept. 11, at 38 years of age. He formerly lived in Kansas City and was chief inspector in the construction of the inter-city viaduct.

WILLIAM G. BUSSLER, chief engineer of the Waterloo (Iowa) waterworks, died Sept. 12, in that city. He was born near Waterloo, Sept. 30, 1864, and had been employed at the waterworks for 32 years.

HUGH B. RAINES, who was city engineer of Dallas, Tex., for twenty years, retiring several years ago when the commission form of government was adopted, died at Louisville, Ky., Sept. 17. Mr. Raines had lived for 45 years in Dallas and was 70 years old. During his service as city engineer he laid out and superintended the construction of some of the most important engineering works in Dallas.

S. D. PORTER, for the past twenty years city engineer of Peru, Ill., died Sept. 12, at LaSalle, Ill. He was born in Hatfield, Mass., Jan. 1, 1850, and studied engineering at East Hampton, Mass. Previous to his service with the City of Peru, he was for ten years connected with the Illinois Central R.R.

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc. — James H. McGraw, President

Engineering News-Record

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. Mehren, Editor

Volume 85 — NEW YORK, THURSDAY, OCTOBER 7, 1920 — Number 15

Leninism Rejected

LENINISM, outside of Russia, received three severe setbacks last week. The Italian workmen in the metal industry acquiesced in the government's proposed settlement and began handing back the plants to their owners. In France the Labor Congress definitely repudiated all attempts to control French affairs from the outside, having Moscow particularly in mind, and the American Federation of Labor, through Gompers and Woll, one of the vice-presidents, denounced the efforts of the British labor party to strengthen the Soviet power in Russia. All of which is evidence that the world is getting back to sounder thinking. The danger of the miners' strike in Great Britain, commented upon in these columns last week, also seems to be passed and with its passing goes, for the time at least, another revolutionary proposal. There is reason for confidence and satisfaction, and for trying by sound means to work out the problems between employer and employed.

Cutting Engineering Costs Unwisely

H. K. BISHOP, for sixteen months chief engineer of the Indiana State Highway Commission, was removed from office Sept. 1 because the highway appropriation "had been cut heavily by the tax board." The salary of the chief engineer has been $7,000 a year. Because surveys, plans and specifications covering work for a year in advance had been prepared the director of the commission felt justified in relieving Mr. Bishop. Seven thousand dollars a year is not a large salary for a highly trained technical man of 15 years experience with Federal and state roadbuilding organizations, particularly when expenditures he directs and work he superintends approximate one thousand times his salary. "Saving" the salary of one in such a responsible position is false economy. Competent engineering supervision should and must be paid what it is worth. Smaller salaries than that received by Mr. Bishop for the administration of large funds may mean mediocre engineering.

Moderation and Conciliation

FOUR WEEKS ago we expressed the view that there was need in the American Society of Civil Engineers to drop the bitter spirit which has been injected in discussions since last January and to get down to solid technical work. The response to that editorial expression has been widespread. New evidence has come that the members are tired of strife. They must, perforce, take interest in pending questions until they are settled, but they are anxious to see them disposed of and out of the way. Signs are, too, that those who have been extreme in their statements are inclining toward greater moderation not only of utterance but of view. There were those who, in the heat of discussion, were willing to believe their opponents guilty not only of insincerity but of a desire to use the society for their personal ends. Such beliefs are giving way to a realization that all parties are sincerely interested in the advancement of the society. They differ as to the effects of proposals and the wisdom of means. It is also realized now that of extremists, on either side, there are very few. This attitude is a clear gain. If it lead to moderate discussion, to dispassionate clarification of view on whatever else may need decision before the road is clear for solid technical work, it will help toward speedy and correct decisions.

A Decisive Step

FOLLOWING on years of discussion of projects for bridging the Delaware River at Philadelphia, the appointment of an engineering board to report on location and construction at last brings the enterprise to a definite start. Important as the step is for the immediately adjoining region, it may prove to have equal or greater importance for the country as a whole, by initiating the period of large highway bridge construction which, according to indications, lies just ahead. There has been little activity of this kind for years, and meanwhile the delays and losses resulting from the interruption of the national road system at main rivers have been making themselves more and more painfully felt. At Philadelphia it was the formidable growth of a demand for unhindered communication between the communities on the two banks that brought about definite action on the bridge project. The same demand exists wherever large streams cut the land in two, and it is bound to grow until it brings about the provision of suitable crossings. Thus, much large highway bridge construction is certain to be demanded and carried out in the early future. The Delaware bridge is the first undertaking of the new era, and it should give effective encouragement to many projects that are delayed by mere want of the courage to go ahead.

Improving Waterwheel Efficiency

THE description of the new record-breaking Niagara turbines which appeared in last week's issue is fittingly rounded out by Mr. Horton's résumé of hydraulic turbine practice on another page of this issue. Waterwheel design has progressed rapidly until now the finished machine is a marvel of efficiency and simplicity. In the large units particularly the small number and lack of complication of parts is remarkable and not even approached by any other kind of prime mover. Just now, however, improvements seem to be looked for only in mechanical refinements and Mr. Horton points out that while these are always desirable a more fertile field may possibly lie in hydraulic improvement, that is in some vital re-

arrangement of parts which would more nearly insure a full recovery of the energy of the water. Toward this end he suggests the necessity of minimizing the constraint of the water passing through the unit. In effect this is what many of the later improvements of the turbine do, but it is Mr. Horton's idea that carried further the idea may result in improving the full load-range efficiency, which has not kept pace with the full-gate efficiency. At any rate, while the principle may not go so far it is responsible for certain improvements that help to make the hydraulic turbine the prime mover paramount.

Financing Public Improvements

AN ARRANGEMENT worked out for financing the $200,000 St. Mary's Ave. grading and repaving project in Omaha deserves attention in view of present financial conditions. Seven interested property owners have deposited with a trust company funds sufficient to pay the contractor each month 80 per cent of the engineers' estimate. Upon completion of the work the city will issue district improvement bonds, which the company will carry until the special taxes have been paid. The principal object of the plan was to attract a large number of contractors who could not afford to tie up their capital for so long a period as would be necessary to carry out the work. R. N. Towl, commissioner of public works, who developed the scheme, is of the opinion that the 84-cent bid on earthwork was obtained because the payments were to be made available at once. Much added competition was obtained and the price is 14¾ cents lower than the Dodge St. grading work let a year ago.

Thicker California Roads

BY DECIDING to increase the minimum thickness of concrete pavement from 4 to 5 in. (see News Section, Sept. 30, p. 671) the California Highway Commission moves in a direction that has been frequently urged upon it. In addition, the 5-in. road is to be reinforced. When the 4-in. pavement, with a ¾-in. topping, was adopted about ten years ago, there was much criticism of the "shortsightedness" of such a policy. As the roads have aged, this criticism, instead of abating, has ripened into attack of one sort or another. At present it is active in the form of an injunction that has, for the time being, stopped work on every State highway contract. It goes without saying that the commission knew a 4-in. pavement was not the best that could be built. It was decided, however, that the broad way to begin on a highway system that would adequately serve California's great expanse of territory was to plan for the greatest possible mileage of well-located and well-graded road with as good a paving as was consistent, all factors considered. By strict requirements for well-prepared sub-grades, careful inspection of materials and mixing, and under California's favorable climatic conditions, the commission has added to the State road system over seventeen hundred miles of paved highway that has given good service. Evidence of what the people who use these roads think of them, as well as an indication of how this maximum mileage policy (always on a sound technical basis) won friends when they were badly needed, is found in the record of votes cast for the successive bond issues. The first issue ($18,000,000, in 1910) was vigorously opposed in some sections and was carried by the narrow margin of 1.3 to 1. The second ($15,000,000, in 1916) carried by 3.96 to 1, and the latest ($40,000,000, in 1919) by a majority of 7.03 to 1. Meantime, pavement has gone to pieces here and there, but on the whole it has stood up well, often under extremely heavy trucking operations that were never thought of until the concrete pavement appeared.

Doubtless the decision for a 5-in. minimum does not mean that thicker pavements will not be built. Surely they are justified in districts where exceedingly heavy trucking operations are carried on, such as in the rice-growing districts of the Sacramento valley. There are those who doubtless will contend that this minimum is not enough under any conditions to be found in the state. Nevertheless, the commission's decision to increase the minimum thickness to 5 in. and to use reinforcing is based on a long experience under one technical head, Austin B. Fletcher, who has been chief engineer of the commission since its formation. Under these circumstances one can safely look upon the new move as being as sound technically as was the adoption of the 4-in. thickness nearly ten years ago.

Commercial Aviation Progress

COMMERCIALLY aviation has not made as great progress in this country as in Europe. Here its greatest commercial use is in the mail service, a fact emphasized by the recent institution of the San Francisco-New York service, and the letting of contracts for Pittsburgh-St. Louis and New York-Atlanta routes. Of passenger business, however, there has been very little. The line between New York and Atlantic City, which has maintained regular service for some years, has required only one plane. Some of the eastern stores, for advertising purposes, have delivered rush parcels to their customers by airplane, and at one or two summer resorts flying has been among the season's amusements. Abroad, the great development has been the London-Paris service, but the London-Amsterdam and the Paris-Brussels routes are just as thoroughly established, though the travel by them is not as great. Four lines conduct daily services between London and Paris, a minimum of six planes a day being used in each direction. There have been occasions when as many as twelve machines left London in a single day. As late as last May the cost per flight was £15 15s. (approximately $75 at normal exchange), but the price has now dropped to £10 10s. (about $50). Short-distance flying, also, is more popular in Europe than here. In May while the golf tournaments were on at the Gleneagles course near Glasgow there was regular airplane service to the course from both Glasgow and Edinburgh, services widely advertised in both cities, in a matter-of-fact way. At summer resorts airplanes are popular forms of amusement, in Switzerland, for example, a single company maintaining no less than eighteen machines. Fifteen-minute flights were made at a charge of 90fr. for two persons, or about $9 per person. These planes may be engaged, also, for flights between any given points, tariffs being arranged and published covering a variety of conditions.

The popularity of the airplane can be gathered from the fact that in the year closing June 30 last the correspondent of the Paris edition of the New York *Herald* estimated, from conference with airplane interests, that 30,000 passengers have been carried in

commercial, pleasure, and exhibition flights at the grounds where commercial service is available in England alone. In these flights not a single casualty or serious accident was recorded. The leading English newspapers, notably the London *Times*, published daily a summation of "aviation weather," giving the wind direction and velocity in the upper air at 2,000, 5,000, 10,000, and 15,000-ft. elevations not only for the course between England and the northern continental points of Amsterdam, Brussels and Paris, but also for the whole of England and Scotland as well.

Lloyd's, the famous insurance house, as is well known, has for some years been writing insurance both upon passenger and goods transportation. So important has this branch of the business become, however, that it has recently begun the publication of an *Aviation Record* to serve the same purpose as its famous *Shipping Record*. It will contain complete listings of the airplanes and airplane companies furnishing commercial service, with records of the pilots, the histories of all the machines, etc., so that there can be, as time passes, more intelligent assessment of rates. In addition, Lloyd's has set up a technical committee on the order of its famous shipping committees, on which are represented the aircraft transport companies, aircraft builders, and underwriters. The purpose is to make such studies and recommendations as will decrease the risk of transportation by aircraft. It is expected that, in time, this will lead to certain standards for commercial airplanes.

While, therefore, through our mail service commercial transportation by airplane is making some progress in America we are far behind Europe. The progress there bears out the predictions which were made as many as ten years ago that the airplane would most certainly become a factor in commercial transportation.

Passing the Crisis in Transportation

WITH the end of maximum coal movement on the railroads this fall there is reason to look forward to at least temporary relief from the transportation crisis through which the country is passing. As a result of the ambitious program of the Association of Railway Executives to increase tonnage movement, most encouraging results have been secured by the efforts of the railroads, with the co-operation of shippers, as shown in current reports from almost all of the larger carriers. A very material increase in carrying capacity has been obtained with no increase of plant. To the construction industry the prospect should appear decidedly encouraging, but there will by no means be satisfaction with a situation so far from perfect. The construction industry itself, through the large proportion of shipping which it represents, can go far toward effecting immediate relief by the fullest co-operation with the railroads in loading and release of cars. But while temporary relief may be had by emergency measures—which even have included much Sunday work—we believe that the permanent cure of transportation ills lies in the hands of the engineer.

Constructive suggestions for broadening the engineer's functions in railroad operation may be found in the article on p. 693, in which the author brings out sound reasons for the proposal that the engineer be given definite recognition by creating the office of "transportation engineer." As the close relation of the engineer to railroad operation is seen more clearly by the managers, this new office would seem to be a logical development and, in fact, a move in this direction has been made by at least one large system. Through his training and exact knowledge the engineer is peculiarly well fitted to the duties proposed, which would open a new field not limited to design and construction.

For the reason that "transportation problems will be solved only by the application of engineering knowledge," it is proposed that every large railway system appoint an engineer to study problems of transportation, vesting him with the necessary authority. It would be his duty to apply engineering methods and logic to many phases of operation which have always been ruled largely by tradition—such as switching and freight-handling costs in large terminals. There is growing belief that the handling and rehandling of cars at many terminal points could be materially reduced and a decided improvement effected in the traditional methods generally used for handling less-than-carload-lots and trap car freight in most of the cities. Here, indeed, lies a vast field of opportunity for the application of engineering principles to such phases of operation as have heretofore been largely governed by custom and by rule of thumb.

Since so long a time must be consumed in extending and revising present transportation facilities to bring them to a point of adequate traffic carrying capacity, emergency methods must be used for some time. We believe that the railroad managements—realizing that failure to provide service would result in government operation, if not in government ownership—have made a supreme effort to meet the emergency. The results of the 30-ton-30-mile-per-day program of the railway executives merit the highest degree of co-operation on the part of all shippers. By capacity loading, regardless of low tariff minimums, and by quick unloading of cars, regardless of demurrage allowance, still more satisfactory results will be obtained.

Recently joint car service committees, consisting of construction men and railway executives, have been established in Boston, New York, Philadelphia, Baltimore, Pittsburgh, Cleveland, and Chicago to secure cars and materials needed for necessary construction which is actually under way and which is delayed or entirely stopped by lack of materials. The railroad representatives were appointed by the Association of Railway Executives, and the construction representatives were nominated by the National Federation of Construction Industries and appointed by the United States Senate's Special Committee on Reconstruction. Appeals for necessary car service should be addressed to the joint committees and if cars are not produced appeal may be made to the chairman of the Advisory Committee of the Association of Railway Executives, and finally to the Interstate Commerce Commission, but so far as is known all requests have been cared for by the joint committees without appeal.

A basis for effective co-operation has been formed between the railroads and the construction industry. In general, the railroads have demonstrated their good faith by the gratifying results already obtained. In the interest of the whole community, as well as the parties immediately concerned, the construction industry should and will do no less than its part in aiding the railroads by full loading, prompt unloading and the most effective use of cars.

Analysis of the Continuous Three-Column Foundation

Distribution of Base Pressure Controlled by Continuity of Main Grillage Girders—How Correct Lengths of Girder Projections Are Computed—Special Case of Limited Projection

By Charles A. Ellis
Professor of Structural Engineering, University of Illinois, Urbana

In designing foundations for high buildings the engineer frequently must place three columns on a single footing, using longitudinal supporting girders resting on shorter cross-beams bearing on the soil, in order to distribute the column loads over a sufficient area of foundation. In such a foundation he endeavors to obtain uniform soil pressure for the support of the concentrated columns loads involved He fixes upon the allowable unit bearing pressure of the soil, determines therefrom the required foundation area, and then shapes the footing by assuming arbitrarily either the length or the width of the footing to suit his convenience The last step of the process disregards the fact that the girders and their loading constitute a statically indeterminate system. Arbitrary proportioning of such a system results in making the soil pressure non-uniform (hence of excessive intensity at some points) and the bending moments in the foundation girders different from those contemplated in his design, which means reduced safety and economy.

A rational analysis of the problem is quite feasible. As the subject does not appear to have been discussed

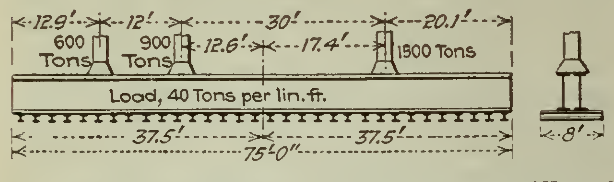


FIG. 1. TYPICAL THREE-COLUMN GRILLAGE FOUNDATION AS PROPORTIONED BY CUSTOMARY METHOD

previously, the writer proposes to give the theory and outline its application to several practical cases. From the theoretical standpoint there is a remaining difficulty in the solution presented: Since the foundation girders distort slightly in performing their office of distributing the loads, the assumption of uniformly distributed soil bearing pressure which the designer necessarily makes (in the present analysis as well as in customary procedure) is unavoidably vitiated. We have no data as to the importance of this effect, but it seems reasonable to conclude that a state of uniform pressure distribution is more nearly approximated when the problem is solved by an analysis that takes account of the continuity of girders than by the present arbitrary choice of proportions.

How the customary method involves arbitrary proportioning may be illustrated by reference to Fig. 1. In the case there sketched, the three column loads total 3,000 tons. A permissible soil reaction of 5 tons per square foot is assumed; hence the required footing area is 600 sq.ft. Next, the length and width of the footing are arbitrarily fixed by the designer as 75 ft. and 8 ft. respectively. The designer then determines the left-hand and right-hand projections of the main girders by finding the center of gravity of the three column loads (12.6 ft. to the right of the center column), and making this the center of gravity of the soil reaction, which requires that the foundation should extend 12.9 ft. to the left of the left column, and 20.1 ft. to the right of the right column.

A grillage so designed satisfies the three conditions of static equilibrium (sum of vertical forces, sum of horizontal forces, and sum of moments about any point, respectively, equal zero). It is therefrom concluded that the three concentrated loads are supported by a

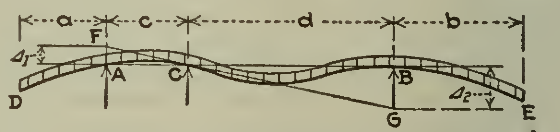


FIG. 2. DIAGRAM OF DEFLECTION OF UNIFORMLY LOADED BEAM ON THREE SUPPORTS
(Inversion of Three-Column Foundation)

uniform soil reaction of 40 tons per lineal foot. That this conclusion is fallacious, however, becomes apparent when the structure in Fig. 1 is inverted, and the soil pressure represented as a uniform load of 40 tons per lineal foot resting upon three supports, whereupon it is seen at once that the problem is statically indeterminate and that the odds are greatly against the probability of the reactions amounting to just 600, 900 and 1,500 tons respectively. In other words, the column loads being the given quantities, the soil pressures cannot be uniform, as assumed, and therefore it is likely that the bending moments in the girders will differ materially from those anticipated by the designer.

Girder on Three Supports

By way of introduction to the rational method, the general case of a girder resting on three supports and uniformly loaded (Fig. 2.) will be considered. Three independent simultaneous equations are required for the determination of the three reactions. The equation $\Sigma H = 0$ lends no aid to the solution, since all the forces act vertically. The two remaining static equations, $\Sigma V = 0$ and $\Sigma M = 0$, are necessary but not sufficient. The problem is therefore statically indeterminate. The third equation necessary for a solution is based upon the elastic theory of beams, and may be derived from the assumption that the three points of support A, C and B remain in a straight line (not necessarily a level line).

Let FG represent the tangent to the elastic curve $DACBE$ at C, and let $AF = \Delta_1$ and $BG = \Delta_2$ represent the tangential deviations of this curve at A and B respectively. Since these deviations are on opposite sides of the tangent, $\Delta_1/\Delta_2 = -c/d$, which is the third equation required.

Application of the three equations to practical cases differs in detail according to the physical conditions governing the problem. Three of the several possible cases are illustrated in Figs. 3, 4 and 5, and will be considered separately. In each case the following points are to be observed:

Each figure is shown inverted, for convenience. The known column reactions are represented by P, Q and R. The spacings of the columns, being fixed by the architectural features, are known, and are represented by c and d. The tangential deviations Δ_1 and Δ_2, not shown in the figures which follow, are to be taken as represented in Fig. 2. Three quantities, differing in each case, are to be determined by a solution of the three independent simultaneous equations cited.

Case I—Projections Not Limited by Site

Referring to Fig. 3, let w represent the intensity of a uniform soil pressure, in pounds per lineal foot. If the architectural conditions do not limit the end projections a and b of the main grillage girders, then it will be possible to attain this condition of uniform pressure by selecting a, b and w accordingly.

Equilibrium of vertical forces and of moments (in this case taken about the left end) gives two equations,

FIG. 3. DIAGRAM FOR ANALYSIS OF THREE-COLUMN FOUNDATION

the third being that for tangential deviation, derived above:

$$P + Q + R - (a + b + c + d)w = 0 \qquad (1)$$

$$aP + (a + c)Q + (a + c + d)R - \frac{w}{2}(a + b + c + d)^2 = 0 \qquad (2)$$

and
$$\frac{\Delta_1}{\Delta_2} = -\frac{c}{d} \qquad (3)$$

The expressions for Δ_1 and Δ_2 may be determined as follows: The bending moment between P and Q at any distance x from P is $M_1 = Px - \frac{1}{2}w(a + x)^2$, and the tangential deviation at P therefore becomes,

$$\Delta_1 = \frac{1}{EI}\int_0^c M_1 x\,dx = \frac{1}{EI}\int_0^c \left[Px^2 - \frac{wx}{2}(a + x)^2\right]dx$$
$$= \frac{1}{EI}\left[\frac{c^3P}{3} - \frac{w}{2}\left(\frac{a^2c^2}{2} + \frac{2ac^3}{3} + \frac{c^4}{4}\right)\right]$$

Similarly, the bending moment between Q and R at any distance x from R is $M_2 = Rx - \frac{1}{2}w(b + x)^2$, and the tangential deviation at R is, therefore,

$$\Delta_2 = \frac{1}{EI}\int_0^d M_2 x\,dx = \frac{1}{EI}\int_0^d \left[Rx^2 - \frac{wx}{2}(b + x)^2\right]dx$$
$$= \frac{1}{EI}\left[\frac{d^3R}{3} - \frac{w}{2}\left(\frac{b^2d^2}{2} + \frac{2bd^3}{3} + \frac{d^4}{4}\right)\right]$$

Inserting these values in eq. (3),

$$\frac{8c^3P - w(6a^2c^2 + 8ac^3 + 3c^4)}{8d^3R - w(6b^2d^2 + 8bd^3 + 3d^4)} = -\frac{c}{d} \qquad (3a)$$

The unknown quantities a, b and w are to be determined by solving simultaneously the three independent equations (1), (2) and (3a), as in the following numerical problem.

Illustrative Problem—Let $c = 12$ ft., $d = 30$ ft., $P = 600$ tons, $Q = 900$ tons and $R = 1{,}500$ tons. To solve for a, b and w, eliminate w from (1) and (2), and from (1) and (3a), obtaining,

$$b = a + \frac{c(-P + Q + R) + d(-P - Q + R)}{P + Q + R}$$

or, $b = a + 7.2$

and

$$6c(P + Q + R)a^2 + 6d(P + Q + R)b^2$$
$$+ 8(c^2Q + c^2R - d^2R)a + 8(d^2P + d^2Q - c^2P)b$$
$$+ (-5c^3 + 3d^3 - 8c^2d)P + 3(c^3 + d^3)Q$$
$$+ (-5d^3 + 3c^3 - 3cd^2)R = 0$$

or
$$10a^2 + 25b^2 - 372a + 468b = 10374$$

whence,

$$a = 7.8 \text{ ft.}, \; b = 15 \text{ ft.}$$

The length of the base, then, is 42 + 22.8 ft. or 64.8 ft., and the soil pressure per lineal foot is $w = 3000/64.8 = 46.3$ tons. If the permissible bearing pressure on the soil is 5 tons per square foot, the foundation should have a width of 46.3/5 = 9.5 ft.

Thus in Figs. 1 or 3, the girders should be about 65 feet long, extending approximately 8 ft. beyond the left column and 15 ft. beyond the right column. The beams of the lower tier of grillage should have a length of about 9.5 feet.

Case II—Projection at One End Limited by Site

Architectural features frequently fix the length at which the footing may extend beyond one of the end columns. Sometimes it is necessary to allow no extension whatever at one end. When either of these two limitations arises the footing may be so arranged that its pressure on the soil per foot of length varies

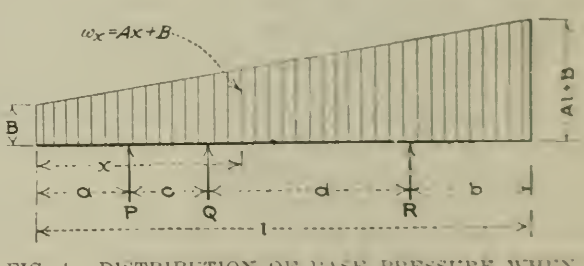


FIG. 4. DISTRIBUTION OF BASE PRESSURE WHEN PROJECTION AT ONE END IS FIXED

uniformly from one end to the other, as shown in Fig. 4. This may be accomplished by a variation in the lengths of the cross-beams, resulting in a trapezoidal area for the footing. Care should be exercised in the choice and spacing of the cross-beams in order that equal deflections at their centers may be assured.

Let the soil pressure per lineal foot at a distance x from the left end be,

$$w = Ax + B$$

Then the soil pressure at the left end will have the intensity B per lineal foot, and at the right end the intensity $Al + B$ per lineal foot. The three equations then become,

$$\Sigma V = Al^2 + 2Bl - 2(P + Q + R) = 0$$
$$\Sigma M = 2Al^3 + 3Bl^2 - 6aP - 6(a + c)Q$$
$$- 6(a + c + d)R = 0$$

and $$\frac{\Delta_1}{\Delta_2} = -\frac{c}{d}$$

The latter, on computing the values of Δ_1 and Δ_2, gives,

$$c\left[4(a+c)^3 + a\left\{3(a+c)^2 + a(3a+2c)\right\}\right]A$$
$$+ d\left[(a+c+d)^3 + (a+c)\left\{2(a+c+d)^2 + (a+c)\left[7(a+c)+3d\right]\right\}\right]A$$
$$+ 5c\left[3(a+c)^2 + a(3a+2c)\right]B$$
$$+ 5d\left[(a+c+d)^2 + (a+c)\left\{5(a+c)+2d\right\}\right]B$$
$$= 20\left[(c+d)^2 + c(c+d)\right]P + 20d^2Q$$

Three of the four quantities a, b, A and B may be determined from these equations. Either a or b is limited by the architectural conditions as we have assumed, and therefore the equations suffice for complete solution.

Illustrative Problem—Let P = 600 tons, Q = 900 tons, R = 1,500 tons, c = 12 ft. and d = 30 ft. The conditions of the site do not allow a to exceed 6 ft., and the designer desires to utilize this full amount; in other words, he fixes a at 6 ft., and has to determine A, B and b from the equations. These latter become,

$$Al^2 + 2Bl = 6000$$
$$2Al^3 + 3Bl^2 = 550800$$

and, $$8273664A + 824040B = 43416000$$

whence $$l^3 - 227.761l^2 + 13884.448l - 209928.788 = 0$$

$$22.78 \text{ ft.}$$

or, $$l = 66.58 \text{ ft.}$$

$$\text{or } 138.4 \text{ ft.}$$

If 66.58 feet is taken, then B = 55.98 and A = -0.328: the intensity at the right end is $Al + B$ = 34.13. That is, the reaction has an intensity of 56 tons per lineal foot at its left end, and decreases uniformly to 34 tons per lineal foot at its right end. Since a = 6 and l = 66.6 ft., the foundation extends b = 18.6 ft. beyond the right column.

The equations given for this case may be applied just as readily when the foundation may not extend beyond one of the outer columns (as when a = 0).

Case III—Both Projections Limited by Site

In the case illustrated by Fig. 5, where both a and b either are fixed or equal zero, the footing may be so proportioned as to produce a soil reaction whose intensity per lineal foot varies according to a parabolic curve. The soil pressure per square foot may be made uniform by varying the length of the lower beams of the grillage accordingly.

The dimensions a, b, c and d, and the loads P, Q and R will be known, while the three constants which determine the intensity of the soil reaction are to be determined by the solution.

Let the intensity of the soil reaction per foot of girder be

$$w_x = Ax^2 + Bx + C$$

so that at the left end the intensity will be C and at the right end $Al^2 + Bl + C$ per lineal foot. The three equations then become,

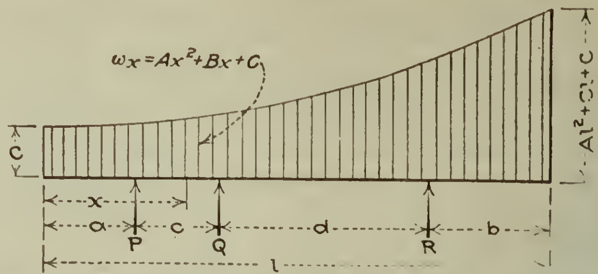


FIG. 5. BOTH PROJECTIONS LIMITED BY CONDITIONS AT SITE

$$\Sigma V = 2Al^3 + 3Bl^2 + 6Cl - 6(P + Q + R) = 0$$
$$\Sigma M = 3Al^4 + 4Bl^3 + 6Cl^2 - 12aP - 12(a+c)Q - 12(a+c+d)R = 0$$

and from $\Delta_1/\Delta_2 = -c/d$, the third equation,

$$c\left[5(a+c)^4 + a\left\{4(a+c)^3 + a\left[3(a+c)^2 + a(3a+2c)\right]\right\}\right]A$$
$$+ d\left[(a+c+d)^4 + (a+c)\left\{2(a+c+d)^3 + (a+c)\left[3(a+c+d)^2 + (a+c)\left\{9(a+c)+4d\right\}\right]\right\}\right]A$$
$$+ 3c\left[4(a+c)^3 + a\left\{3(a+c)^2 + a(3a+2c)\right\}\right]B$$
$$+ 3d\left[(a+c+d)^3 + (a+c)\left\{2(a+c+d)^2 + (a+c)\left[7(a+c)+3d\right]\right\}\right]B$$
$$+ \left[15c\left\{3(a+c)^2 + a(3a+2c)\right\} + 15d\left\{(a+c+d)^2 + (a+c)\left[5(a+c)+2d\right]\right\}\right]C$$
$$= 60\left[(c+d)^2 + c(c+d)\right]P + 60d^2Q$$

Illustrative Problem—Let P = 600 tons, Q = 900 tons, R = 1,500 tons, a = 6 ft., b = 12 ft., c = 12 ft.. and d = 30 ft. Then l = 60 ft.

Substituting the numerical values in the above equations and reducing,

$$1200A + 30B + C = 50$$
$$1800A + 40B + C = 51$$
$$623028A + 38304B + 3815C = 201000$$

The solution of these equations gives A = 0.0291, B = -1.646, and C = 64.466, and the intensity of the reaction at any point is, therefore, $w_x = 0.0291x^2 - 1.646x + 64.466$. Values of the reaction computed for the ends and five intermediate points are:

x Ft.	w Tons / Lin. Ft.	x Ft.	w Tons / Lin. Ft.
0	64.5	40	45
10	51	50	55
20	43	60	70.5
30	41		

Where the foundation must not extend beyond one of the outer columns, so that, say, a = 0, the equations still apply, and substitution of the numerical values in the algebraic forms given for Case III will supply the correct numerical solution. The same is true when the foundation is not to extend beyond either outside column, in which case a = 0, b = 0 are to be substituted.

Modern Developments of Hydraulic Turbine Design

Precedent and Principle as Exemplified in the New Niagara Wheels—Minimum Constraint a Factor in Efficiency

By Robert E. Horton

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In "Engineering News-Record," Sept. 27, 1920, p. 646, two of the foremost American turbine designers, Lewis F. Moody and W. M. White, described in some detail the new 37,500-hp. turbine units built by their respective companies for the latest American Niagara Falls development. The contrast between these two largest waterwheels yet built and the early foreign-designed and foreign-built wheels installed in American power plants is so marked that this seems a proper time for a résumé of hydraulic turbine practice, with particular relation to American contributions to such practice and the prospects for future improvements. Such an article has been prepared for "Engineering News-Record" by Mr. Horton.—Editor.

When American manufacturers undertook the development of modern specially designed turbines they nearly all imported Swiss or German designers. Without any intended disrespect, it is not too much to say that some, at least, of the foreign designers brought to this country were a bit "cocky" regarding their capabilities. Time has shown that American designers were able to learn all that the Europeans knew, and so far as printed records go there is nothing to show any work in the way of turbine designing done in continental Europe comparable in efficiency, capacity, or flexibility with recent American practice.

Today the hydraulic turbine is the simplest, most reliable, most durable, most efficient and most powerful per single unit of all prime movers. How this has come about is a long but interesting story, which will not be recounted here further than is necessary to show the bearing of precedents on the development of turbine practice and efficiency.

This process has taken place through the slow and costly operation of the logic of exclusion and the "survival of the fittest," but it has taken place almost entirely within the United States. Less than a century ago a turbine having a capacity of one-tenth of one per cent of that of the new Niagara units was about the available limit. Fifty years ago a turbine runner of one-tenth of the capacity of the Niagara turbines was considered large, and it is only recently that single runners as large as 10 per cent of the capacity of the Niagara units have been used. Among the earliest of these were the old Leffel Niagara turbines, deriving water from the same canal which supplies the latest installation.

Features of Niagara Turbines

Features of the new Niagara turbines of special interest are of two classes: (1) Structural and mechanical features, relating to provisions for durability, repair, and convenience of operation. (2) Hydraulic features, relating particularly to considerations of efficiency.

Among the structural features worthy of note are the use of the Johnson penstock valves, renewable parts for wearing surfaces, adjustable gate actuating mechanism, with provision to take up wear and avoid lost motion, complete separate hand control to permit of repairs of governors during operation and the provision of brakes.

In this connection the use of metal volute casings imbedded in concrete calls attention to the fact that although concrete alone has often been used for turbine spiral settings, yet in this instance because of the relatively great head, and the desire to secure maximum efficiency a metal lining of the volute was deemed necessary. One builder has chosen cast iron and the other steel plate for this lining. Arguments in favor of each are given in the articles referred to.

One reason advanced for the use of steel plate volute casings is freedom from casting strains. Still the runner of the same unit is made of cast iron, cast in one piece, and it would seem that in so complicated a casting as a waterwheel runner the danger of shrinkage strains and cold shuts is much greater than in the simpler cast segments of the volute casing.

Features of the design relating especially to hydraulic conditions include the use of carefully designed and formed volutes to supply the water to each wheel—the use of the hydraucone on one and the "spreading draft tube" on the other unit, the use of fixed auxiliary guides, forming also supports for the volute casting, in addition to the use of ordinary efficiency type guide-gates in the I. P. Morris unit, and the use of labyrinth clearance cells to reduce runner leakage from the same unit.

Simplicity Is Remarkable

Preliminary tests of the new Niagara turbines indicate turbine efficiencies of 93 per cent at full load. Part of the remaining 7 per cent is unavoidably consumed in mechanical and bearing friction, and some in skin friction. These losses represent energy supplied from the water, so that considerably more than 93 per cent of the potential energy of the water is abstracted therefrom in passing through the turbine runner. Equally high efficiencies have heretofore been obtained in a few instances, and there is nothing extraordinary about the efficiencies of these turbines, except possibly that the efficiency can be maintained high in so large a machine. The remarkable thing, and one which these particular turbines emphasize, is the fact that any hydraulic turbine can abstract anything like so great a portion of the energy of a stream of water by merely letting the water flow through so simple a thing as a turbine runner. The runner has been called a "thing" purposely, and not a mechanism, because a turbine contains only one moving part, properly speaking; namely, the runner, which in these instances is a single casting, yet capable of deriving 37,500 hp. from a stream of water.

The reader can readily make for himself a comparison of water turbines with other prime movers, as regards simplicity and efficiency. While a hydro-electric power unit, with its turbine, casing, gates, inlet valves, draft tube, and governor, is a fairly elaborate system of mechanism, yet the runner, the part that really does the work, is so simple that one stands in wonderment as to the manner in which so efficient a result is accomplished in such a simple way.

There is an old fundamental tenet of turbine design that "the water must enter without shock and leave

without velocity." Early experimenters naturally assumed that to attain this requirement the water must be guided smoothly and accurately through the turbine along predetermined lines of flow. The prevailing idea seemed to have been that a definite passage must be fixed in advance for each separate filament of water. Practically this could not be attained, but looking toward this end guide and runner vanes were multiplied and contorted. Fins were added in some cases to the vanes. The clearance between the guides and runner was reduced to a minimum, and in some instances grooves and convolutions were cast in the runner vanes, as if with the idea of suggesting to the water the direction it was desired that it should pursue in its course through the wheel.

Minimum Constraint Desirable

The invariable verdict of early Holyoke tests of such complicated contrivances was "weighed and found wanting." The more the water was tortured in its course through the wheel the less power it yielded. It is only recently that the idea of giving the water direction with only a minimum of constraint has been developed. Some direction is necessary as the water enters a turbine runner, as everyone knows water can only enter the buckets without shock when it approaches the wheel with a tangential component of velocity equal to the peripheral velocity of the runner.

The question may naturally be asked—Why did it take nearly a century for turbine inventors and designers to discover that they had hitherto mostly been working along lines contrary to high efficiency? In answering this question it may be stated that there is probably some misapprehension among those not conversant with this highly specialized subject as to just what is meant by turbine designing. Theory, meaning thereby the more formal and mathematical treatment of the subject, furnishes a basis for determining certain elements of a turbine design for specific conditions, including the diameter of the runner, the net cross-section of the water passages, and the guide and bucket vane inlet and outlet angles but theory in the sense referred to does not determine the best number of guides or buckets or the permissible clearance space between the inner ends of the guides and the outer edges of the bucket vanes—nor does it determine either the course or form of cross-section of the bucket passages. The design, so far as these elements are concerned, is a matter of common sense, experience and judgment, combined with certain requirements for strength and rigidity.

Water is a nearly incompressible and relatively frictionless fluid. If the mean path of the filaments of water through a turbine is correctly fixed, then within certain limits each filament forms in effect a guiding surface for the adjacent filaments. In other words, the water itself affords constraint, to which the water flowing through the runner naturally adjusts itself, and which is superior in every way to any fixed material constraint which can be devised. This principle of hydraulics received application in various ways other than in turbine design long before its import was fully appreciated—in fact it seems thus far to have been expressed only more or less vaguely, and never in succinct concrete form.

The matter of reducing the constraint of water in passing through a turbine has been carried to an extreme in a type of waterwheel recently placed on the market. In this turbine the runner vanes are reduced to three or four in number—the rim band is omitted—and the vanes are cut down to little more than a vestige of their categorical type, so that the runner resembles the form of a boat propeller wheel. A case and guides are provided like those of an ordinary turbine. Such a construction is reported to give efficiencies well up in the scale, though several per cent below the maximum of the best of the present existing types.

Here the reduction of constraint has apparently been carried too far for maximum efficiency, but something else has been accomplished, since it is found that such a turbine gives a flatter efficiency curve than any obtained hitherto by designs of the more usual type Precedents are found for this novel construction, not only in the well-known screw propeller but in some early turbines, such as the Bastian, a waterwheel largely used in the north for sawmills in early days because of its speed and freedom from obstruction. The runner was of the Jonval type, with only two vanes, set at a low angle, and with very large clear openings between them, affording so little constraint to the water that it was said of these wheels that a sawlog could pass through one of the buckets without injuring either the runner or the log.

Possible Improvements

The significance of all this is that it suggests the only possibility remaining open for any material hydraulic improvement in turbine design. Given 93 per cent maximum efficiency, as in the new Niagara turbines, and others of recent construction, there is obviously little to be gained in maximum efficiency, but that figure is attained at virtually one speed and one load only. Over the ordinary range of loads, say one-half to full gate, when running at constant speed, an average efficiency as high as 80 per cent has rarely been attained. It is possible that by a happy combination of limited restraints in guides and runner a turbine may yet be produced that will give an average efficiency near 90 per cent over the full ordinary range of loads, but the prospects are not very bright.

Referring to the matter of constraint of water, one of the significant differences between the Allis-Chalmers and I. P. Morris units of the new Niagara development is the use of preliminary or directive guides in the volute case in conjunction with the latter. Whatever may be their structural utility, some question arises in the light of experience as to their hydraulic value. The use of preliminary guides has abundant precedent, but the result is mostly against their use. There have been advocates of the other extreme, who favor the omission of guides altogether, a practice commonly followed in the early central discharge turbines with volute or scroll cases, and even with some earlier Jonval wheels, and following still earlier precedents of wooden flat vane central discharge wheels, which rarely or never had guides.

In view of the poor construction and meager experimental data of such early waterwheel types, it is impossible to determine with certainty whether the better efficiencies obtained following the insertion of guide vanes in the runner cases were really due to the use of guides or to improved construction. The general belief is that guides are beneficial, if not absolutely necessary, in all turbines, to secure maximum efficiency

at full load and gate, but this belief may rest too largely on their more apparent necessity for wheels in rectangular flumes. For wheels like the new Niagara turbines, in volute cases, there is still a question as to the hydraulic benefit derived from guides under full load conditions, at least. Of course with present-day methods of speed control they cannot be dispensed with since they are integral with the speed gates, but it is worth mentioning that some twenty-three years ago the late J. P. Frizell published an able discussion of water turbine possibilities, in which he suggested that maximum hydraulic efficiency and flexibility might yet be attained through the use of a turbine without guides.

Vortex Energy Recovered

Much of the energy of the water leaving a turbine runner is energy of internal motion in eddies and vortices. If this motion is suddenly arrested the energy will be dissipated, and if the eddies leave the draft tube with the outflowing water the energy is lost. The hydraucone and spreading draft tubes mentioned in the articles on the Niagara turbines appear to recover much of this vortex energy by reconverting it into potential energy within the draft tube itself. This is apparently accomplished through the application of the principle of minimum constraint. The water is constrained only so much as necessary to permit it to follow freely its natural lines of flow, leaving the eddies and vortices to cavort and contort at will and unhindered, until they are slowly and smoothly dispersed by fluid friction. Here, as De Vilamil pointed out a few years ago, internal friction of water may be a positive benefit in increasing the available efficiency, since, as Helmholtz showed many years ago, vortex motion would persist forever in a frictionless fluid, and the energy of eddy motion could not then be recovered. Incidentally, the Boyden diffuser applied about 1850 to early Fourneyron or outward flow turbines appears to have been a precedent of the more modern devices for recovering the energy of discharge from a turbine.

So far as the runners of the Niagara turbines are concerned, they apparently involve nothing new in hydraulics. The form of buckets or water passages through these latest and largest turbine runners differs but little from that developed by John B. McCormick, following the earlier attempts at the production of an efficient inward flow turbine runner by Howd, Francis and Swain.

McCormick's improvements, which have been so widely applied in American turbines of the stock pattern type, consisted in lengthening the bucket passages so as to give the water a chance to escape with a minimum velocity relative to the earth, and the shortening and tapering of the inlet cone, increasing the clearance between the guides and runner vanes. This type still persists, and undoubtedly will persist, and the modern turbine designer only modifies it to the extent of specifying certain dimensions, so that it may be adapted in advance to the specific conditions of load and speed. Incidentally, Mr. McCormick relates that the familiar extended spoon or ladle bucket form was discovered by accident. Under Mr. McCormick's direction, iron plate extensions were riveted on to the bucket outlet edges of an old inward flow turbine at a small Pennsylvania sawmill, to reduce the discharge capacity so that the wheel could run with the water supply available. To his surprise, the modification not only reduced the discharge of water but it also increased the power.

Naturally, other features than efficiency are important in turbine design. This fact is emphasized by the rapid displacement of efficient overshot waterwheels by crude turbines in the early decades of the last century. Overshot wheels, tested by John Smeaton, between 17[illegible] and 1760 in England, gave an efficiency often above [illegible] per cent, yet such wheels were rapidly replaced by crude turbines having efficiencies often of only 20 to 35 per cent. This was largely because of the high speed and compactness of the turbine wheel.

Spiral or volute casings for turbines have been long in use, dating back at least to the primitive flat vane wooden central discharge wheels of 100 years ago or more—so there are ancient precedents for nearly all the hydraulic features of the most modern turbines. It is in the adaptation of principles and practice formerly applied on a small scale to these large units, and the combination of the good features evolved during the past 100 years, but rarely hitherto all combined in a single turbine unit, which make the latest hydraulic turbine developments so remarkable for efficiency and other characteristics, as compared with the best of other types of prime movers.

There are, however, various matters related to the structural design of powerful turbine units such as these which have to be given very careful consideration, although they may be relatively unimportant in the design of the ordinary smaller hydraulic turbines. These include, for example, the problem of bearings, and the problem of designing a governor mechanism sufficiently sensitive to give speed regulation of a high order, and at the same time sufficiently powerful to move and control the enormous weights and inertia involved.

Advanced Hydraulics

At the recent Niagara professional meeting of the Engineering Institute of Canada, Frank Barber, the Toronto bridge engineer, told this story. He was having dinner at a small hotel in an upper Ontario town with several other transients, among whom was a talkative citizen who might have been a prosperous merchant or banker—at least one accustomed to be listened to. "Nice town you have here" opened this gentleman. "We think so," allowed Barber, not bothering to disavow a local status. "But you ought to develop all of this water power that's running away" said the man. "Well," returned Barber, "It would cost a lot of money." "Not at all," said the visitor, "Not at all. I guess you don't know about the way they develop power these days." "No," inquired Barber, "I guess I don't. Is it cheaper than they used to get it?" "Simple as can be," said the man. "All you have to do is to dig a deep hole in the ground, as deep as you want to provide machinery for, and put your wheels at the bottom of the shaft. You dig a canal to the top of the hole, the water drops down the hole and drives the wheel and there you are." "That's great," said Barber, "But I didn't quite get all the details of the scheme. What did you say became of the water after it got by the wheel?" "Young man" said the authority pityingly, looking around the table with the superior air of one who states the obvious "Young man, I guess you needn't care what becomes of the water after it has got the wheel to moving."

Jackscrews Tighten Wood Block Pavement in Place

Blocks Slid Together Over Pitch Bed Distances of 125 Ft. Each Way From Jacks—Movement in 250 Ft. Reaches 30 In.—Blocks Move Most in Direction Against Traffic

BY W. W. HORNER
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FACED with the probability of having to take up 7,500 sq.yd. of loose wood block at an estimated cost of about $10,000 there has been developed this year, in St. Louis, a successful method of tightening pavement without removing and relaying the block. Briefly the task was accomplished by cutting into the pavement at intervals, and tightening up the block on each side of the cut with jackscrews. In consultation with John Richards, block paving superintendent, the apparatus shown in Fig. 1 was developed. It consists of 4 x 6-in. timbers laid against the wood block pavement, and practically flush with the pavement surface. One of the timbers bored out takes the screws of short trench braces. These braces are equipped with large hexagonal screw nuts working against steel bearing plates, which rest loosely against the side of the timber. The width of the pavement from curb to rail is about 22 ft., and the jack frames were made 11 ft. long in order more nearly to fit the curve of the crown. Three jacks were used for each set. This original apparatus, and two other sets, slightly modified, were used, under the supervision of Mr. Richards, throughout the summer on this work. It was found possible, with the proper combination of hot weather and pressure on the jackscrews, to slide the blocks on the pitch bed over considerable distances.

DEVELOPMENT OF CONDITIONS REQUIRING REPAIRS

In an article in *Engineering News-Record*, April 22, 1920, p. 814, the writer recited difficulties encountered during the construction season of 1919 with the laying of new wood block pavements in St. Louis. Three projects were described, in the first of which, Contract *A*, the blocks shrank so badly after laying that the pitch filler settled under the blocks, completely ruining the paving. In this instance it was necessary to take up all of the blocks, clean them in tar kettles in creosote oil, re-lay them, and apply new filler. The total cost of this work was about $1.25 per square yard. In the second project, called Contract *B*, where the traffic was exceptionally heavy, and where the surface was almost continually shaded, and therefore at all times somewhat moist, no difficulty whatever was experienced, and the blocks remained in an ideal condition. On the third project, called Contract *C*, which was exposed directly to the sun, but which had considerable traffic, some difficulty was encountered. A number of the blocks floated with pitch filler, and the surface of the pavement for a short distance at the beginning of the work very seriously loosened and deteriorated. After this difficulty was discovered, the blocks on the remainder of this contract were paved very closely, and driven as tightly as possible by means of heavy sledges. As an additional preventive a somewhat harder pitch filler was used, and on a portion of the contract the bottom of the joints were swept full of fine dust for a depth of ¼ in. in order to prevent pitch in the joints from running underneath the block. By this means it was felt that the probability of trouble from shrinkage of the blocks was very considerably reduced, but in order to permit of a slower adjustment of the pavement, the blocks on this project were kept covered with sand, which was sprinkled heavily throughout the summer. As a result of the combination of these precautions, the surface of the street on Contract *C* remained in good condition throughout the summer and winter of 1919, and was in excellent condition in the spring of 1920. As it later developed it was the sprinkling of this pavement which was most effective in preventing shrinkage and floating during the summer of 1919.

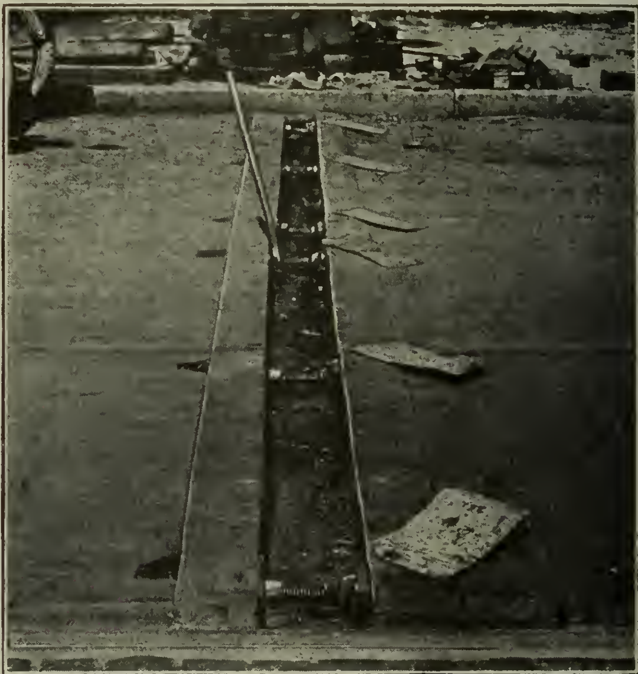


FIG. 1. ARRANGEMENT OF JACKSCREWS FOR TIGHTENING WOOD BLOCK PAVEMENT

In May, 1920, the sand covering had been washed from the street until only a slight resulting mat remained. During the first warm weather in May the pavement started bleeding, and although no bleeding had taken place in the first year, these blocks bled heavily during May and June. The street was sanded from time to time, but a series of heavy rains kept it washed fairly clean. In the dry weather of middle June the shrinkage of the blocks began, and went on in every respect as it had in Contract *A* the previous year. This resulted immediately in somewhat warped blocks, and in open joints, which permitted the blocks to rock under traffic, and which hastened the settlement of the pitch filler. As later investigation also showed, the bleeding of the blocks had very seriously cut the back filler, and there is no doubt that the filler in June, 1920, was much softer than the softest which had been put in the previous year. In fact, one sample of filler was found, the melting point of which was below 100 deg. This was an extreme case, and I should estimate that the melting

TABLE I. PROGRESSIVE MOVEMENTS OF POINTS 5-FT. APART IN DIRECTION OF TRAFFIC—FEET

Temp. Deg.	July	9	10	13	14	15	16	17	19	20
	Min.	80	69	82	78	77	79	80	67	
	Max.	83	81	93	84	84	88	92	83	
Distances Out from Jack-screws—Feet	5	0.06	0.22	0.39	0.54	0.65	0.92	1.13	1.16	1.26
	10	0.03	0.17	0.32	0.47	0.57	0.85	1.05	1.08	1.18
	15	0.01	0.11	0.25	0.39	0.48	0.74	0.94	0.98	1.06
	20	....	0.08	0.21	0.34	0.42	0.67	0.87	0.91	1.00
	25	....	0.05	0.16	0.29	0.37	0.62	0.80	0.85	0.93
	30	....	0.04	0.13	0.25	0.32	0.55	0.74	0.79	0.85
	35	....	0.02	0.10	0.20	0.27	0.50	0.68	0.72	0.80
	40	....	0.01	0.07	0.17	0.23	0.45	0.61	0.67	0.73
	45	....	....	0.05	0.14	0.20	0.40	0.58	0.61	0.66
	50	....	....	0.03	0.11	0.16	0.34	0.51	0.55	0.60
	55	....	....	0.03	0.09	0.14	0.30	0.46	0.50	0.55
	60	....	....	0.02	0.08	0.12	0.26	0.42	0.46	0.50
	65	....	....	0.01	0.05	0.09	0.21	0.34	0.40	0.44
	70	....	....	....	0.04	0.06	0.16	0.31	0.35	0.38
	75	....	....	....	0.01	0.04	0.04	0.24	0.27	0.31
	80	....	....	....	....	0.01	0.01	0.20	0.23	0.25
	85	....	....	....	....	....	....	0.18	0.22	0.23
	90	....	....	....	....	....	....	0.15	0.19	0.20
	95	....	....	....	....	....	....	0.11	0.17	0.18
	100	....	....	....	....	....	....	0.07	0.12	0.15

IN DIRECTION AGAINST TRAFFIC—FEET

Temp. Deg.	July	9	10	13	14	15	16	17	19	20
	Min.	80	69	82	78	77	79	80	67	
	Max.	83	81	93	84	84	88	92	83	
Distances Out from Jackscrews—Feet	5	0.05	0.25	0.44	0.60	0.76	1.02	1.14	1.19	1.30
	10	0.03	0.20	0.37	0.53	0.68	0.93	1.05	1.12	1.28
	15	....	0.15	0.31	0.46	0.61	0.85	0.94	1.02	1.13
	20	....	0.12	0.26	0.40	0.54	0.77	0.87	0.94	1.03
	25	....	0.09	0.20	0.33	0.46	0.68	0.78	0.85	0.94
	30	....	0.07	0.16	0.29	0.41	0.61	0.71	0.80	0.86
	35	....	0.05	0.12	0.24	0.35	0.55	0.64	0.73	0.79
	40	....	0.04	0.10	0.21	0.32	0.50	0.59	0.68	0.73
	45	....	0.03	0.08	0.18	0.27	0.44	0.52	0.60	0.66
	50	....	0.01	0.05	0.14	0.22	0.39	0.45	0.54	0.59
	55	....	....	0.05	0.12	0.19	0.34	0.40	0.49	0.53
	60	....	....	0.04	0.10	0.17	0.30	0.36	0.45	0.49
	65	....	....	0.03	0.08	0.13	0.25	0.30	0.39	0.42
	70	....	....	0.02	0.06	0.11	0.21	0.26	0.34	0.36
	75	....	....	0.01	0.04	0.08	0.16	0.21	0.29	0.31
	80	....	....	....	0.04	0.07	0.14	0.18	0.25	0.27
	85	....	....	....	0.02	0.04	0.09	0.12	0.20	0.21
	90	....	....	....	0.01	0.02	0.05	0.07	0.15	0.16
	95	....	....	....	....	0.01	0.02	0.05	0.11	0.12
	100	....	....	....	....	....	0.01	0.02	0.09	0.09
	105	....	....	....	....	....	....	....	0.06	0.06
	110	....	....	....	....	....	....	....	0.05	0.05
	115	....	....	....	....	....	....	....	0.03	0.03
	120	....	....	....	....	....	....	....	0.02	0.02

TABLE II. SHORTENING OF SPACES BETWEEN 5-FT. BLOCKS—IN DIRECTION OF TRAFFIC—FEET

Temp. Deg.	July	9	10	13	14	15	16	17	19	20
	Min.	80	69	82	78	77	79	80	67	
	Max	83	81	93	84	84	88	92	83	
Distances Out from Jackscrews—Feet	5	0.03	0.05	0.07	0.07	0.08	0.07	[illegible]	0.08	[illegible]
	10	0.02	0.06	0.07	0.08	0.09	0.11	0.11	[illegible]	[illegible]
	15	0.01	0.03	0.04	0.05	0.06	0.07	[illegible]	0.07	[illegible]
	20	....	0.03	0.05	0.05	0.05	0.05	[illegible]	[illegible]	[illegible]
	25	....	0.01	0.03	0.04	0.05	[illegible]	[illegible]	[illegible]	[illegible]
	30	....	0.02	0.03	0.05	0.05	[illegible]	[illegible]	[illegible]	[illegible]
	35	....	0.01	0.03	0.03	0.04	[illegible]	[illegible]	[illegible]	[illegible]
	40	....	0.01	0.02	0.03	0.03	[illegible]	[illegible]	[illegible]	[illegible]
	45	....	....	0.02	0.03	0.04	[illegible]	[illegible]	[illegible]	[illegible]
	50	....	....	0.00	0.02	0.02	0.04	[illegible]	[illegible]	[illegible]
	55	....	....	0.01	0.01	0.02	0.04	[illegible]	[illegible]	[illegible]
	60	....	....	0.01	0.03	0.03	0.05	[illegible]	[illegible]	[illegible]
	65	....	.	0.01	0.01	0.03	[illegible]	[illegible]	[illegible]	[illegible]
	70	....	..		0.03	0.02	0.02	[illegible]	[illegible]	[illegible]
	75	....			0.01	0.03	0.03	[illegible]	[illegible]	[illegible]
	80	....	.			0.01	0.01	[illegible]	[illegible]	[illegible]
	85	....	..					0.03	[illegible]	[illegible]
	90	....	..					0.04	0.02	[illegible]
	95	....				...		0.04	[illegible]	[illegible]

IN DIRECTION AGAINST TRAFFIC—FEET

Temp. Deg.	July	9	10	13	14	15	16	17	19	20
	Min.	80	69	82	78	77	79	80	67	
	Max.	83	81	93	84	84	88	92	83	
Distances Out from Jackscrews—Feet	5	0.02	0.05	0.07	0.07	0.08	0.09	0.09	0.07	0.02
	10	0.03	0.05	0.06	0.07	0.07	0.08	0.11	[illegible]	0.15
	15	....	0.03	0.05	0.06	0.07	0.08	0.07	0.08	0.10
	20	....	0.03	0.04	0.07	0.08	0.09	0.09	0.09	[illegible]
	25	....	0.02	0.04	0.04	0.05	0.07	0.07	0.05	[illegible]
	30	....	0.02	0.04	0.05	0.06	0.06	0.07	0.07	[illegible]
	35	....	0.01	0.02	0.03	0.03	0.05	0.05	0.05	0.06
	40	....	0.01	0.02	0.03	0.05	0.06	0.07	0.08	0.07
	45	....	0.02	0.03	0.04	0.05	0.06	0.07	0.06	0.07
	50	....	0.01	0.00	0.02	0.03	0.04	0.05	0.05	0.06
	55	....	....	0.01	0.02	0.02	0.04	0.04	0.04	0.04
	60	....	....	0.01	0.02	0.04	0.05	0.06	0.06	0.07
	65	....	....	0.01	0.02	0.02	0.04	0.04	0.05	0.06
	70	....	....	0.01	0.02	0.03	0.05	0.05	0.05	0.05
	75	....	....	0.01	0.00	0.01	0.02	0.03	0.04	0.04
	80	....	....	...	0.02	0.03	0.05	0.06	0.05	0.06
	85	...	....	...	0.01	0.02	0.04	0.05	0.05	0.05
	90	...	....	....	0.01	0.01	0.03	0.02	0.04	0.04
	95	....	....	...		0.01	0.01	0.03	0.02	0.03
	100	...	....	....			0.01	0.02	0.03	0.03
	105	.	....	...			....		0.01	0.01
	110	...	....	..			...		0.02	0.02
	115	....	.	.			..		0.01	0.01
	120	.							0.02	0.02

point would not generally average below 130 deg., or a softening of 20 deg.

In the first experiment tried, the blocks were moved for a distance of 75 ft. on each side of the cut. Later, with favorable weather conditions, it was found possible to move the blocks for a distance of 125 ft. on each side. The attempt was not made to force the movement of the blocks, but merely to keep a uniform pressure on the jack-screws in an amount which would be easily secured by the use of a long-handled wrench, and which could be followed up from jack to jack as fast as the flow of the pitch under the blocks released the pressure on the screw. The rate of progress, therefore, varied almost directly with the temperature of the pitch bed under the blocks, and this was determined by the general temperature and the amount of sunshine. The direct effect of the hot sunshine in accomplishing these results was very noticeable. An hour of this condition was worth several hours of a hot, cloudy day in facilitating the movement of the blocks.

A typical record of this movement—Opening No. 5—is shown in Tables I and II. The figures represent the movement, at points laid out in advance of the work, at each 5-ft. interval from the center of the jacks. Thus, on the first day, the points 5 ft. each side of the jacks moved, respectively, 0.05 and 0.06 ft. On the second day the total movement had become 0.25 ft. and 0.22 ft., and so on to the completion of this work, when the total movement secured on one side was 1.3 ft. and on the other 1.26 ft., or over 30 in.

The movement was primarily a closing up of open joints, and very little compression was put into the timber at any time. This is noted from Table II, which indicates the closing up of the spaces, between 5-ft. points. It will be noted that this closure in the vicinity of the jacks amounted to from 0.06 to 0.09 ft. for each 5 ft. of pavement, while at the extreme of the movement this reduced itself to practically zero.

Undoubtedly, by carrying on the operations for a greater length of time closures of as much as 0.06 ft. could have been secured 100 ft. from the jacks, but at this stage of the operations the progress was slow, and it was found more economical to remove the apparatus and to replace it further down the street in such position as to move the blocks back up to the point reached in its first location. The fact that no permanent compression was put into the pavement was indicated in several instances where, on the removal of the jacks, no tendency was shown in the blocks to creep back into the open slot of the pavement. In other cases, however, a slight pressure had existed, and the hole was closed up as much as an inch while it was being repaved.

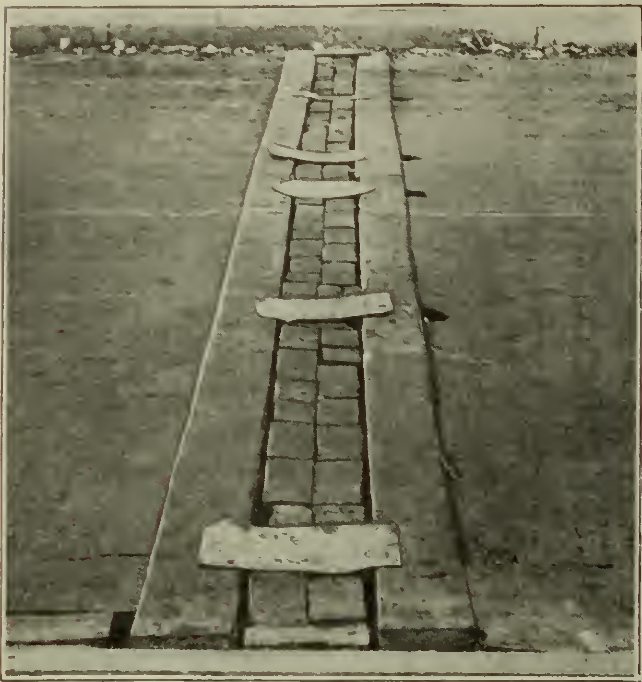


FIG. 2. JACKSCREW OPENING TEMPORARILY FILLED TO PASS TRAFFIC

Another very interesting phenomenon in connection with the operation of the jacks is shown by the relative motion of the opposite sides of the opening. As will be noted in Fig. 2, this work was all done under traffic. This was considered desirable, as it kept the blocks ironed out during the tightening process, and undoubtedly had a considerable effect in the smoothing out of the pavement. Traffic on this side of the street is from north to south, and at each opening the movement of the blocks towards the south, or with the traffic, was much less than the movement to the north, or against the traffic. In some cases, the movement with the traffic was only 50 per cent of the reverse motion. This was undoubtedly due to the tractive effort of the tires in pushing the pavement in the direction opposite to that taken by the vehicles. In Opening No. 5, however, the motion in the two directions was nearly equal, and this was accounted for by the fact that this opening was within 100 ft. of the intersection of a main thoroughfare, and that probably as many vehicles had occasion to stop within the area considered as there were vehicles which passed over without stopping, and that the braking effect of the stopping vehicles counteracted the tractive effort of those passing on.

In all, three sets of apparatus were used, and sixteen cuts were made in the pavement. In every instance the movement from adjacent jacks was made to come to a common point, so that when the whole of this pavement was tightened up in this manner the amounts of closure varied directly from the jacks to the intermediate points. The smallest amount of spread secured with any installation was 0.59 ft., and the greatest amount was 2.56 ft. The total of sixteen openings amounted to about 23½ ft., which was the length of the new wood block pavement inserted in the street. This is slightly less than 1 per cent of the original wearing surface, or about half of the measured shrinkage of the block.

The effect of this work on the pavement surface is noticeable in both Figs. 1 and 2, which are shown during the operation of tightening, as compared with the condition of Fig. 3. The surface has also improved somewhat since the removal of the jacking apparatus, and it appears that the effect of traffic is very beneficial to the surface after the blocks have been made to fit tightly together, just as the traffic was a factor in increasing the roughness of the pavement when in the condition shown in Fig. 3.

The pavement surface is now highly satisfactory, the result was accomplished without inconvenience to traffic, without the removal of any of the old pavement except that necessary to insert the jacks, and with practically no loss of blocks whatever. The entire work of tightening 7,500 sq.yd. was carried out with a force of one paver, a helper who adjusted the timbers, inserted the apparatus, repaved the wood blocks after the removal of it, and of one inspector who handled the wrench and kept pressure on the timber at all times. The work was interrupted for several days at a time by spells of cool weather, and the paver and helper were, during this time, used on miscellaneous adjustments and on the repair of high spots in the pavement. The work was started on June 14 and was completed on Sept. 14, at a total cost of about $1,200 for labor and supervision, and about $200 for new materials, a total of $1,400 or about $0.19 per square yard as compared to the $1.25 per square yard, the cost of relaying blocks.

As the street was originally paved, the blocks were laid tightly together, but were at their maximum size, and the shrinkage of two to three per cent which took place in the pavement left them entirely loose. The blocks in the shrunken condition have again been placed tightly together, so that the joints are wood to wood, or separated by a small amount of original filler which was squeezed up during the tightening operation. The blocks will probably take up some moisture during the wet season, and some internal pressure will develop, but this should not be sufficient to cause a blow-up at any point, and, in fact, is exactly the condition which was customary in the laying of wood blocks under the old specification for sand cushion and sand filler.

FIG. 3. CONDITION OF PAVEMENT BEFORE TIGHTENING

The writer has come to the conclusion that the shrinkage of wood blocks in the St. Louis climate in the last two years has been due to a great extent to the green condition of the timber treated, resulting in a block of maximum size on delivery, and to an equally great extent, in the specification for laying these blocks on a pitch bed and with a bituminous filler. Under this specification, the block is surrounded, except on its upper surface, with bitumen, and cannot take up any appreciable amount of water, while it can evaporate freely from its upper surface. This certainly must result in the lowering of the moisture content, and in establishing a normal moisture content much lower than that noted at the time of treatment, and, incidentally, much lower than the normal moisture content of the wood block pavements laid under the old specifications.

With the combination of expanded block on delivery and a thoroughly sealed street, shrinkage appears to be inevitable. The method of laying must take this into account by putting initial compression into the pavement surface as we are doing in St. Louis with our new work this year, or we must be prepared to return to the work and do the necessary tightening after the shrinkage takes place.

Slag Aggregate Makes Satisfactory Concrete

Tests made in 1916 and 1917 by the United States Bureau of Standards on the value of slags for fine and coarse aggregate have recently been reported. The concrete so made seems to be of an equal strength with concrete made from ordinary gravel. In the tests concrete of satisfactory local sand and gravel was made at the same time of the same cement and mix as the concrete using crushed slag furnished by three commercial companies. The consistency in all the concretes was the same as judged by eye. The slag was crushed to coarse and medium sizes, the former being fairly uniformly graded from ¼ to 1½-in. openings, through the larger of which 100 per cent passed, the latter being all through a ½-in. screen, 57.4 per cent through a ¼-in., and 6.2 per cent through a 0.85-in. screen, these figures of course being for only one of the specimens and being merely typical. The weight of the gravel was approximately 100 lb. per cubic foot, while the slag was between 70 and 85. The various slags had a sulphide sulphur content varying between 0.04 and 1.43 per cent. The strength of the various specimens varied according to the different times and the different mixtures of which they were made, but quite uniformly the crushed slag aggregate made stronger concrete than the Potomac gravel aggregate. The conclusions of the bureau are as follows: Crushed slag as a coarse aggregate produced concrete of as high a strength as gravel. The tests were not extensive enough to determine the durability of the slag, but to the extent of the tests there were no signs of disintegration due to the sulphide sulphur or other causes. Slag sand, because of its lack of fine material, does not produce easily workable concrete when used as a fine aggregate. If it must be used its working qualities can probably be improved by the addition of small amounts of fine sea sand, hydrated lime or other fine material. Provisions in specifications for slag aggregate calling for a maximum sulphide sulphur content of 1.5 per cent and a minimum weight per cubic foot of 70 lb. are tentatively recommended.

Experience with Slab Pavements at Minatare Dam

Break Repaired Temporarily with Sacks of Gravel Placed Shingle Fashion—Sills Under Hinge Joints for Repairs

FOR protection of a 150-ft. break in a concrete slab pavement of the Minatare Dam on the North Platte Project of the U. S. Reclamation Service, bags of gravel were used as a revetment until the slabs could be replaced. From the experience gained from this break and former failures in 1916 the engineers in charge concluded that the material of the earth dam may be prevented from being sucked out through the joints and cracks by placing concrete ribs on sills under the joints between courses, the latter to extend up and down the slope in an unbroken sheet. Such precautions are deemed unnecessary where a 12-in. layer of gravel or spalls is placed under the slab for a foundation. This last break occurred in April and W. H. Fisher, assistant engineer, tells of it in the September *Reclamation Record*. The proposed reconstruction is described also by Andrew Weiss, project manager, who gives the experience of the Service at several other points. Extracts from both papers follow:

The reservoir water level at the time of the storm in April was 3 ft. below that of maximum capacity. The waves reached a maximum height between crest and trough of 5 to 7 ft. and the face of the dam received almost the full effect of the waves. The slope on the reservoir side of the dam is 2½ : 1 from the base of the dam to the elevation of maximum high water. Above this point the slope is 2 : 1 to the top of the earth dam for a vertical height of 15 ft. A concrete parapet wall surmounts the top of the concrete slab 1 ft. above the top of the dam, thus affording a total freeboard above high-water level of 16 ft. The effective freeboard at the time of the storm was therefore 19 ft. The concrete facing was made up of 8-in. rectangular slabs 10 ft. x 20 ft. with the 20-ft. dimension up and down the slope. These slabs were not reinforced except for a few short bars placed near the horizontal joints of the slabs to strengthen them in transmitting the component of slab weights lying along the slope. The effect of this reinforcing is practically negligible as far as the strength of the slabs is concerned. The horizontal joints between slabs are rounded, but the transverse or sloping joints are straight vertical joints. All joints have one thickness of ruberoid roofing inserted to separate adjacent slabs. The width of the break measured along the dam was about 38 ft. extending from a slab joint 9 ft. above the maximum high-water level of the reservoir to a line roughly 6 ft. below the same datum or 3 ft. below the water level at the time of the storm. The slabs above the high-water line were not badly broken, but for the most part were simply dropped down or left standing on a steep slope against the nearly vertical earth face left at the back of the washout along the dam. The position in which these slabs were left prevented a more extensive earth washout before the storm subsided. The lower portions of the slabs seem to have been badly cracked or broken by the violence of the storm and were shoved out over the unbroken pavement below, together with the earth filling washed out. A total of about 550 cu.yd. of the earth filling of the dam was removed during the storm, the major portion of which was dropped onto the submerged paving below the break.

During the fall of 1919, when the reservoir was empty, a series of tests was conducted to determine whether any hollow spaces existed beneath the slabs near the high-water line. Holes 4 in. in diameter were chiseled through

the slabs at what appeared as likely spots for investigation, but no hollows of any consequence were found, the largest being not over 2 in. deep and 3 or 4 in. wide.

The Minatare reservoir has been in service five years. During that time numerous cracks have developed in the concrete facing, and several of the transverse or sloping joints have opened up to some extent. Most of these cracks or openings are negligible but some have reached a critical width of ¼-in. so that with violent wave action it is possible and indeed probable that some of the underlying material, which is mostly coarse sand, has been washed out, particularly along those cracks running up and down the slope. There was evidence of this along one of the sloping slab joints, which was exposed by the break, where a small pocket about 3 in. deep was visible directly under this joint at a point at least 5 ft. above the water level. Such pockets would probably reach a maximum size at or near the water level, and it is conceivable that when such a pocket had reached a certain size the impact effect of heavy masses of water falling on such a slab might ultimately cause a settlement of one edge of the slab, especially should there happen to be a longitudinal crack in the slab that would readily allow such settlement to take place. Cracks might then open up to such a degree as to wash out still more material, until actual undermining would take place, and the slab would drop and expose the underlying material to direct wave action.

Temporary repairs of the break were started two days after the storm by a force of six laborers breaking up the large pieces of dislodged concrete slabs with gads and sledges. The pieces were left as large as practicable for handling and were then built into a bulkhead or wall along the lower edge of the break which was under 2 to 3 ft. of water. This wall had a minimum thickness of 3 ft., and was built as tight as possible, using only the rough broken pieces of slab. There was enough broken slab available to carry this wall to a height of about 3 ft. Coarse gravel was dumped on the crest of the dam immediately above the break. A single pulley block was anchored near the water line with a team on one end and a mormon scraper on the other. The team was kept on the dam and two men handled the scraper, pulling the gravel over the parapet wall and down into the cavity, which was thus filled to within 2 ft. of the original surface of the paving. A gang was then started filling sacks with gravel and placing them shingle fashion, starting at the bottom. First a layer was made of burlap sacks and then two layers of cement sacks on top. These sacks extended well over the top of the wall.

Proposed Reconstruction

A similar but less serious failure of a portion of the paving of Minatare dam occurred in August, 1916. Its cause was thought to be primarily the settlement of the dam foundation, which was noticed during the time of the building of the dam, and caused a series of horizontal cracks in the paving. In some cases these cracks became sufficiently enlarged to permit the wave wash to suck some of the fine material from under the blocks, thereby partly undermining them. As this process advanced the facing blocks finally lost support, and horizontal cracks opened until failure occurred.

Numerous tests were made over the entire facing, especially near the places where these horizontal cracks had developed, to determine the extent and location of hollows which had formed or were in process of forming. A compressed-air grouting machine was installed, the defective places in the face being tapped with holes and grout forced into place to refusal. The broken portion of the pavement was replaced after the close of the irrigation season in 1916 and no further deterioration was noted on the facing until the recent break.

The repair of the present break is thought to be a simple matter of replacing the broken paving with slabs of the original thickness 10 ft. in width and either of continuous length or with hinge joints horizontally placed, as originally built. This paving should be reinforced with ¼-in. square bars, slab reinforcement being placed horizontally as well as along the slope. Under the joints it is suggested that concrete sills 6 in. thick and 12 in. wide be placed to prevent the further removal of fine material by sluicing from underneath. This means of prevention was adopted in the case of the Pruitt Reservoir, illustrated on p. 103, vol. 77, *Trans.* Am. Soc. C. E., 1917.

An effort will also be made to locate any further hollow places which may have formed under the paving elsewhere, particularly where any other cracks are noted through which the sand may have been drawn by the wave action.

The behavior of the Minatare dam facing suggests that wherever it is desirable to omit the screened gravel layer between the concrete facing and the body of the dam the facing should be reinforced and placed in continuous layers from bottom to top, or in slabs of not less than 20 ft. length with hinge joints, and that the joints between these courses be underlaid with reinforced-concrete stringers or ribs, which would prevent the sucking of sand from under these slabs. It is very seldom that unscreened gravel can be obtained containing a sufficient proportion of coarse material to resist effectively the wave wash. In consequence a crack of any size, even a temperature crack, becomes a source of danger unless the underlying material is in some manner protected from resulting suction.

There has been so far practically no trouble whatever on this project with dam facings constructed of layers of unscreened material overlaid with screened gravel or spalls, on top of which was placed loose rock paving. This method of paving has proved an excellent protection at the Pathfinder Dike, and also at Lake Alice, where no repairs have been necessary since those dikes were built seven years ago.

Two Sources of Brittleness in Steel Rails

According to a review of the present status of our knowledge of brittleness in steel rails, presented as a report to the Rail Committee of the American Railway Engineering Association by M. H. Wickhorst, engineer of tests to the Rail Committee of the association, brittleness is of three kinds, showing itself in fracture starting (1) from an area of segregated carbon and phosphorus, (2) from a minute internal crack, and (3) from a seam (narrow groove) in the bottom face of the base. Both of the first two causes are responsible for failures which originate in the head or develop when the rail is so bent as to put the head in tension. Fractures developing when the base is in tension are due to the first and third causes only. While brittleness due to segregated areas exist simultaneously in head and base of the rail, the segregation generally extends farther into the head than into the base, and therefore is more readily detected by bending with head in tension than with base in tension. Mr. Wickhorst consequently recommends that in acceptance bend tests to determine ductility the head should be put in tension. Bend tests show the same ductility whether the drop testing machine or a hydraulic bender be used, but in the former case the impact is likely to break off the flange in case there are seams in the base, which would defeat the object of showing the actual ductility of the metal. The hydraulic bender, which always gives normal tension breaks, is therefore recommended as preferable to the drop testing machine. Segregation of carbon and phosphorus causes not only longitudinal but also transverse brittleness, the latter producing split heads when the top part of the head flows under the rolling action of wheels. The same effect may be due to large amounts of non-metallic inclusions, commonly manganese sulphide.

Boston Molasses-Tank Trial: The Case for the Defense

(A bomb caused the notorious molasses-tank collapse, it is maintained by the defense—the company owning the tank—in the trial of damage suits now in progress. All reports of the accident directly after it occurred, and the facts developed in the official inquest by the municipal court, indicated that the tank was seriously defective, and was so highly overstressed that its failure in service was to be expected. Because of the opposite character of the explanations of the collapse, a summary of the facts and expert opinions advanced by the defense has been secured by our technical correspondent—EDITOR.)

TRIAL of about 100 damage suits brought against the United States Industrial Alcohol Co., owner of the molasses tank in Boston which collapsed on Jan. 15, 1919 (see *Engineering News-Record*, Feb. 13 and May 15, 1919, pp. 353 and 974), killing 12 persons, has now been progressing before Col. Hugh W. Ogden as master for nearly seven weeks. The plaintiffs contented themselves in direct evidence with proving the ownership of the tank and the damages done. Such expert testimony relating to the structural soundness of the tank or other matters as they may have to present is apparently being held back to be submitted in rebuttal of the defendant's case. The interesting features of the case thus far made public are, therefore, included in the defendant's case, which now seems to be nearly complete.

The defense is that the failure of the tank resulted from the explosion of a bomb or its equivalent maliciously placed in the tank and thus from causes over which the company could have no control. Testimony has been presented to show that the company had had labor troubles involving damage to property; that two of its nearly new tank steamers have been mysteriously lost at sea; and that posters threatening damage to property were found in Boston not far from the tank within a comparatively short time before the failure. They also produced a witness living in a house near the site of the tank who testified that she happened to be on the roof of her house at the time of the failure and that, a few seconds before the tank gave way, she saw smoke rising from the ventilator in the roof of the tank. Some of the experts testified that they could find no cause for this smoke other than a burning fuse, presumably attached to an explosive.

Frank E. Sherry, a civil engineer of Boston, testified to measurements and plans of the locality of the tank and of the broken pieces, and also to his examination of the locality shortly after the failure. All of the parts were carefully measured and their original position in the tank determined so that it could be seen how far and in what directions the various parts were carried by the disruptive force. The most significant part of his testimony relates to a section of the bottom and of the lower course of plates of the tank, which was torn in an irregular and jagged manner through a point in the bottom about 11 ft. from the side, approximately vertically through the side plate, the tear going through the manhole and then below the riveted joint near the top of the lower course. This section of the tank, which weighed about 2½ tons, was found at a distance of 180 ft. from its original location.

The tank was 50 ft. high and 90 ft. in diameter, surmounted with a conical steel roof or light steel trusses. The roof plates were about ¼ in. thick and there were four trap doors or manholes in the roof. These were not fastened and could be easily opened. A 6-in. pipe ventilator was set in the apex of the roof. There was a spiral stairway leading from the ground to the roof and, although a locked gate was provided at the foot of the stairs, it was not difficult to scale this, and it is stated that workmen frequently did climb to the roof of the tank for the purpose of watching interesting occurrences in the harbor.

A portion of the bottom nearest the center of the tank showed a decided depression, as did other sections of the bottom plates at this locality. Further, there was a marked hollow or depression in the cushion upon which the tank had been set immediately under this point in the bottom. This cushion originally consisted of a mixture of dry cement and sand. It had partially set, so that over most of the base it remained in place when the molasses flowed out, although it was brittle and comparatively easily broken. At this particular point, however, a piece perhaps 3 ft. across had been entirely washed away by the flowing molasses. The way the bottom plates were bent and this depression in the cushion indicated to Mr. Sherry that an explosion took place in the tank at this point of the bottom.

Prof. George E. Russell, of the Massachusetts Institute of Technology, Prof. George F. Swain, of Harvard University, and Lewis E. Moore, engineer of the Massachusetts Public Utility Commission, testified as hydraulic and structural experts, and all to substantially the same effect: that the tank was structurally safe, although the factor of safety was materially less than they would have provided. The tank did not fail at its weakest point, which was in a lap joint in the second course of plates, where the stress was computed at about 31,800 lb. per sq.in., allowing an efficiency of 66 per cent in the riveted joint. The greatest stress at the point of rupture through the manhole was computed at about 28,000 lb. per sq.in. The tensile strength of the steel was found by test of a considerable number of pieces to be 55,000 to 56,000 lb. per sq.in. The actual weight of the molasses used in computing the stresses was 88 lb. per cu.ft

The section of the bottom and side referred to above as carried to a distance of 180 ft. from its original position could have been propelled to this point by flowing molasses only in case a velocity of 52 ft. per second were developed, according to Professor Swain's testimony, whereas he found that under the actually existing pressure of 29.8 lb. per sq.in. the greatest velocity could not have exceeded 40 ft. per second.

The factor of safety was computed as approximately 1.6. Although the engineers agreed that this was lower than the best engineering practice would dictate, they saw no reason to believe that structural weakness was the cause of the failure. The company owns a number of similar tanks which are located at various points along the Atlantic seaboard. All of them have been examined and several have been found to be under greater stress than the one which failed. All of them, however, have been in use for considerable periods of time and show no signs of failure.

The fractures did not show any signs of gradual failure, but in every case the breaks were sharp and no drawing down of the metal could be discovered. There

were also no signs of fatigue such as might have resulted from repeated filling and emptying. The tank had been filled 13 times previous to the final filling, which was absolutely inadequate to cause fatigue in the metal and yet was more than enough to develop structural weakness if any existed. Mr. Moore testified that hundreds of thousands of repetitions of stresses beyond the elastic limit were necessary to cause failure due to fatigue.

The plates of the lower course in the vicinity of the point where the explosion is presumed to have occurred showed a bulging about 1 ft. above the bottom varying from 1 to 4 or 5 in., and also five vertical cracks were discovered. In preparing for the case, the experts had two small tanks 9 ft. high constructed upon the company's property in Baltimore, and destroyed them by small charges of dynamite. In one case a charge of 8 or 9 ounces of dynamite was exploded at a distance of 3½ ft. from the wall of the tank, this explosion resulting in a decided wave of molasses, which went over the top of the tank, and bulging the upper plates. In the second case, 5 ounces of dynamite were exploded 1½ ft. from the side of the tank and the effect was almost exactly similar to that produced upon the Boston tank which failed.

A. L. Colby testified to the tests of the metal cut from the plates of the tank which were made at Lehigh University.

Mr. Wedger, explosive expert for the state of Massachusetts, gave testimony relating to various kinds of explosives and their effects, but during his testimony no one not connected with the case was allowed to be present, so that it is impossible to give at this time any account of his testimony.

Prof. A. H. Gill, of the chemical department of the Massachusetts Institute of Technology, testified to his examination of the tank on the day of the accident and stated that he did not at that time have any idea that the failure might have resulted from a high explosive inside the tank. He made his examination originally with the idea of finding whether failure could have resulted from fermentation, from the explosion of gas which might have formed or accumulated in the tank, or from an explosive placed outside the tank, and could find no evidence which would support any of these theories.

Dr. Gill testified to experiments carried on at Baltimore in a tank filled with molasses to a depth of 19 ft. to see whether smoke from a burning fuse would rise through molasses and be visible at the top. Eight pieces of waterproof fuse of two different brands were used. From the moment that they were lowered below the surface of the molasses, smoke began to bubble up to the surface, and it passed out from five 6-in. circular holes in the top of the tank. He believed that a single piece of such fuse burning in the tank which was destroyed would produce a smoke which could be seen rising from the ventilator of the tank.

The company intends to present evidence from Prof. Albert Sauveur of Harvard as metallurgist, and it is inferred from the references made in the testimony already given that this testimony will relate largely to the presence of the so-called Neumann bands in the fractured metal, and will state that such bands have never been found except in metal fractured by explosion or similar disruptive force. It is possible that one or two other experts may be put on, but it is not expected that any other new lines of evidence will be presented.

It is presumed that the plaintiffs will present evidence from their engineering experts in rebuttal, but no indication of the causes which they expect to assign for the failure has yet been presented.

Hospital Service and Expenses in Construction

From an address by Dr. J. P. Cleary on Sept. 29, at Milwaukee, Wis., before the Construction Section of the National Safety Council.

IN THE construction of a plant for the Cadillac Motor Car Co. in Detroit, Mich., the du Pont Engineering Co., from August, 1919, to August, 1920, employed about 17,000 men, the maximum at any one time being about 3,600, and the minimum about 800. During the year there were 4,490 injuries. Of that number 80 were major injuries, necessitating the loss of time. Of the 80 major injuries, four resulted fatally, one in permanent, total disability, and the remaining 75 caused a loss of approximately 14,752 working hours, an average of 196⅔ hours per major accident. In addition to the 4,490 first dressings or treatments administered, approximately 3,229 re-dressings were required, amounting to 7,719 treatments for injuries administered during the year.

It is estimated that 3,500 medical cases were treated, making a total of 11,219 treatments given during the year. During the influenza epidemic last winter an average of 30 medical cases were treated every day. Of the 11,219 treatments, perhaps 1,432 were required in cases of major injuries, leaving 9,787 treatments administered for minor injuries or illness.

The cost of equipping and maintaining the plant hospital for the period mentioned amounted to $6,800. Of this amount, $5,900 was applied to the treatment of minor inquiries and medical cases. Dividing this amount by the number of treatments, 9,787, shows an average cost of 60c. each. During this period of time, 15,765 men were examined by the medical department, and 15,615 were accepted and placed on the company's roll. In addition to this number there were approximately 2,500 men on the rolls of the subcontractors during this time, making a total of 18,115 men who were protected by the medical department during the year in question. This amounts to an expenditure of approximately 37c. for each man so protected. There were 366 penetrating wounds of the feet resulting from stepping on nails. Of that number two, or 0.54 per cent resulted in lost time.

Starting Engines on Locomotives

Locomotives with "booster" or starting engines on the trailing axles to give increased power in starting are being tried on the New York Central R.R. as a means of increasing the efficiency in handling heavy passenger and freight trains. A two-cylinder inclosed horizontal engine mounted at the rear of the frame of the trailing truck drives a pinion which through an idler drives a gear on the trailing axle. The engineman can put this "booster" in operation only when the reversing lever is in full position and the throttle is open. When he notches up the lever the booster is cut out automatically and is disengaged so that it cannot become a load on the locomotive when running at ordinary speeds. The additional weight is about 3,500 lb. but is said to be equivalent to increasing the adhesion weight of the engine by about 25 tons. It is intended to give an increase of 25 to 30 per cent in drawbar pull for different types of engines, thus insuring a steady and even start, which reduces damage to the engine and the cars.

The Transportation Engineer and Railway Economics

New Position Suggested to Insure Broader Views of Operating Problems and Their Economic Relations

CLOSE relationship of the engineer to railway transportation, or the operating department of railway service, is of sufficient importance to warrant wider official recognition and his appointment to a position of responsibility with regard to operation in which he will cover a broader field than that included in his more specific relation to construction and maintenance. This opinion was presented at a recent meeting of the Western Society of Engineers by J. A. Peabody, signal engineer of the Chicago & Northwestern Ry., who outlined some of the problems to be dealt with in the endeavor to increase the efficiency and economy of main line and terminal railway operation. Extracts from Mr Peabody's paper follow:

On every large railway there is a place for an engineer who, with proper assistance, should make a specialty of studying problems of transportation. In what part of the organization the engineer of transportation would best fit would vary on different railways, depending somewhat on the size of the railway, more on the amount and importance of the work undertaken, and most on the man. In every large railroad organization probably there is a man who, due to his experience, breadth of vision, good judgment and understanding of operating questions is eminently fitted for the work of transportation engineering.

To get the proper results he must be given freedom in developing his plans, and authority to call on any department for information. His position must be such that when his plans are completed he would naturally be called in consultation with such officials as the vice-president in charge of operation, who would give the reasons for the necessity for additional operating facilities, and the chief engineer, who would advise as to the best methods for the carrying out of the work. Where such a separate organization is formed there should be no fear that the transportation engineer would take prerogatives from any of the present department heads, engineering or otherwise.

Transportation engineering has a wide scope, because with the movement of both freight and passenger traffic to be studied there must come studies of the growth of communities, mining, farming, urban, suburban and industrial. The studies relative to handling of freight would include not only those relative to moving trains over the road, but also those of handling freight from the time it approaches the railway property to the time it is delivered into the cars or freight houses, and then the handling of cars into trains. The handling of passengers, baggage, express and mail should be analyzed in the same way, each of these being a problem and having a relationship to the others which is too often overlooked.

When the question of facilitating the movement of freight trains over the road is under consideration, how often is a definite analysis made to determine where interference occurs? Wellington mentions the necessity for proper location of passing tracks, but it was not until recent years that F. L. Dodgson developed a method of analysis to determine the proper location of passing tracks on a single track railway as described in the "Proceedings" of the American Railway Engineering Association for 1916, 1917 and 1919. An analysis and a complete plan for passing tracks of each division should be made, so that as money becomes available it may be so expended as to develop this complete plan.

With reference to the cost of operating trains there are several items which should be investigated. For instance, the cost of stopping a train and its relation to the cost of preventing that stop. There is no complete information on this subject and a brief paper which I wrote in [illegible] is referred to even today, although the figures are entirely obsolete. The cost of operating trains, not for the railway as a whole but for each engine division, should be investigated in order to determine, if possible, how it may be reduced. The cost of switching in each yard and of handling engines at each terminal should be known, but in a recent investigation I have found that men who have given me the cost of switching in certain yards doubted their own figures.

Analysis should be made of conditions at each piece of congested main track to determine methods for increasing its capacity, together with the cost. The relative cost of operation under present and improved conditions also should be taken into consideration. This study would cover the location of passing tracks, the signaling and interlocking, the despatching system, reduction of grades and curvature and all other items that affect economical operation. Analysis of large freight terminals should be made to determine whether the handling of cars cannot be reduced materially. In a large terminal such as Chicago the consolidation of some yards would reduce the transfer work and, therefore, the several handlings of a car. It would also shorten materially the time required to deliver a car from the road to an industry. The methods generally used in the handling of l.c.l. and trap car freight in large terminals seem to be crude and a close study of this problem should produce methods resulting in quicker and cheaper handling.

In passenger service there are opportunities for materially decreasing the cost of operation, particularly in handling suburban traffic. The steam railway engineer is behind the electric railway engineer in his knowledge of what can be done in this direction. As to main line electrification there seems to be no doubt that many lines which now suffer from traffic congestion on account of their grades could increase their capacity greatly by electrification and probably decrease the cost of operation at the same time. My conclusion is that transportation problems will be solved only by the application of engineering knowledge, and that consequently the engineer has a better opportunity of showing his worth today than ever before.

Concrete Piers Hooped in Upper Part

In extending the King Edward Hotel, Toronto, Canada, foundations were constructed by excavating open wells to rock, about 35 ft. below street surface (or about 20 ft. below basement floor over most of the area), and filling these wells with concrete to form piers on which the steel columns of the building foot at basement-floor level. For the exterior columns, however, it was found more economical to carry up the concrete piers to a little above street-floor level and start the steel columns here. Because of the height of these exterior piers it was considered desirable to take special pains for insuring that the column load would be transmitted to the whole cross-section, it is stated in the course of a description of the work given by R. E. W. Hagarty in the *Canadian Engineer* of Aug. 26, 1920, p. 273. Below the steel I-beam grillage capping the pier, therefore, the concrete is reinforced with steel hooping (1 per cent of the cross-sectional area) for 6 ft. of height of the pier. At the 6-ft. level, it was considered, the stress would be thoroughly distributed over the pier cross-section; below this point no reinforcing is used. Mr. Hagarty, together with A. H. Harkness, carried out the engineering design of both foundations and superstructure of the building. The architects are Esenwein & Johnson, and Watt & Blackwell.

Building the American Niagara Power Extension

Details of the Dredging, Tunneling and Erection Operations on the War-Time 100,000-Hp. Addition to the Hydro-Electric Plant of the Niagara Falls Power Co.

Two earlier articles, Engineering News-Record, Sept. 23 and 30, 1920, described the structural and hydraulic features of the new extension to Station No. 3 of the Niagara Falls Power Co., which was started during the war, largely at the instance of the Government, to provide 100,000 hp. additional power at Niagara Falls. This article, by members of the construction staff of the company, completes the series describing this largest hydro-electric development now operating.

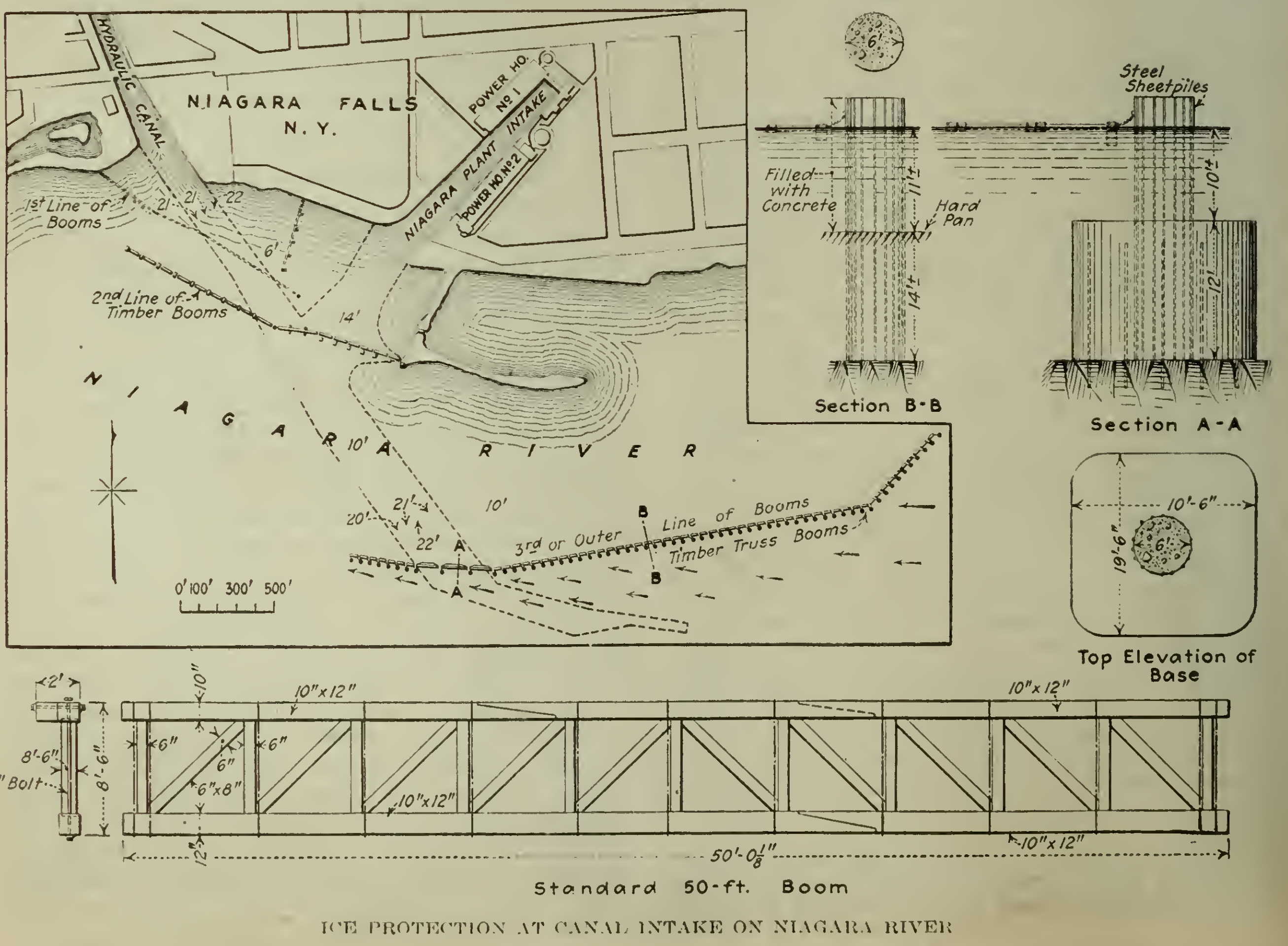
Enlarging Channels and Erecting the Station

By O. D. Dales
Construction Engineer, Niagara Falls Power Co., Niagara Falls, N. Y.

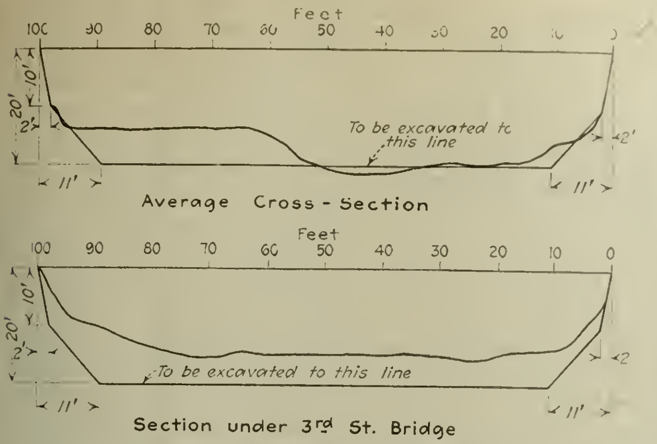
THE excavation of the 20-ft. channel from the head of the canal out into the Niagara River was through limestone for the first 1,000 ft. out from shore, the balance being in hardpan. The drilling was done by four drill boats with steam drills, the holes being placed on 4-ft. centers each way. Drilling was carried down to 3 ft. below the finished grade. The dredging was done by three dipper dredges with 6½-yd. buckets. The excavated material was placed in dump scows and towed out into the river just above the upper rapids, this class of excavation being similar to most dredging operations in large rivers. Disposing of the excavated material was rather difficult on account of the location of the dumping ground. Extreme caution was exercised by the contractor, but in spite of this one dump scow broke its two tow lines and floated down the Canadian channel to below the upper cascade rapids where it went aground on some rocks about 800 ft. from the Canadian shore. The two men on board were removed by the Fort Niagara life-saving crew by means of shooting a line out to the scow and bringing them ashore in the breeches buoy.

Piers for Booms

Most of the piers for supporting the two inner lines of booms were built in previous years and consist of concrete piers upon rock-filled timber cribs. These offered considerable resistance to the water so another type of pier has been developed which consists of Lackawanna steel sheet piling driven through the hardpan to the rock, which is from 6 to 15 ft. below the bottom of the river. These piers were built as 6 ft. diameter cylinders filled with concrete from the hardpan to the top. Details are shown on an accompanying drawing. This type of pier was used in the outer line of booms and were placed 50 ft. apart except in the deep dredged channel where they were 150 ft. apart.



ICE PROTECTION AT CANAL INTAKE ON NIAGARA RIVER



TYPICAL CANAL CROSS-SECTIONS

As there was no hardpan in the dredged channel the bottom of the 6-ft. cylinders were encased in 19-ft. 6-in. square concrete bases 12 ft. high. The past winter was very severe and a large amount of ice passed through the Niagara River thoroughly testing these piers and booms.

It has been the intention for a number of years to deepen the canal to 20 ft. below mean water level with a cross-section approaching as nearly as possible the typical section shown on the drawing herewith. Excavation had been carried on in the canal for a great number of years and up to 1912 had been excavated on the right-hand half, looking downstream, down to 20 ft. for nearly the entire length of the canal. The left-hand side of the canal was left at 14 ft. deep, while under the bridges it was approximately 14 ft. deep on both sides.

In order to have sufficient water available for the operation of the new plant along with the old plants it was necessary to excavate and clean up the canal to a depth of 20 ft. for the entire width approaching the typical section shown on the drawing. The excavation in the canal was a much more difficult task than that of the river. It was all in hard tough limestone, and the mean velocity of the water was 6 ft. per sec. which gave a surface velocity of 10 ft. per sec. when dredges and scows were in place. Eight bridges span the canal which vary from 6 to 15 ft. above the water surface. The drilling and blasting in such a severe current presented many difficulties, but was accomplished from a drill boat which was developed for this work.

Canal Drill Boats

The canal drill boat is equipped with five tripod drills operated by a crew of 12 to 15 men. Each drill has one runner and helper. The drill-boat bow is divided into 12 spaces 4 ft. apart and the boat moves back on ranges 4 ft. apart, making the spacing of the holes 4 x 4 ft. and they are drilled 3 ft. below finished grade.

The drill steel is 1¦ in. diameter and from 20 to 26 ft. long, depending on the depth of the water, with $1\frac{1}{2}$- to $2\frac{1}{2}$-in. bits. The steel drill rods are protected from the current by a main guide barrel of different lengths so as to keep it at least 3 to 4 ft. above the rock. The main guide barrel is 6 in. in diameter and has a 3-in. slit opening from the top to the bottom so that the steel drill rods may be pulled into place. At the bottom of this main guide barrel is a $1\frac{1}{2}$-in. ring band to which a cable with a chain fastening is attached to the upstream end of the boat so as to keep the main guide barrel in a vertical position against the strong current. In order to protect the drill rods down to the top of the rock, a 4-in. diameter pipe and a 2½-in. diameter pipe, one 6 ft. long and the other, or bottom piece, 5 ft. long, are made to telescope one another. This telescopic pipe is inserted into the main guide barrel and dropped to the bottom by a chain. There is a $\frac{1}{2}$-in. round rivet stopper about 3 in. long which projects out from the side of the telescopic barrel about 6 in. down from the top and as the stopper slides down the slit in the main guide barrel it is stopped by the $1\frac{1}{2}$-in. round cable band at the bottom of the main guide barrel which holds the telescopic barrel in place and which is lengthened or shortened by the telescopic action and weight of the pipe.

The drill rods are put into place by hand. They are first run about half-way out from the end of the boat and pulled back into the main guide barrel through the

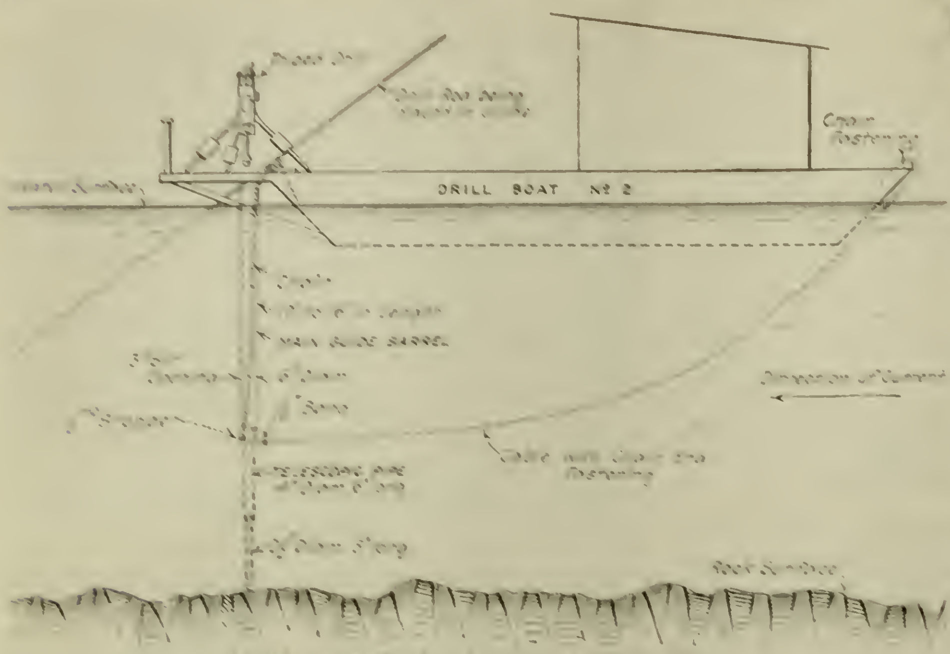
ICE BOOMS IN ACTION ON NIAGARA RIVER, MARCH 19[illegible]

slit opening by two men and dropped to the top of the rock. As each two feet are drilled it is replaced by a longer drill rod.

In blasting a 2-in. tin tube 20 ft. long is run down to the top of the hole through the guide pipe which keeps it from bending or breaking. The sticks of dynamite are put down the tube by a sectional lowering stick, the exploder stick being in the center of the charge which has the two wires attached and extend to the boat up the tube. Before the charge is fired the telescopic barrel is pulled up into the main guide barrel by the chain and let stand, also the tin tube is removed. The charge is set off by a battery and one hole is fired at a time. The kind of explosives used is 60 per cent Dupont and averages about 1 to 1½ lb. per cu.yd.

The ordinary $1\frac{1}{2}$-yd. dipper dredge was used for dredging between the bridges. The dredging under the bridges was accomplished by two dipper dredges with extremely low cranes, one having a [illegible]-yd. and the other a 2-yd. dipper. These dredges were developed particularly for this work on the canal and have given very satisfactory results. One is shown in operation in one of the views.

The rock excavated from the canal was placed in steel skip boxes on board scows and floated down the canal under the control of a strong tug to the crusher plant at the canal basin where the rock was unloaded by derricks and crushed. From this point the rock was shipped by train and truck.



DRILL BOAT USED IN CANAL EXCAVATION

The drill boat and dredges built for this canal work were developed by R. R. Coddington, General Superintendent, from his many years' experience on this class of excavation. The contractor for the excavation in the river and canal is the Great Lakes Dredge & Dock Co.

Basin Excavation

The old canal basin which connected the canal with the inlet to Station No. 3 was 70 ft. wide and approximately 18 ft. deep. As the water for Station No. 3 Extension is taken from this basin, it was necessary to increase the carrying capacity of this basin which was done by increasing the width by excavating on the east side to a width of 117 ft. at the upstream end of the forebay inlet and gradually narrowing down to the old width of 70 ft. near the inlet to old Station No. 3. A curve of 143 ft. radius tangent to the north line of the canal and to this new basin line has made a very good entrance to the basin. With this enlargement of the basin the mean velocity of the water will be 4.5 ft. per second.

The top of the limestone rock lies about 8 ft. below the earth surface and about 2 ft. above the water surface in the basin. The earth was excavated with a -yd. steam shovel. The rock was drilled and blasted in the dry down to about 2 ft. below the water surface by leaving a narrow ridge of solid rock as a cofferdam. The blasted rock was removed into dump wagons by the -yd. steam shovel.

The next 11 to 13 ft. down was drilled and blasted in the dry and removed with a dipper dredge. The drilling was done with tripod drills, holes being placed about 4 ft. apart each way and along the side it was close drilled. These holes were 6 to 8 in. apart. It has been found that this close drilling in this class of rock gives a comparatively smooth wall for the side of the cut. In the excavation above water 0.8 lb. of 60 per cent dynamite per yard was used.

The lower 9 ft. of excavation for the basin enlargement was drilled and blasted from the drill boat and removed by the dipper dredge along with the deepening of the rest of the basin and in the same manner as the canal excavation.

Much of this basin enlargement was done in the summer and fall of 1918 when it was imperative on account of the war to keep all the old power plants running to their utmost capacity. The blasting up of the bottom of the basin, the ridge formed in front of the dipper dredge and the dredge with scow restricted the cross-sectional area so as to increase the velocity of the water very much. These conditions are shown in the view on p. 697, which was taken Oct. 19, 1918. The work was done in strips the length of the basin and sufficiently wide for the convenient operation of the dredge. Each strip was completed through before beginning another so as to reduce the cross-section as little as possible.

The forebay was built in rather cramped quarters, being separated from the basin by the basin road and between two large flour mills on the north and south, while on the west were busy switchtracks.

The old west wall of the canal basin, which is shown on p. 697, is built of concrete upon limestone. The top of the rock is at about water level. Under the roadway the inlets to the forebay have been built.

In the construction of the forebay this west wall with a wider strip of rock under it was at first used as a natural cofferdam for the excavation. As soon as the basin had been widened and deepened enough by dredging to allow a cofferdam to be built in it and also permit about 7,000 sec.-ft. of water to pass to old Station No. 3, a cofferdam was built. It was quite important that this cofferdam should restrict the flow as little as possible. With this in mind a narrow cofferdam was built of Lackawanna 12¾ x ⅜-in. straight web steel sheet piling in water varying in depth from 16 to 24 ft. The cofferdam consisted of 18 oval-shaped pockets. The size of a typical pocket in plan is 14 ft. 4 in. long, 9 ft. 10 in. wide at the mid-section, and 6 ft. 5 in. at the end where it joins the adjacent pocket. The outside row is composed of piles 24 ft. long and the inside row of 20-ft. piles.

In the construction, timber trusses were first built in lengths 28 ft. long and 8 ft. deep, using 12 x 12-in. timbers for the chord members and 8 x 8's for the diagonal members. These were built on the bank alongside of the basin, launched, and floated into their place which was along the old concrete basin wall. Upon the cofferdam side of the truss were fastened timbers shaped to fit the outside of the pockets. After the truss was in place templets made of two thicknesses of 2-in. plank and the shape of the inside of the pocket were floated into place and the sheet piling placed around these templets and against the truss. Work was begun at the upstream end so as to take advantage of the current. As soon as the piling for one pocket was placed they were driven with a light

piledriver so as to drive them through any loose rock which might be on the bottom of the basin and cause them to fit as closely as possible to the solid rock. After this a diver went down into the pocket and closed up any openings that were found between the piling and the rock, using bags filled with concrete. Good rich concrete was then poured in the bottom of the pocket for a depth of about 2 to 3 ft. so as to properly seal the bottom and thoroughly fasten the cofferdam to the rock. The pocket was then filled up to the top with ordinary gravel, the pressure of this gravel causing the pockets to bulge slightly and completely tightening the joints. This made a very narrow cofferdam but it was thoroughly fastened to the rock at the bottom by concrete and at the top supported by two stiff wooden trusses.

In excavating the rock back of this old basin wall as much solid rock was left as possible between the piers to act as pilasters for supporting the old concrete wall which was receiving the load thrust upon it through the trusses from the top of the cofferdam.

As soon as the piers were completed the old concrete wall was removed directly in front of the piers so that timber struts could be placed between the trusses and the piers, thereby transferring the pressure of the top of the cofferdam from the old wall to the new piers. The old wall and the rock between the piers was then blasted and removed.

Excavation back of the cofferdam was carried down to a depth of about 6 to 8 ft. below the bottom of the cofferdam and within an average of about 2 ft. of the inside line of the cofferdam, and in a few places the rock broke back of this inside line. The concrete seal which had been placed in the bottom of the pockets could then be seen quite plainly in such places and showed that a good bond with the rock bottom had been made. As the excavation progressed downward and closer to the cofferdam, extra struts of 12 x 12-in. timbers were placed from the piers to the cofferdam. The view on page 699, which was taken back of the cofferdam, shows the piling of the cofferdam on the right, the piers on the left with the timber trusses above, and the excavation carried up to within about 2 ft. of the cofferdam. At the time when the excavation of the forebay was completed the entire leakage of the cofferdam and rock did not exceed 4 sec.-ft.

On page 698 is shown the completed cofferdam. As ome of the piling drove into the bottom farther than was anticipated on account of there being more loose rock on the bottom than was expected, it was necessary to build a light wooden cofferdam along the top in order to take care of any extreme high water.

It was necessary to locate the power house as close to the cliff as possible in order to get the foundations and tailraces on solid rock. The top of the cliff here is about 218 ft. above the water level in the gorge. Extending upward about 100 ft. from the water surface is a talus slope which consists of a layer of about ten feet of loose rocks which had fallen from the cliff.

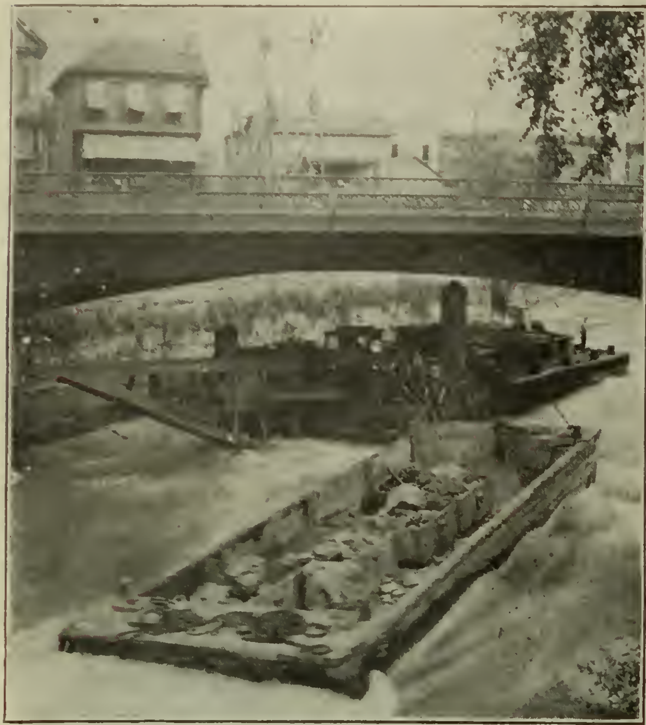
Excavation was begun at the toe of the slope using a [illegible]-yd. steam shovel, the loose rock being washed down to the shovel with a hydraulic giant. This hydraulic giant had a 4-in. nozzle and the water was supplied to it by a 10-in. pipe line carried from three of the 9-ft. penstocks in old Station No. 3. This gave a working head of about 180 ft. at the nozzle. As soon as sufficient area had been cleaned off with the hydraulic giant, drilling and blasting of the solid rock was begun. Excavation of the solid rock was carried down to about 4 ft. above mean water level. Then a concrete cofferdam was built on solid rock the length of the proposed power house and about 60 ft. west of the west wall of power house. Excavation was then carried down to 23 ft. below mean water level. The excavation above El. 370 consisted of shale and limestone, from this to the water surface alternate layers of Medina sandstone and red shale, and below the water level was solid Medina sandstone.

DREDGING IN A STIFF CURRENT IN THE NIAGARA HYDRAULIC CANAL

As soon as the excavation was completed the concrete foundations for the turbines were poured. The mixing plant was located at the top of the cliff. The gravel was brought in on cars and unloaded unto a belt conveyor which carried the gravel to a storage pile. It was then conveyed from the storage pile to hoppers over the mixers by a clamshell bucket operated from a derrick. The mixed concrete was conveyed through flexible sheet iron, elephant trunk, chutes suspended in cables extending from the top of the cliff to the bottom.

The piers and heavy reinforced-concrete floors for supporting the entire units were completed up to the bottom of the wheel cases. Then the wheel cases were set. After the cases were set the concrete piers and power-house floor were poured.

Manufacturers of all machinery were requested to ship in pieces not heavier than 50 tons, also that each piece must pass through a door 12 ft. wide and 16 ft. high.



LOW BOOM DREDGE FOR WORK UNDER BRIDGES

The equipment for the power house was carried below the bank by means of a large 50-ton crane which is a permanent structure built in 1906 and was used in the construction of old Station No. 3. This 50-ton crane is operated over a crane runway, the westerly end of which is a cantilever extending 53 ft. over the edge of the cliff and running back easterly over the switchtracks which are about 200 ft. from the edge of the cliff. The crane has a 50-ton and a 5-ton hook with a total lift of 235 ft. By means of this crane all equipment was lifted from the railroad cars upon the switchtracks, carried out to the end of the cantilever and lowered 225 ft. below unto a car which runs on a standard-gage track into the south end of old Station No. 3 and there turns into the new station.

Within the new station are two electric cranes of 100 tons each. By means of these cranes all parts of the equipment were easily carried from the car and distributed to their proper place in the power house. In the erection of the turbines and generators it was necessary as the parts were assembled to make lifts from 150 to 200 tons. This was accomplished by using the two cranes together by means of a large whiffle tree, which was a 200-ton capacity box girder beam arranged so that the two cranes should be readily hitched at each end with a large lifting hook in the middle of this beam.

Tunneling and Lining the Penstocks

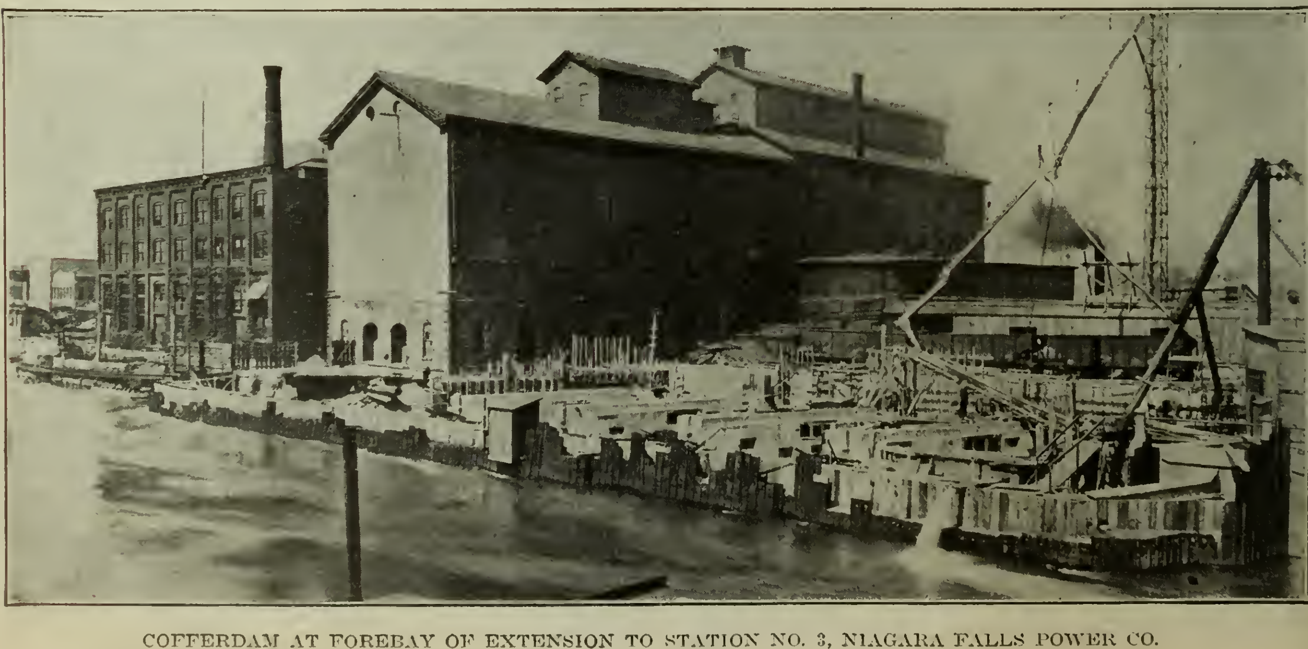
By G. W. Hewitt

Field Engineer, Niagara Falls Power Co., Niagara Falls, N. Y.

THE three penstocks of Station No. 3 extension are identical, and except for a few minor details during the construction, the conditions met were the same. Each tunnel was driven from the lower portal up through the rock to the top, a distance of 350 ft. Excavation started at the face of the deep excavation of the power house and ended at the face of the excavation of the forebay. The excavation of the bell-mouth section inside the limits of the forebay gatehouses was open excavation and was part of the excavation of the forebay.

The center line of tunnel was level at El. 353 to the P. C. of the lower curve, the P. I. of which was 86 ft. from the portal. At this point the line turned 18° 19′ to the right and 45° to the vertical, making the actual intersection angle 47° 50′. The two tangents were connected by a 40-ft. radius curve. The inclined section of tunnel was 45° to the vertical until the upper curve was reached, which also had a 40-ft. radius, and then into the open excavation of the bell-mouth section, the center line of which was El. 538, or a vertical distance of 185 ft. from center of lower horizontal section to horizontal section of bell-mouth.

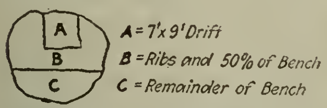
The diameter of finished tunnel is 15 ft. 6 in. and the plans called for a minimum of 18 in. of concrete, making the excavation 18 ft. 6 in. in diameter theo-



COFFERDAM AT FOREBAY OF EXTENSION TO STATION NO. 3, NIAGARA FALLS POWER CO.

retically, although sunflower cross-sections showed that the diameter of excavation averaged 20 ft.

Excavation was started as the lower portal, using four water Leyner column drills, and the entire heading, or upper half of the tunnel, drilled and shot. Disposal was made on the horizontal section by shoveling the rock into 4-yd. cars, which were hauled out by steam dinkeys. After the bench had been uncovered, it was then drilled and shot and the material disposed and the track run back. At the end of the horizontal section a heavy timber hopper was built under which the cars could be run and loaded so that after shooting the rock would roll down the 45° slope onto the hopper. Above this point and for the remainder of the tunnel, the drilling and shooting were done in three operations, as can be seen from the accompanying sketch.



STAGES IN PENSTOCK TUNNELING OPERATIONS

First a drift A approximately 7 ft. x 9 ft. was driven through to the upper portal, then the ribs and about 50 per cent of the bench B, and lastly the remainder of the bench C.

Excavation of the drift was naturally the most difficult operation, as the drilling and shooting of portions B and C more nearly approximated that of open excavation and were quite rapid. During excavation of the drift the work was carried on in two shifts of eleven hours each, working seven days a week. For the lower two-thirds of the 45° tunnel, each shift was able to drill and shoot a heading, averaging about 7 ft. each shot. Above that the progress slowed down owing to the difficulty of getting the heavy equipment of the 45° slope and also to the wet working conditions.

The drills, columns, and other equipment were hauled up the long slope by a rope passing through a block attached to an eyebolt in the roof. The planking and 8 x 8-in. timbers for staging were first hauled up and placed and the heading was then scaled, after which the columns and drills were hauled up and set up in place. The electricians and pipefitters went in as soon as possible after the rounds had been shot to make any repairs that had to be made to the lighting circuit and to the air and water lines.

After about 100 ft. up on the incline the air became so bad that an exhaust fan had to be installed and an 8-in. suction pipe attached to the roof of the tunnel. An auxiliary pump also had to be installed to keep up the water pressure.

The field party consisted of a chief, a transitman, and two chainmen. They gave two headings in each of the three tunnels every day as a rule, checked their lines and bases, estimated quantities, etc. As a rule they laid out the grade and roof line while the drillers were getting their material together. Grades as well as line were given with a transit using the vertical arc and correcting for distance of set-up above center line, which on a 45° slope was normal distance times the secant of 45° (1.414) equals the vertical distance.

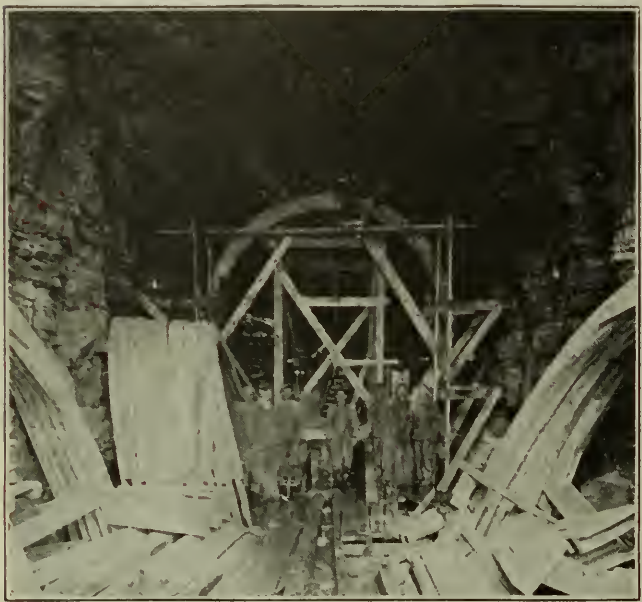
On the lower curve the horizontal and vertical projections were both parabolas owing to the circular curve being on an inclined plane. About five points on the

BEHIND THE FOREBAY COFFERDAM

curve were calculated for their projections and were then plotted up on cross-section paper and the curves were then drawn through them, prints made and furnished to the field party. In laying out the heading on the curve, the field party could always tell how far to the right and above the center of the horizontal section the center line was at the heading by picking the points of the curve without any long calculations of parabolic formulæ. They could also tell the heading foreman just how much he had to point his drills up for the next round of holes.

The rock on the lower horizontal section was hard Medina sandstone. Above this, at the upper end of the curve, was a thin layer of shale overlaid by about 12 ft. of the Clinton ledge of limestone. A small amount of seepage was encountered in this shale in each of the three tunnels, while in the first one a drill opened up a water pocket which flowed for about twenty minutes and had a very strong sulphur smell. Above the Clinton limestone the tunnel went through approximately

100 ft. of shale, which was soft and stratified at the lower end and which shaded into an unstratified slate just under the limestone at the top. For the remainder of the distance limestone was encountered, varying from hard blue limestone just about the slate to well-seamed limestone near the top. The slate formation underneath the limestone was so hard that the drillers insisted that they were in the limestone heading before



TUNNEL HEADING OF PENSTOCK—OUTSIDE CUT ABOUT 20 FT. DIAMETER

they really reached it. The seepage in the upper part of the shale and lower portions of the limestone was such that it resembled a rainstorm, while considerable seepage was again encountered in the upper end.

The concreting of the lining was carried on in several independent operations in order to co-ordinate with the other work above and below the bank.

On the lower curve a 15-in. concrete invert section was first built with slots and pipe for the reinforcing. The wooden ribs were then set up and lined and then the wooden lagging placed. Two rows of circular reinforcing bars were then placed and the concreting done through chutes from the upper end of the tunnel. This section was the only one on which reinforcing bars were used.

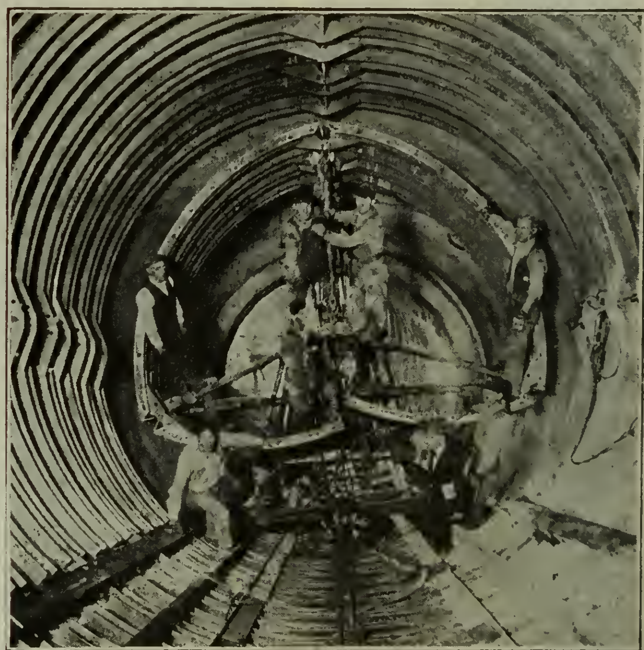
The seepage was taken care of by an 8-in. wrought-iron pipe emptying into the tailrace. A T was placed at the end of every 20-ft. section and a short length of 4-in. pipe and elbow attached to each side. Just below each elbow a dam was built out of sacks of concrete and just before the concrete reached the top of them they were covered with a piece of canvas and a few more sacks of concrete, thus leaving a permanent drain.

The bell-mouth section was concreted around wooden forms with a bulkhead between each tunnel. Concrete was carried to a height of 25 ft. above the bottom in a solid mass. The first pour was about a foot above the bottom so that the forms would not float, the second pour to slightly above center line, and the last pour to about 4 ft. above the highest part. The steel guides for the gates, anchor bolts for the racks, etc., were all set in place before concreting.

It was the original intention to concrete from the top of the lower curve to the top of underground portion with steel forms and then to connect the tunnel concrete with the bell-mouth section with wooden forms on the upper curve. However, as it was deemed advisable to rush the steelwork of the gatehouse in order to be able to use the crane, it was decided to concrete in the entire upper curve before doing that of the 45° slope. This necessitated making the joining at the top of the slope entirely underground. Pipes were placed along the roof of the curved section so that the slope below could be concreted at the connection.

On the 45° slope Blaw-Knox steel forms were used, having a diameter of 15 ft. 6 in. and a length of 5 ft. Twelve complete sections of forms and five extra invert sections were used. Concrete on this section was continuous from bottom to top, never being less than four batches per hour or just enough so that the top concrete had not set up when a new batch was poured. It was found that by having the men walk around and stirring up the top that so-called mud seams or seepage rings were prevented from forming. Forms were only moved during the day shift and iron workers were employed for this work. After the first two days in getting acquainted with their equipment and making a few minor changes in the traveler, they averaged four sections or 20 ft. each day. The traveler was moved by a hoist at the top. Besides the crew of five iron workers on the forms, there was a concrete crew of three men taking care of the concrete as it came through the chutes from the top.

Lastly the steel lining was placed and concreted around. The steel plates were assembled under the



FORM FOR CONCRETING PENSTOCK TUNNEL. CLEAR DIAMETER 15½ FT.

crane in the Johnson valve chamber and when riveted were skidded back and new sections attacked. This steel lining extended 68 ft. in from the edge of the cliff. The diameter was 15 ft. 6 in. except where connecting to the Johnson valve, at which point it was 17 ft.

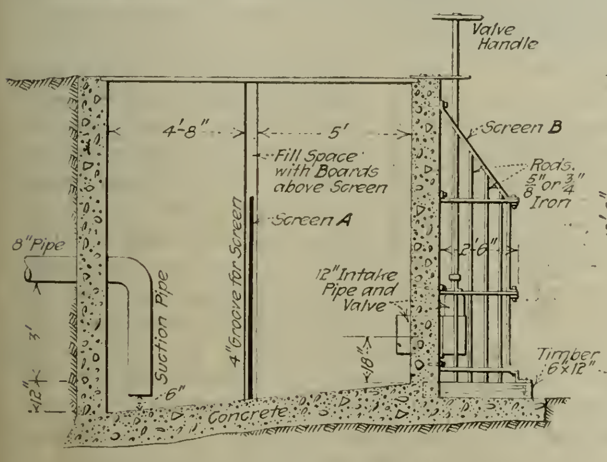
With the steel penstock in place the Johnson valve was next assembled and connected to the steel lining

and the wheel case. Riveting was then completed, burnt rivets being cut out and replaced by new ones. In the majority of cases, however, it was found that the electric weld on the rivet gave excellent results and made a tight job.

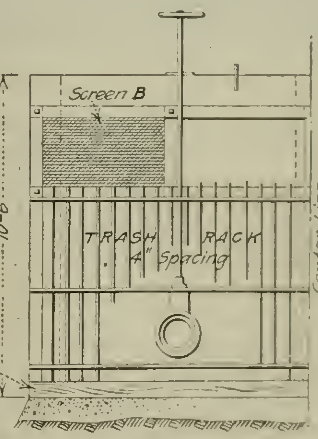
After the riveting was completed and all connections made, the portion under-ground was concreted in, grout pipes being placed along the roof through which grout was afterward forced under air pressure to fill any cavities along the roof which could not be concreted. At the lower end of the curve, where the joints in the concrete were made, a small keyway was left which was painted with soft asphaltum to prevent leakage in case of contraction. Several boxes were also placed at the joint with ¾-in. pipe leading from them into the open at the testing chamber so that any leakage from contraction at the joint would show.

Intake for Railroad Water Station Protected from Drift

A PROTECTED intake of simple design for the pumping plants of water stations has been built by the Baltimore & Ohio R.R. at several points where the supply is taken from streams which carry large quantities of drift. This intake consists of a chamber or suction well located at the edge of the bank and taking water through a pipe fitted with a valve. The design is used with either a single or double chamber, the latter

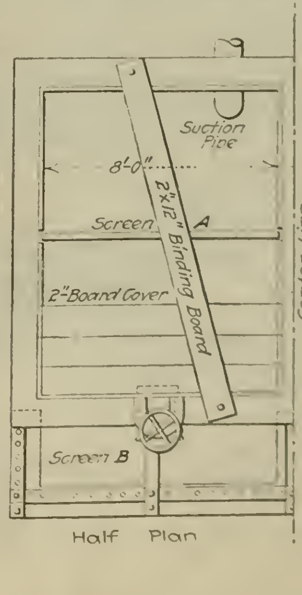


Sectional Elevation



Half Elevation

PROTECTED INTAKE FOR RAILWAY WATER STATIONS



Half Plan

of which is shown in the accompanying drawing.

Around the entrance of the intake pipe and valve is a protecting cage of rods, the cage being closed at the top by an inclined screen which excludes drift when freshets submerge the intake and prevents the drift from lodging as the water subsides. The intake pipe may be placed in either the front or side wall of the well and a second intake pipe at a higher level may be provided for use in case of obstruction of the lower pipe, but this precaution has not been found necessary in present installations. The intake chamber is divided by a removable screen sliding in guides, the suction pipe from the pump entering the rear of the chamber. Netting for the spark arresters of locomotives may be utilized for the screens.

This form of intake was designed by S. O. Benjamin, 1323 Hollins St., Baltimore, Md. while he was in the water service department of the Baltimore & Ohio Railroad.

Pumping Project with Low-Level Storage and Semi-Gravity Supply

By R. A. Trufant

Engineer, Llano Grande Plantation, Mercedes, Texas

IN ONE of the lower Rio Grande valley newest pumping projects, precedent was largely disregarded. The settling and storage basin is located below the average ground level, eliminating seepage. Gates are provided for filling this low level reservoir by gravity during rises of the river, and pumps to fill the reservoir during low stages of the river. The river storage pump and the main canal supply pump are duplicate 30-in. electrically-driven units using power from a full-Diesel oil engine and a 115-kw. generator. The overall efficiency of the plant is figured at 20 per cent against the 4 to 6 per cent common in the valley. The gravity supply features further reduces operating costs to an extent not yet determined.

At this point the Rio Grande is bordered by lakes formed by the meandering of the river. The common practice is to build a levee around a lake up to the main canal level and to use the basin thus formed for storage and settling. Thus seepage is away from storage, and the maximum lift is about 25 ft. On the Llano Grande project, the lakes are to be held at a level midway between lower river level and the main canal. Seepage is then toward the storage. Two pumps are necessary, one to lift the water from the river into storage and one from storage into the canals. But these pumps (and the power plant to operate them) need be only half the size of those ordinarily employed, as the maximum lift is halved. The river pump is to be operated nights and the main canal pump days when needed for irrigation.

The river is subject to frequent short rises; therefore gates are provided between the river and the lakes, so that the storage can be filled by gravity in half a day from the crest of the rise. Thus the river pump need be operated only during protracted periods of low river.

The cost of installation, about $100,000, is somewhat higher than for the average local plant, but the economies of operation will more than compensate for this added cost. The plant is designed to irrigate one-third of the 7,000-acre Llano Grande Plantation

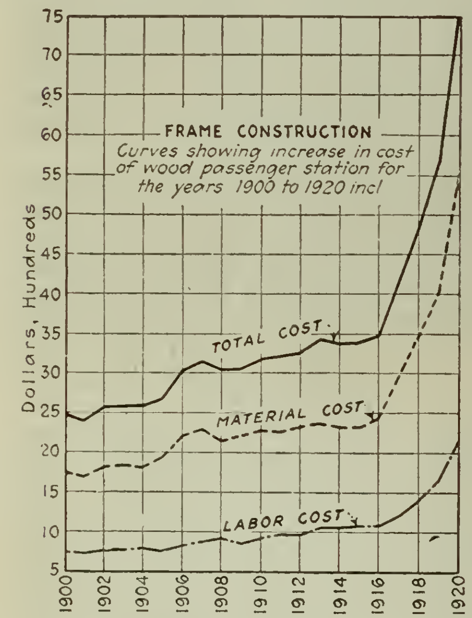
near Mercedes, Tex., owned by W. M. Bancroft and planted largely to sugar cane.

The equipment was furnished by the Allis-Chalmers Co., the construction work was done by Dodds and Wedegartner, of San Benito, contractors, and the design was made and supervision handled by the writer as engineer of the plantation.

Curves of Building Cost Increases Used in Valuation Work

By F. E. Barnes
Supervising Building Valuation Engineer, New York Central Lines

As is well known to most engineers, the Interstate Commerce Commission has been making a physical valuation of all railroads of the United States. To do this it was necessary to make a field inventory of all railroad property, which was so large an undertaking that it was impossible to complete the work in any one year. It therefore became necessary to give each railroad a valuation date, and various roads were assigned different years, ranging from 1914 to 1920. All roads are, however, being valued by using prices which were in effect in 1914 in order that the results would be comparable.



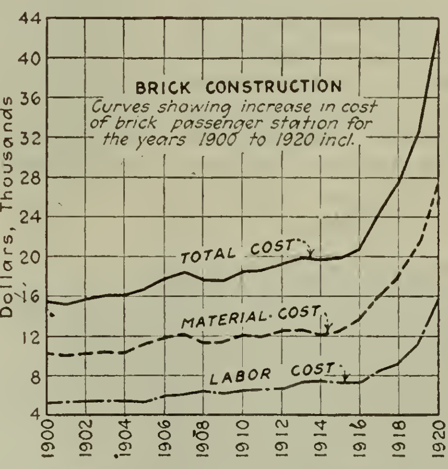


FIG. 1. INCREASE IN BUILDING COSTS FOR FRAME AND BRICK STRUCTURES

Although the railroad records show the construction costs of many of their buildings, yet these costs are seldom for the year 1914. The writer, therefore, has prepared cost trend curves by the use of which the probable cost of a building in 1914 can be obtained when its original cost and date of construction are known. For this purpose bills of material were prepared for typical buildings, both frame and masonry, keeping the labor costs separate from the material costs. These bills of material and labor were then priced for each year from 1900 to 1920 inclusive and the results plotted on a curve as shown in Fig. 1. The labor cost, material cost and the total cost are shown separately.

Fig. 2, which shows the relation of cost between any two years, was prepared as follows: The cost of the building for the year 1914 was taken as 100 per cent and the cost for any other year was shown as a percentage of the 1914 cost. This is shown by the curve made with a dotted line and designated the percentage curve. The curve shown with the full line is the reciprocal of the percentage curve, and is simply one divided by the percentage. By the use of these two curves it is possible, when the cost of a building for any given year is known, to determine what the cost would be for any other year covered by the diagram. This can be done as follows: To find the equivalent cost of construction new of any building for the year 1914 when the actual cost for some other year is known, multiply the actual cost by the percentage found on the reciprocal curve for the given year. When the cost new for the year 1914 is known, then the cost for any other year can be found by multiplying the cost for the year 1914 by the percentage found on the percentage curve for the year in question.

The curves as shown on the diagrams given were prepared from bills of material for a standard frame passenger station 22 ft. wide by 55 ft. long and for a brick passenger station 31 ft. wide by 133 ft. long. The prices of material and labor were for Albany, N. Y. These curves would not necessarily be accurate for other class of buildings nor for the same buildings in other parts of the country, but by actual test the writer has concluded that the curves in all cases will be very similar to those given, and will not vary for different classes of buildings, or even different sections of the country, as much as ordinarily would be expected for different types of construction and locations.

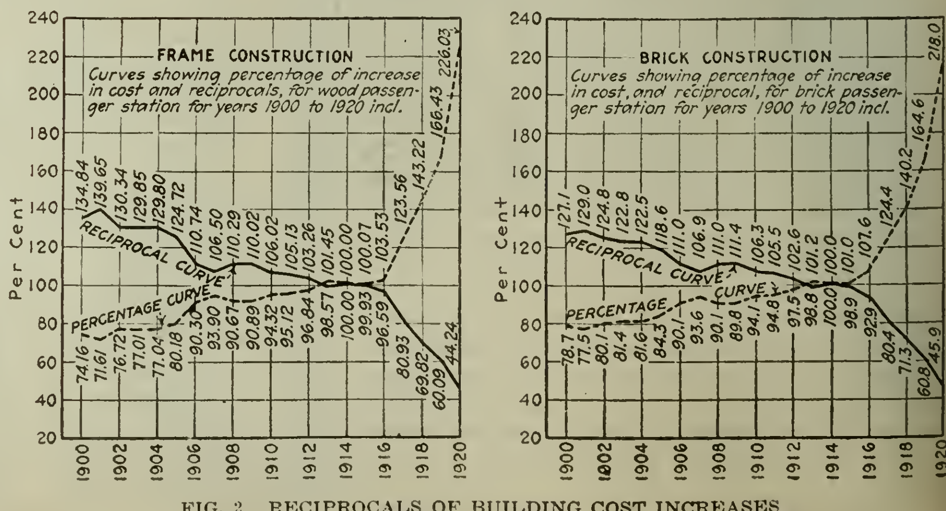


FIG. 2. RECIPROCALS OF BUILDING COST INCREASES
Based on 1914 prices and used in railroad valuation.

Such curves are useful not only in valuation work, but if kept constantly up to date for determining the proper fire insurance schedules, probable cost to construct similar buildings, etc.

City-Manager Plan Widely Endorsed

TO SECURE first-hand information on the practicability of a city-manager form of government, the Sacramento Chamber of Commerce made inquiry of Chambers of Commerce, newspaper editors and individual citizens in a number of cities where the plan is in operation. Such letters were not addressed to city managers or other city officials because an unprejudiced opinion was sought.

In the letters of response there was a sweeping expression in favor of the city-manager plan, according to *Pacific Municipalities*, in which typical replies are published. There was not a single instance in which the plan was declared to be a failure but there were many enthusiastic endorsements of it. Other letters sent to cities having the commission form of government brought "a large majority of answers voicing dissatisfaction and complaints, a number stating that there was strong sentiment for the city-manager form." The accompanying list gives the names of cities with an estimated population of 20,000 or more now operating under or pledged

State	City	Pop.	In Effect	City Manager Salary	City Manager Vocation
Ariz....	Phoenix.......	40,000	April, 1914	$5,000	Mech. Engr.
Cal.	San Diego.....	95,000	May, 1915	4,000	....
	San Jose.......	40,000	July, 1916	6,000	Physician
	Santa Barbara .	20,000	Jan., 1918	4,000	....
Iowa...	Dabuque......	47,500	April, 1920	.. ...	....
Kan...	Wichita........	75,000	April, 1917	6,000	Elect. Engr.
Mich..	Grand Rapids. .	165,000	Mar., 1917	5,000	Banker
	Jackson........	52,000	Jan., 1915	4,000	Civil Engr.
	Kalamazoo.....	55,000	June, 1918	6,000	Sec. Chamb. Com.
	Muskegon.....	50,000	Jan., 1920	......	....
N. M..	Albuquerque...	20,000	Jan., 1918	5,000	Civil Engr.
N. Y...	Auburn........	40,000	Jan., 1920	4,000	....
	Newburgh.....	30,000	Jan., 1916	3,600	Business
	Niagara Falls...	55,000	Jan., 1916	5,000	Civil Engr.
	Watertown.....	40,000	Jan., 1920	7,500	Civil Engr.
N. C...	Gastonia.......	20,000	Aug., 1919	3,600	....
Ohio...	Akron.........	200,000	Jan., 1920	10 000	Attorney
	Ashtabula.	21,500	Jan., 1916	3 000	Business
	Dayton........	170,000	Jan., 1914	7.500	Civil Engr.
	E. Cleveland...	25,000	Jan., 1918	6,000	Civil Engr.
	Sandusky......	25,000	Jan., 1916	5,000	Business
	Springfield.....	70,000	Jan., 1914	6,000	Civil Engr.
Okla...	Muskogee......	50,000	April, 1920	...	....
Penn...	Altoona........	65,000	Jan., 1918	7,500	Civil Engr.
Texas..	Amarillo.......	20,000	Dec., 1912	2.500	Business
	Beaumont.....	35,000	May, 1920	. .. .	....
	Ranger........	30,000	May, 1919	....	....
Va.....	Lynchburg.....	35,000	June, 1920	... ..	....
	Newport News.	37,500	June, 1920	......	....
	Norfolk...	115,777	Sept., 1918	12,000	Civil Engr.
	Petersburg.....	25,000	Sept., 1920	......	....
	Portsmouth...	80,000	Jan. 1917	5 000	Civil Engr.
	Roanoke..	47,000	Sept. 1918	4 800	Civil Engr.
W. Va	Charleston.	43,000	May, 1915	4 500	.
	Wheeling..	80,000	July, 1917	8,000	...

Cleveland, Ohio, population 500 000 will vote on City Manager Charter this fall.

to some form of city-manager government. The total number of all cities of the United States so operating on March 25, 1920, was 177.

Control Cement Content by Field Beam Tests

Machine Devised on New Orleans Inner Harbor Canal Which Measures Breaking Load of Large Concrete Beams

BY MARSHALL G. FINDLEY

Assistant Designing Engineer, Board of Commissioners of the Port of New Orleans, New Orleans, La.

IN THE design of the reinforced-concrete lock for the New Orleans Inner Harbor Navigation Canal, considerations of weight and cost led to the use of unit stresses somewhat higher than usual. As a protection,

TESTING THE CONCRETE BEAM ON THE JOB

however, it was specified that the concrete should test in compression on 8 x 16 in. cylinders at least 2,200 lb. per square inch at the end of 28 days. In the early part of the work these cylinders were made at New Orleans and shipped to the laboratory of Columbia University, in New York City, for test, but delays in transit led to the establishment on the work of a home-made testing machine, in which the center breaking load on a concrete beam could be measured. This machine is now being used to control the proportions of the concrete.

In March, 1919, 106 cylinders were cast and sent to New York. These varied in mix and water content and showed that while the water would account for certain variations in strength, there were apparently differences due to the quality of the cement, which was being stored on the site in large quantities. It was felt, therefore, that there should be some check on the cement and its proportion in the mix, so the following system was established:

The cement storehouse was divided into sections and each individual section filled as far as possible from one shipment so as to have, if possible, uniform quality throughout. When filled, representative samples were selected and six cylinders made using a 1 : 2 : 4 mix and as dry a mixture as could be placed in the lock. After two weeks these samples were shipped to the Columbia testing laboratory and tested. On receiving results of these tests in New Orleans a decision as to proper proportions could be made, using 1 : 2 : 4 concrete when the cement tested well and 1 : 1½ : 3 concrete when the strength showed below 2,000 lb. per square inch.

This procedure seemed to meet all demands for a

COMPUTED UNIT STRESS IN OUTER FIBER OF BEAMS BROKEN IN MACHINE, MAY-JUNE, 1920

Concrete = 1 : 2 : 4
Age = 15 days

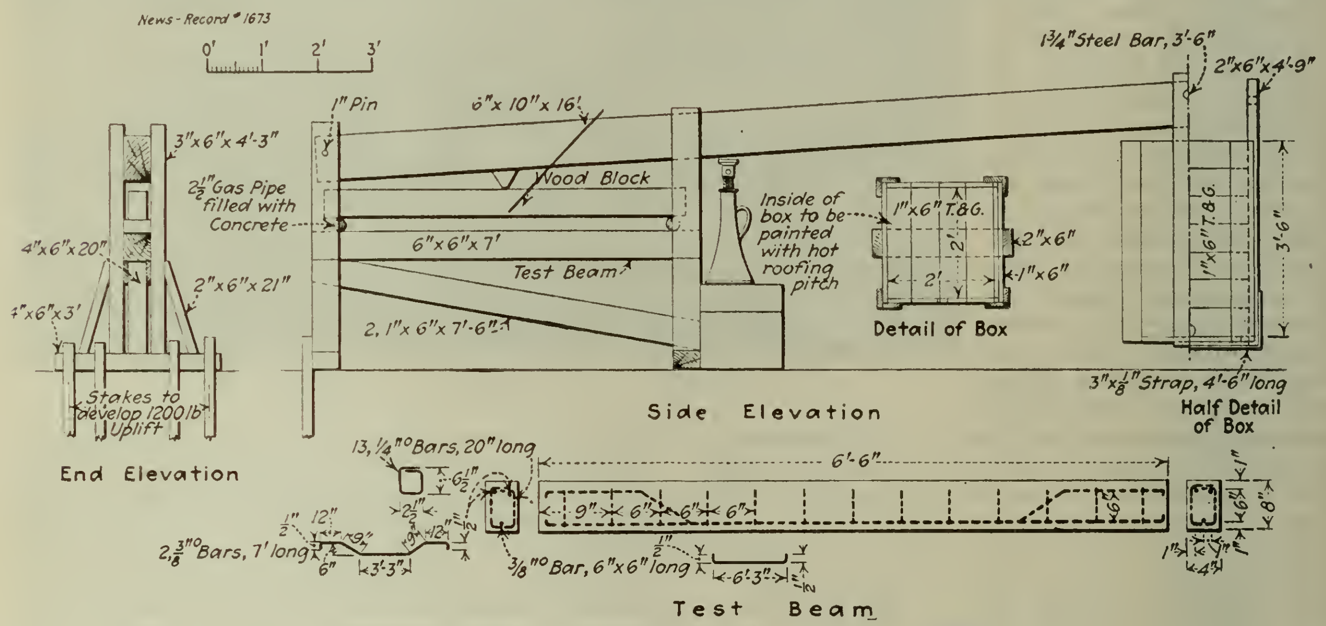
Failure = Compression, as a rule, in lb. per sq.in.
Each figure represents one beam.

	Sec. 3 Lost 1B, 1A	Sec. 3 Lot 1C	Sec. 7 Lot 2	Sec. 2 Lot 1	Sec. 6 Lot 2	Sec. 1 Lot 1	Sec. 5 Lot 2	Sec. 4 Lot 2
	2,100	1,760	2,130	2,050	2,680	1,790	2,210	2,470
	2,285	1,970	2,230	2,185	2,470	1,635	2,525	2,525
	1,945	2,130	2,310	2,000	2,500	1,580	2,105	2,470
	2,285	2,130	2,180	1,920	2,260	1,820	2,365	2,315
	2,390	2,075	2,270	2,155	2,420	1,820	2,315	2,365
	2,285	2,075	2,260	2,210	2,470	1,710	2,470	2,155
Av.	2,215	2,023	2,230	2,087	2,467	1,726	2,332	2,382

time, when transportation difficulties began to make trouble of two kinds. The first of these was that cement was being used faster than it was received, and it became evident that even if all else went well, it would soon be necessary to use cement from sections on which formula, which applies when the beam is at or near failure, and with constants determined for the test beam the compression fiber stress $f_c = 870 + 52.4\ h$. Thus for a depth of water of $23\frac{1}{2}$ in. as for the first result noted in the table, the value of $f_c = 2{,}100$ lb. per square inch.

Some preliminary tests carried out on beams 7, 14 and 35 days old were not altogether satisfactory on account of variation in results, so the method was laid aside temporarily.

In May, 1920, it became evident that reports of cylinder tests could not be received in time for use and it was decided to try the beam tests again, using specimens 15 days old, which was just about the leeway possible. The accompanying table shows the results of these first tests. They were quite consistent and satisfactorily high, so that it was thought safe to use a mix approximately 1:2:4 for all the cements except those from



DETAILS OF FIELD CONCRETE BEAM TESTING MACHINE

a report had not yet been received. Reports on cylinders were in general received by telegraph about six weeks after the cylinders were made. Then, in addition, it was found that the cylinders, although sent by express, were being delayed between New Orleans and New York. Orders were then given to attempt a method of locally testing the concrete in beams, based on the results of a short previous investigation.

Previous to this the suggestion had been made that tests of small beams might be as valuable as tests of cylinders. On account of the fact that cylinder tests are better standardized, it was not intended that beam tests should take the place of cylinder tests. But nevertheless a machine was designed, as shown in the drawings. This consists of a heavy wood frame lever machine, in which the load, a tank of water, is applied at the center of a standard 4 x 8-in. by 6 ft. 6 in. concrete beam, the breaking load being readily measured by the inches of water in the tank. In the tests reported in the accompanying table, for instance, the weights and leverage are such that the total load on the center of the bear $W = 2{,}578 + 155\ h$ where h = depth in inches of the water in the loading tank. Using the parabolic Section 1, for which the proportion of cement was increased by $16\frac{2}{3}$ per cent. Attention might be called to the fact that figured by the straight-line formula, it would take about one-quarter of the average breaking load on these beams to stress the concrete in compression to 800 lb. per square inch, the extreme figure allowed in design.

The above investigations were carried on under the direction of the consulting engineers, represented in New Orleans at first by George M. Wells and afterward by Col. George R. Goethals. The cylinder tests were made by Prof. A. H. Beyer, of Columbia University, and under the direction of Modjeski and Angier, testing engineers.

Chicago Bascule Bridge

In the article on the Michigan Ave. double-deck bascule bridge, in *Engineering News-Record* of Sept. 9, p. 508, an intended correction of the matter on safety devices was omitted. As the installation of these devices and the signal system has not been completed it should be stated that this equipment "has been designed" instead of "was installed."

Sheet Asphalt Maintenance Costs in District of Columbia

Use of Salvaged Material Makes Cost $1.74 Square Yard, Including Asphalt Cost, Haulage, Cutting Out, Working Patch

By Major F. S. Besson
Assistant Engineer Commissioner, District of Columbia

THE EFFECT of the severe winter was, during the early spring months of this year, very noticeable on a goodly portion of the 170 mi., comprising 3,334,157 sq.yd., of sheet asphalt pavements in the District of Columbia. It is our general experience that streets surfaced with sheet asphalt need no repairs until after they reach an average age of seven years, and the effect of the severe conditions instanced was immaterial on pavements within the age limit, but on older streets, it was most apparent. As sheet asphalt pavements grow older they require an increasing amount of attention which cannot be interrupted if the streets involved are to be kept in condition above criticism.

During a usual Washington winter, the highway division is able to keep its sheet asphalt repair gangs at work more or less continuously. The past winter was an exception and for several months work had to be entirely discontinued. Ordinarily, from an economic standpoint, defective spots are repaired while in what might be called an incipient state. Instead, during the winter, while covered with snow or slush and subjected to heavy traffic, the defective spots could not be repaired, and developed into bad holes, daily becoming larger and larger and more numerous. As soon as weather conditions permitted in the Spring, four repair gangs were organized, averaging twenty men to the gang. By July 1, the end of the fiscal year, each had averaged 61 working days, and our sheet asphalt streets were in first class condition. Ninety three thousand cubic feet of asphaltic material were used. More than 35,000 separate patches were made, the averaged sized patch being 0.9 sq.yd., laid at an actual cost of $2.07 per square yard.

Asphalt Plant Operation

The normal output of the municipal asphalt plant is but 800 cu.ft. per day, therefore it had to be supplemented by purchases from a local contractor having the contract for new pavement. The material purchased was standard asphalt binder and topping, 38c. per cubic foot being paid for the former and 48c. per cubic foot for the latter. The coarse aggregate for the mixture turned out by the municipal plant consisted of old material salvaged from previous cuts and resurfacing jobs. The average cost of the hot product was but 25c. per cubic foot. Based on the use of old material alone, the cost per square yard for patching was $1.74.

There are several points of interest in the operation of the municipal asphalt plant. The old material is broken to a maximum 1¼-in. size by means of a crusher consisting of a box 2 ft. x 2 ft. x 2 ft., with a floor made of horizontal 2-in. square steel grate bars. Within the box are revolved a number of hammer heads attached to a shaft by chain link handles. The hammer heads are of flat steel, 4 in. x 8 in. x 1¼ in., the striking edge being the 8-in. x 1¼-in. face. The shaft makes approximately 1,000 revolutions per minute, and the hammer heads strike upon and break up the old material, as brought from the streets. This is fed into the top of the box, the finely broken product escaping through the bottom bars. The cost of crushing is $1.40 per cubic yard. Usually no crushing is done during the warm summer months, as it has been found better to handle and crush old material during cool weather. From the crusher the product is delivered to store piles from where it may be taken with the aid of a pick even after a storage of several months.

The asphalt plant is a portable one purchased in 1912. Its batch capacity is normally 24 cu.ft. of hot mixture. The process with old material in the plant is generally similar to usual practice with all new materials. Prior to reaching the mixing chamber, it is passed through a drying drum, a charge for which consists of 15.6 cu.ft. of old material, 8.4 cu.ft. of sand and 75 lb. of limestone dust. The drum is operated by steam power and fuel oil furnishes a hot blast through it to dry and heat the charge. Each Sunday, because of the asphaltic content of the old material, it is necessary to put a man inside the drum to clean off the accumulation sticking to the sides. From the drying drum the charge is shifted into the mixing chamber which is adjoining it on the same shaft. To the charge in this chamber is added 100 lb. of asphaltic cement from a melting kettle, the heat for which is furnished by a wood fire. This item of asphaltic cement presents one of the significant economies in the use of old material which itself is given credit as having a 100-lb. asphaltic content per charge. In other words, with the addition of 100 lb. of new cement, a hot mixture is obtained equivalent to a 200-lb. asphaltic content mixture wherein new materials are used for the aggregate.

Manufacturing Cost

The cost of a cubic foot of old material mixture is as follows:

0.65 cu.ft. of old material	$0.0337
0.35 cu.ft of sand	0.0273
3.12 lb. limestone dust	0.0069
4.16 lb. asphaltic cement	0.0426
Total cost of material, 1 cu.ft. of hot mixture	$0.1105

Hauling to the plant is included in the above costs, except in the case of the old material for which the hauling is charged to the street work from which it is salvaged. Ten per cent is added to the list price of asphaltic cement in order to make an allowance for tare.

Cost of Salvaged Material

The gang for plant operation consists of one overseer, one steam engineer, one skilled laborer, one kettle man, one drum man, one elevator man, five material men, and one utility man. Manufacturing cost per cubic foot is as follows:

Labor	$0.1211
Plant maintenance	0.0198
(b) Total manufacturing cost	$0.1409

No charge is made for plant amortization since it has reached an age where such is no longer necessary. In fact, very little of the original plant remains, it having been replaced bit by bit in running repairs. Neither is a charge made in connection with the buildings and ground occupied.

The cost of old material mixture at the plant is therefore:

(a)	Material for 1 cu.ft.	$0.1105
(b)	Manufacturing 1 cu.ft.	0.1409
(c)	Cost of mixture 1 cu.ft.	$0.2514

The completed hot mixture is discharged directly into trucks fitted with dump bodies, for transportation to the streets. These trucks are hired by the District and are of two types: One carries two batches or 48 cu.ft., the other carries one batch. During the past season's work the average distances from the contractor's plant and from the municipal plant to the job on the street were approximately equal. The length of haul may be judged by the fact that five was the average number of loads per truck per day for the 93,000 cu.ft. of hot mixture delivered. (d) The bill for hauling totalled $7,037.30, or 7½c. per cubic foot.

It has been ascertained that there are 3 cu.ft. of hot mixture per square yard of area repaired, based upon which the material cost delivered on the job, in the case of the old material output of the municipal plant, is as follows:

(c)	Material for 3 cu.ft. of hot mixture	$0.7542
(d)	Hauling, 3 cu.ft.	0.2250
	Total cost, per square yard, of material delivered on the job	$0.9792

The standard asphalt pavement in Washington is sheet asphalt with a binder course of 2 in. before compression and a topping specified as 2½ in. before compression, which gives a finished pavement of approximately 3¼ in., laid on a 6-in. concrete base. When a rough, or otherwise bad spot appears in a pavement, the sheet asphalt in the defective area is cut out down to the concrete base. The cost for cutting out, painting the edges of the cut with hot asphaltic cement, maintaining equipment and tools, and hauling the old material from the streets amounts to $0.3905 per square yard of area cut out.

The cost of spreading the hot mixture in the patches, rolling and dusting the surface with portland cement, totals $0.3729 per square yard. Three of the patching gangs worked with hand rollers weighing approximately 1,500 lb. and operated by three laborers. The fourth gang used a small steam roller weighing 2½ tons. The results obtained, both as to costs and quality of work done, did not differ materially for either method of rolling.

Adding the 37.29c. per square yard for working the patch, to the 39.05c. per square yard for the cutting out, gives a total cost for the repair work on the streets of 76.34c. per square yard.

Of the aforementioned $1.74 per square yard for patching with old material, hot mixture is seen to be comprised of two costs: 98c. for the material delivered to the job; and 76c. for the actual work on the street.

During the short Spring working season up to July 1, the end of the fiscal year 1920, $65,000 was spent on patching, which is a maintenance rate of 2c. per square yard for the entire yardage in place. Previously during the fiscal year, $55,000 had been spent for maintenance, giving a total of $120,000 for the entire year, or a rate of 3.64c. per square yard. This figure may be taken as representing the maintenance on a group of average pavements under present traffic, labor, and material conditions. It has long been considered that Washington sheet asphalt pavements with a 6-in. concrete base give 25 years of service before requiring replacement of the asphaltic surface. During the early years of this service the maintenance is practically nothing while as the pavement approaches its age limit the maintenance rapidly rises, but with conditions as at present it may be taken that the average for each year of its life of 25 years, approximates slightly more than 3c. per square yard. For some pavements the rate is below this and for others above. Some are resurfaced long before giving 25 years of service, while other existing Washington asphalt pavements have reached an age of 40 years.

In making a study of defective pavements, it is seen that some surfaces crack excessively, and others, while they do not crack, roll into bumps and depressions, causing uncomfortable and slow travel over them. The four repair gangs in the District have been making patches at the rate of more than 500 per day. A close scrutiny of this work shows that cracks in the asphaltic surface bear absolutely no relation to whatever cracks there may be in the concrete base. Also that surface rolling is independent of whether the concrete base presents a smooth or rough foundation. Cracking and rolling are dependent upon the skill used in selecting the materials and handling them in the construction of the pavement. It is practicable to obtain a surface that will neither crack nor roll. In trying to obtain this ideal it is considered that defects due to cracking can more readily be repaired to meet the requirements of traffic than can those due to rolling.

Streets Needing Replacement

Of much importance is the bearing that the amount of money spent for repairs has relative to a demand for resurfacing. Is maintenance the only essential in determining when replacement of the asphaltic surface shall take place? From a survey of the District there has been prepared a list of asphalt streets now needing resurfacing. This list comprises 141 items, well distributed throughout the District and averaging between 2,000 and 2,500 sq.yd. each. The total is 330,025 sq.yd., which, at a cost of $4.75 per square yard for stripping the old surfacing, making incidental adjustments and placing a new surface, amounts to practically $1,500,000. The age of the pavements in question range up to 46 years with an average of 29. The cost of repairs per square yard for these streets each year for the past seven, averages slightly less than 4½c. With conditions as at present it may be estimated that this figure for the coming twelve months will approximate 6c., and this is the only tangible expenditure for which data are available for comparison with the yearly amortization charges that would be necessitated if a new surface were to be substituted.

Charges for a replacement to cost $4.75 per square yard and to have an estimated life of 25 years with money at 5 per cent are:

23.75 cents per square yard per year for interest
2.50 cents per square yard equated annual repairs
9.50 cents per square yard depreciation annuity

Total 35.75 cents per square yard amortization.

In other words, it costs six times as much to resurface the pavements as it does to continue to repair them. In making a decision therefore, in favor of resurfacing it

is evident that there are elements for consideration other than that of maintenance, and of five times the importance. At present these elements are rather intangible, comprising as they do the comfort of passenger traffic, waste of time used in traveling, appearance of the pavement from the viewpoint of civic pride, and increase in ton-mile operating cost due to rough highway surfaces. The necessity of placing any particular street on the resurfacing list was determined not by an examination of the street's data card in the office, but by a study of its actual physical condition. Similarly the order of urgency on the list was determined not by relative maintenance costs but by relative conditions of the surfaces presented.

In contrast to asphalt pavements in their prime, the surfaces presented by the streets listed for resurfacing are rather rough. Furthermore, on these worn out streets it is not practicable to raise the expenditures for repairs to such a point as to make the rough surfaces the equal of new. The only remedy is to resurface. Rough pavements mean increased maintenance and depreciation expenses for motor vehicles. Many truck owners do not understand costs of operation, and while sincere in the belief that they are making a comfortable living, are really using up their original investment for current expense. The measure of the actual efficiency of a vehicle is the engineer's ton-mile cost as determined by the gross weight transported including the tare of the machine. If, because of these rough pavements the engineer's ton-mile cost is raised but ½c., it amounts to an excess charge for the traffic of 1,000,000 tons per mile per year, using these streets, to $5,000. For a street of 20,000 sq.yd. to the mile this signifies 25c. per square yard, a charge relatively large in comparison with that of but 6c. per square yard for road repairs.

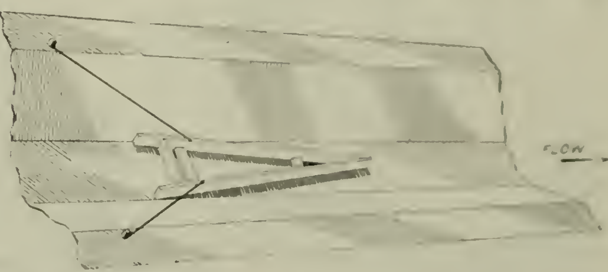
Principles Governing Replacement

Highway funds for the District are dependent upon appropriations made by Congress and that body reflects the attitude of the general public which is rather indifferent to slight increases in fuel consumption and intangible depreciation. Interference with the comfort of the travelling public is a great, and more often than not, the sole influence in directing attention to a poor highway, but this influence usually aids one or two favorite thoroughfares to the neglect of many others equally deserving. Not one of the items, (1) increase in maintenance, (2) comfort of passenger traffic, (3) waste of time used in travelling, (4) appearance of the pavement from the viewpoint of civic pride, or (5) increase in ton-mile operating cost; standing by itself, is sufficient to warrant resurfacing, and the highway engineer is the only one who gives relative merit to all in order to arrive at a rational conclusion. A great number of pavements may be listed for resurfacing, but until such time as the public is educated to appreciate the elements upon which the list is based, appropriations are going to be sufficient to accomplish but a very small portion of the list, and this is borne out by Washington experience.

For a decade or more it has been considered that Washington's asphalt streets give an average service of twenty-five years. To accept this as true to date and to maintain this status with 3,334,157 sq.yd. of pavement in place, 120,000 sq.yd. of resurfacing should be accomplished this year, and the amount should increase 2 per cent yearly in order to keep pace with additional new construction. Such an ideal has not been achieved in the past. If it had the average age of all Washington asphaltic pavements would be 12½ years. To the contrary, there are 670,000 sq.yd. beyond 25 years of age and the average age is close to 16 years. Of late years, instead of increasing, the resurfacing yardage accomplished each year has been decreasing. Though 330,000 sq.yd. with an average age of 29 years may be listed for resurfacing, appropriations are sufficient to carry out less than 50,000 sq.yd. For the future it must be considered that instead of 25 years, 30 years of service are rendered by the average Washington sheet asphalt pavement. Instead of a synthesis of engineering principles governing, the real criterion is "Satisfy the Public."

Sand Removed From Ditch By Scouring

To CLEAR irrigation ditches of drifted sand a scouring device has been used with success on the Mapleton district of the Strawberry Valley project, in Utah. As shown in the accompanying drawing this device consists of a timber A-frame, which is placed in the canal with its nose pointing downstream and is kept in position by guy lines attached to the upstream end and either secured to stakes or held by men on the banks



FRAME FOR SCOURING DRIFT SAND FROM CANAL.

When the frame is loaded with rock so that it rests on the bottom, the water rushing under it scours out the sand. The frame settles until the desired depth is attained. Then the lines are released and the frame is allowed to move slowly downstream, the water scouring out the sand ahead of it.

In the Mapleton canal nearly 15 in. of drift sand was removed in this way in 1919. The method is described in the *Reclamation Record* of August, 1920, by T. R. Smith, hydrographer on the Strawberry Valley project of the U. S. Reclamation Service. A somewhat similar scouring method on the Umatilla project, but with the use of a vertical template shaped to the cross section of the canal or ditch, was described in *Engineering News-Record* of Dec. 11, 1919, p. 998.

Noted Irrigation Project Completed

Completion of the North Side Twin Falls Irrigation Project has been announced. This is one of the earliest and for a long time most discouraging projects in Idaho which takes water from the Snake River. It is now one of the most prosperous of the Carey Act enterprises, has been accepted as completed by the state and turned over to the settlers for management. Work of segregation began in 1906. Of the 170,000 acres involved 145,000 are now under cultivation. The canal system is 300 miles long and the total cost of construction is $4,500,000.

Notes from Foreign Fields

SWITZERLAND'S SPECIAL ENGINEERING PROBLEMS—THE ENGINEER'S PART IN EXPLOITING SWISS SCENERY

By E. J. Mehren
Editor, *Engineering News-Record*

PHYSICAL conditions give the engineers of Switzerland a concentration of difficult and interesting transportation problems. The country is mountainous, the passes few and steep, the valleys tortuous. The provision of transportation facilities under these conditions is difficult and expensive.

Moreover, the population is relatively dense, while on every side are countries normally busy and wealthy. As a result there is heavy through as well as heavy internal traffic.

The picturesque character of the country adds to the transportation problem, since the tourist wants to go in comfort to places that for commercial or agricultural reasons might well be served with quite primitive transportation agencies.

The engineering visitor, therefore, can well afford to spend much time in studying the Swiss railways, the highways, the tunnels and the bridges.

Almost of equal interest are the stream-control and the water-power problems. The streams from the snowclad mountains are obvious sources of water power, while the concentration of population makes it necessary to use every square foot of cultivable ground and to safeguard it from the destructive action of the swift mountain watercourses. The art of mountain-stream control and the regulation of rivers have, accordingly, attained a high development, and offer a set of interesting solutions to those who can find time to study them.

The main line railways are, in general, of the same gage as our own, constructed as a rule with maximum curves of 300-m. radius (somewhat less than 6-deg. curve). The grades run to very high figures, some as high as 6.6 per cent. On the heavy through roads, such as those connecting with the St. Gotthard and the Simplon tunnels, the grades are held to 2.7 per cent.

There is also a large mileage of meter-gage road, principally through difficult mountain country. On these meter-gage roads the maximum curvature is, as a rule, of 120-m. radius (14 deg. 38 min.), though on the famous Chur-Arosa line the maximum curve has a radius of 60 m. (about 29 deg.). The grades on the adhesion sections are as high as 7 per cent, but on some of the rack-rail sections, principally on mountain scenic lines, the grades run to 25 per cent, and in one case, the Pilatus Railway, to 48 per cent.

The chief railway tunnels of Switzerland are known by name to every engineer. The Simplon, he knows, is 12.3 miles long, the St. Gotthard (double-tracked) 9.3 miles, but he is probably unprepared for the statement that there are no less than ten other tunnels which have lengths greater than 3½ miles. The Loetschberg is 9 miles long, the Mont Cenis 8 miles, and the Arlberg 6.3 miles, all three being double-tracked.

Naturally the highways present interesting problems. The traffic, as a rule, is light, with relatively few automobiles, so that waterbound macadam, laid both with and without large-stone bases, has been principally used, though for the last 30 years large-stone foundations have been considered standard on the important roads. Tar macadam and bituminous spraying are coming into larger use. Improvement work, however, is hampered now since the costs are three times what they were before the war.

The principal roads have widths of from 5 to 7 m. and, in the mountains, maximum grades of about 10 per cent. On roads in the high passes short stretches of 12-per cent grade are found.

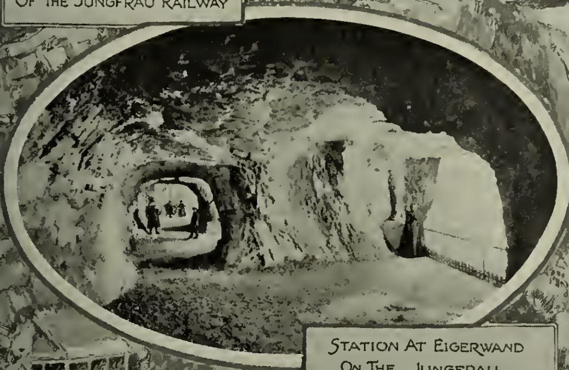
The development to keep the grades down to the 10 per cent maximum in the mountains is very elaborate. A view herewith shows a section of the famous

MOST FAMOUS OF SWISS MOUNTAIN-CLIMBING RAILROADS AND ITS CONNECTIONS
The Jungfrau Railway starts at Scheidegg, near the center of the picture.

FOUR PAGES of SWISS ENGINEERING ACHIEVMENTS
ILLUSTRATING ALSO, THE ENGINEER'S PART IN EXPLOITING SWISS SCENERY

THE SIX OPENINGS ARE THE EISMEER STATION OF THE JUNGFRAU RAILWAY

HIGHEST RAILWAY STATION IN EUROPE — JUNGFRAUJOCH 11,340 FEET ABOVE SEA LEVEL



STATION AT EIGERWAND ON THE JUNGFRAU RAILWAY

ONE OF THE VIEWS FROM THE JUNGFRAUJOCH STATION

NEAR THE STARTING POINT JUNGFRAU RAILWAY — MOUNTAIN IN THE FOREGROUND IS THE SILBERHORN ONE OF THE JUNGFRAU GROUP

JUNGFRAU — AN EARLY WINTER PICTURE — CHARACTER OF VIEWS FROM MOST FAMOUS OF SWISS MOUNTAIN RAILWAYS

PHOTOS BY PHOTOGLOB-ZURICH

Rock Gallery On The Axen Road — One Of The Most Famous Highways Of The Mountain District

Steep Section On The Rack Railroad Ascending Mt. Pilatus

Bürgenstock - Lift - On The Lake of Lucerne Elevator Rises 537 Ft.

Wetterhorn - Lift - Aerial Cableway At Grindelwald — With Rise Of 1370 Feet

On The Road From Weesen To Amden - Near Lake Wallen -

Photos by Photoglob Zurich

HIGHWAY OVER THE
KLAUSSEN PASS
A FAMOUS SWISS ROAD
ELEVATION OF SUMMIT 6396 FT.

BANK PROTECTION
ON THE RHONE
AT A POINT HALF A MILE FROM THE
NORTH PORTAL OF THE SIMPLON TUNNEL

CHECK DAMS ON A
MOUNTAIN STREAM—
TORRENT CONTROL HAS BEEN
HIGHLY DEVELOPED IN SWITZERLAND

ELECTRIC LOCOMOTIVE
ON MOUNTAIN RAILWAY—
OPERATED BY RACK SYSTEM
ON THE STEEPER GRADES

AERIAL CABLEWAY
AT GRINDELWALD
ANOTHER VIEW OF THIS INSTALLATION SHOWN ON A PRECEEDING PAGE

LOWER REACHES OF A
MOUNTAIN STREAM—
THE SCHAECHEN-CHECK DAMS
ARE USED ON THE UPPER REACHES

SWISS SOLUTIONS of BRIDGING PROBLEMS

GRÜNJETOBEL BRIDGE
ON THE CHUR-AROSA RAILWAY
SPAN – 275½ FT.

WIESEN VIADUCT
ON THE RHAETIAN RAILWAY–
CENTER SPAN 180 FEET

KORNHAUS BRIDGE
A FINE HIGHWAY AND ELECTRIC RAILWAY BRIDGE WITH A CENTRAL SPAN OF 350 FT.

LANGWIESER VIADUCT
ON THE CHUR-AROSA RAILWAY–
LONGEST REINFORCED CONCRETE SPAN IN SWITZERLAND 321½ FT.

LANDWASSER VIADUCT
ON THE ALBULA RAILWAY –
BUILT ON CURVE OF 328 FOOT RADIUS

PHOTOS BY PHOTOGLOB ZURICH

Klaussen Strasse, which goes over the Klaussen Pass from Altdorf to Linthal. The maximum elevation attained is 1,952 m. (6,402 ft.), and of this height the last 3,122 ft. are attained in a distance of 7½ miles.

Bridges—A few photographs herewith, beneath each of which will be found the span of the particular structure, gives some idea of the character of the solutions worked out by the Swiss engineers for their bridging problems.

Engineers' Part in Exploiting Swiss Scenery

What has been said so far of the transportation facilities (except as to the Klaussen Strasse) applies chiefly to lines of communication essential for commercial traffic. There is another system of communication whose sole object is to carry tourists to points otherwise attainable only through difficult mountain climbing. In other words, the engineer has lent his genius to the exploitation of Swiss scenery, and the resulting work form in themselves a most fascinating study.

The most notable, by far, of the mountain railways is the Jungfraubahn (the Jungfrau Railway). The art of mountain-railroad building had been highly developed in Switzerland by the beginning of the last decade of the Nineteenth Century. There were cable inclines and rack railroads in large number. Many of the latter had been built under great difficulties and were noteworthy examples of engineering. For the most part, though, they were below altitudes of 6,000 ft., and were free from snow the greater part of the year. Moreover, traversing the lower slopes, they did not have to contend with sheer precipices, and deep gorges, even though on most of them grades of 25 per cent were necessary. None of the roads offered precedent for surmounting the difficulties of the higher regions—eternal snow, glaciers and precipitous cliffs.

Nevertheless, a bold spirit dreamed of plans for conquering by engineering means the Jungfrau, the most famous and possibly the grandest, even if not the highest, mountain of Switzerland. Realizing the futility of trying to build a line on the face of the mountain, understandable even from the pictures shown herewith, he conceived the idea of tunneling to the top and of breaking out observation stations at points affording magnificent views. Fortunately, financial backing was available, and in 1897 the project worked out by Adolph Guyer-Zeller was put under way.

The plan contemplated a line 7½ miles long, starting at Kleine Sheidegg, a station on the Wengernalp Railway, at an elevation of 6,770 ft., and ascending by rack railroad to a point inside the mountain, at an elevation of 13,430 ft., directly under the Jungfrau summit. From this point an elevator was to rise through a height of 240 ft., placing the tourist without physical effort on the tip of the Jungfrau, 13,670 ft. above the sea. A station was to be established in the open at Eigergletscher, 1¼ miles from the starting point, but from Mile 2 the line was to be entirely in tunnel, three observation stations being broken out between Eigergletscher and the summit.

The project has been carried out for a length of 5¾ miles, to Jungfraujoch, at an elevation of 11,340 ft. The final stretch to the summit has not been built.

The line is of meter gage, with a single-track tunnel, 12 ft. wide and 14.3 ft. high. Operation is under adhesion up to grades of 6.6 per cent. Above that the rack system, with maximum gradient of 25 per cent, is used. The trains are electrically driven, with current supplied from near-by hydro-electric stations. The cost of construction was 12,000,000 francs (about $2,400,000 at normal exchange rates), and the highest section, from Eismeer to Jungfraujoch was put in operation in 1912.

The start is made along a length of adhesion track affording a magnificent view of the great mountain mass. At Eigergletscher opportunity for studying a large glacier is afforded, and after a short stop the train soon plunges into the long tunnel. The speed is low, 11 miles per hour on the adhesion and 5½ miles on the rack sections, but the one-and-a-half-mile stage to Eigerwand station is traversed before one has finished musing on the fine scene that has just been left behind. The station is a long arched room, with two tracks and two platforms, from which a passage, 26 ft. long, leads to a gallery parallel with, and just inside of, the face of the mountain. Along the gallery are three drifts, each 18 ft. wide, to the face of the mountain, affording a fine view of the valleys to the north. The passage, the valley and the drifts are, of course, all excavated out of the solid rock.

From Eigerwand, at the north face of the mountain, the line crosses to the south, and at Eismeer presents a magnificent picture—a glacier basin, surrounded by the high peaks of the Barnese Range. From the engineering point-of-view the Eismeer station is the most remarkable on the line. As at Eigerwand, a passage leads from the platforms to the face of the mountain, but instead of merely a bare rock gallery, there is here a finely-finished and appointed dining room, with capacity for seating 200 guests at one time. The cooking and heating are done by electricity. The six wide windows of this station, as seen from the outside, is shown in one of the accompanying views.

The final climb is at the 25 per cent gradient. The present terminus, Jungfraujoch, at elevation 11,340, has a small restaurant, a post-office, and sleeping rooms for those who want to see sunset and sunrise from this point of vantage or make mountain-climbing tours. The Jungfrau, it is said, is easy of mastery from this point, the ascent, over snow and ice even in midsummer, requiring 3½ hours. The view here is unsurpassed, some idea of what can be seen being afforded by one of the illustrations.

As a piece of engineering the line deserves a visit no less than for the magnificent panorama it affords. A quick ride to the top of the world is necessarily an interesting experience, particularly to an engineer, who appreciates the toil required to build this comfortable mountain-climbing railroad. One does not even suffer from the cold, for the cars, like the stations, are electrically heated—a really necessary provision, for out on the balcony at Jungfraujoch and in the gallery and drifts at Eigerwand one quickly became chilled to the bone even in July. Mountain climbers look with contempt on the weaklings who do their peak-scaling by railroad, but for the average mortal the Jungfrau Railway affords the only means of getting to the top of a peak of eternal snow.

For that boon the engineer is to be thanked, and particularly Guyer-Zeller, a tablet in whose honor now looks out on the panorama of the Eigerwand station.

Other Mountain Lines—While the Jungfrau line i

by all odds the most interesting of the mountain railways, there are others that would deserve mention if space allowed. The grades, as a rule, are 25 per cent maximum, but a very notable exception is that of the Pilatus Railway, which has maximum grades of 48 per cent. A photograph of one of the steep sections is shown herewith.

Both steam and electric power are used for driving these mountain lines. On the steam lines the braking on the rack sections is effected through bands on both sides of the pinions which engage the rack. On the electric roads both this type of braking is employed and also electric braking—by running the motors as generators, working against a resistance.

There are many cable roads, but they are of relatively short length. There is also one cableway installation—the famous Wetterhorn Lift, illustrated herewith. At this installation two cars operated so as to counterweight each other travel on cables and rise through a distance of 1,376 ft. above the Grindelwald Valley.

Another installation of unusual character is a high-lift elevator at Buergenstock, illustrated herewith. It stands on the face of an almost sheer cliff and has a total travel of 537 feet.

Yet another means of communication developed by engineering science is coming into use in Switzerland, though with it the civil engineer has relatively little to do. The company has instituted an aëroplane service on four of the Swiss lakes: For 50 francs one can have a 15 minutes' flight, whilst special flights from lake to lake can be arranged to suit the tourist. At present machines are in service, indicating either successful commercial operation or the faith of the promoters in the development of the enterprise.

Mountain Stream Control

Reference has been made in a previous article to present progress in the development of Swiss water powers, so that further reference is not necessary here. A word should be said, however, with reference to the very extensive operations in the control of mountain streams. These naturally bring down large quantities of debris and if uncontrolled deepen their beds and create constant havoc.

In the upper reaches the building of small dams, of the type illustrated in the accompanying photographs, is the common remedy. These have the same purpose, of breaking the flow and thus catching the debris, as the dams built experimentally by Mr. Olmstead in the mountains near Los Angeles, but the construction is more substantial.

In the lower reaches dry-laid and mortar-laid bank protection is used, while with the larger streams, after the floor of the valley is reached, spur dykes are in common use. Along the Rhone, at Brigue, where the north portal of the Simplon Tunnel is located, the banks are protected by dry walls and spur dykes 100 ft. apart. A picture of these dykes is shown herewith.

In the 50 years ending in 1913 no less than 139,000,000 francs were spent on stream correction and control in the lower reaches and 56,000,000 francs in the higher reaches.

Under the control of the same branch of the government which looks after the streams is the study and prevention of land and snow slides. Work is constantly under way at points where dangerous conditions are developing, the method being to intercept the water which is saturating a seam and creating a slippage plane.

Conclusion.—These problems and solutions offer to the American engineer a variety of interesting studies that tempts one to spend fully as much time in this small country as in any of its larger neighbors. In the larger countries one can study conditions and solutions which are akin to and have application in our own country. In Switzerland it is rather the novelty of conditions that attracts.

Zurich, July, 9.

Harbor Piloting and Ship Location by Radio Methods

THE PROBLEM of piloting vessels by radio signal has been studied from several points of view recently. The Navy Department is just completing a very important series of tests in the New York Harbor on a system using what is called a "radio piloting cable." This system was first tried out by the Navy Department nearly a year ago but the first tests were not successful due to damage of the cable by fishing operations. A new cable designed by the radio division of the Bureau of Engineering of the Navy Department has, however, proved successful and recent tests are reported to be exceedingly encouraging.

The work requires a cable energized by a low frequency alternating current laid along the center of the channel through which vessels are to be guided. The magnetic waves from this cable are picked up by any one of several types of receiving equipment aboard ship and the pilot lays his course in accordance with the relative intensity of the signals from the right or the left receiving units. A full report upon this work will be available on completion of the present tests on best intensity and character of signals, most suitable type of receiving equipment, and other important technical details.

In connection with the radio location of ships the Navy has now under consideration the establishment of a large number of additional radio compass stations. These will be placed along the Western seaboard and on the Great Lakes. It is anticipated that they will find extensive use in directing the merchant marine, though they will be designed primarily for naval service.

Another problem also under investigation by the Government is being studied through the Bureau of Navigation of the Department of Commerce. This investigation relates to determination of ship location by radio signal. The system in use at the present time by the Navy employs radio compass stations on shore which measure the angle from which the signal is sent by the vessel to be located. By a system of triangulation two or more shore stations working together can determine the location of a vessel. The new system under test by the Department of Commerce reverses the operations by sending the signals from shore stations and doing the radio compass work aboard ship. Recent tests on this system are reported to have been very successful, but further investigations both as to apparatus and methods of manipulation are anticipated before any extensive application will be recommended.

Economic Weight of Rail for Varying Traffic Conditions

ECONOMIC VALUE of rails of different weights in relation to cost of rail maintenance is determined by the traffic, and a minimum traffic of 900 cars per track per day is the economic limit between rails of 100 lb. and 130 lb. per yard. These statements are the principle conclusions of a report presented at the recent annual meeting of the Roadmasters and Maintenance of Way Association by J. B. Baker, engineer of maintenance of way, Pennsylvania System, Cleveland.

Records for seven stretches of 100-lb. rails show an actual life ranging from 14 to 24 years and a traffic of 400 to 900 cars per track per day. On seven stretches having 917 to 1,700 cars per track per day the life ranged from 5½ to 20 years, but in two of these records the life was only 5.5 and 8.1 years. The number of cars per track per day as the unit of measure for traffic conditions was adopted as representing closely the locomotive tons and gross tons, and because the figure at any point can be determined without difficulty.

RELATIVE LIFE AND ECONOMY OF RAILS OF DIFFERENT WEIGHTS

Cars per Track per day	100-lb. Rail Life Years	100-lb. Rail Annual Cost Per Mile	130-lb. Rail Life Years*	130-lb. Rail Annual Maint. Cost Per Mile	85-lb. Rail Life Years†	85-lb. Rail Annual Maint. Cost Per Mile
1,600	10.30	$1,250	20.6	$1,175	5.89	$1,400
1,400	11.40	1,200	22.8	1,145	6.52	1,400
1,200	12.75	1,140	22.5	1,100	7.29	1,320
1,000	14.10	1,090	28.2	1,080	8.06	1,250
800	15.90	1,040	31.8	1,050	9.09	1,165
600	18.40	990	....	......	10.50	1,095
400	21.10	940	....	......	12.05	1,025

*Life of 130-lb. double that of 100-lb. rail.
†Life of 85-lb. 4/7 that of 100-lb. rail.

A heavier rail is economical, as a general proposition, when its longer life will make the annual cost less than that for a lighter rail. The annual labor cost of rail maintenance will become less as the weight of rail is increased, less labor being required to install and maintain the heavier rail under nearly all conditions. The design of track may be changed radically by increasing the weight of rail and decreasing the number of ties, but this is a question of economic track design. There is also a special case where a very heavy rail will give practically infinite life and at the same time make possible a very low annual labor charge for maintenance. This point is illustrated where electric railways of light traffic use rails of a weight and strength which bear no relation to the traffic conditions, the economy of the track structure being due to the very long life and the small cost of maintenance.

For a uniform life of ten years, it is estimated that the annual cost of maintenance per mile of track is $1,116, $1,269 and $1,587 for 85-, 100- and 130-lb. rails respectively. But it is estimated that under uniform traffic conditions the life of the 100-lb. rail will be 1.75 that of the 85-lb., and the life of the 130-lb. will be double that of the 100-lb. or 3.5 times that of the 85 lb. He gives the average life at 6.55, 8.25 and 12.85 years for the three weights respectively. A comparison of life and cost under different traffic conditions is given in the above table.

On the basis of relative life, the report states that on track where an 85-lb. rail lasts only two years and has an annual maintenance cost of $3.327 per mile of track, the life for 100-lb. and 130-lb. rails would be 3½ and 7 years respectively, with corresponding maintenance costs of $2,490 and $1,945. Under these conditions the 130-lb. rail is the most economical. Similarly, where an 85-lb. rail has a life of nine years and an annual maintenance cost of $1,176, the life for the two heavier rails will be 15¾ and 31½ years, with maintenance costs of $1,030 and $1,050 respectively. In this case the 100-lb. rail is the most economical.

Land Classification Used by Farm-Loan Engineer Appraisers

Water Supply, Construction Service and Drainage Conditions Factors on Which Farm Loan Bureau Approves Loans

ENGINEERING factors in irrigated farm appraisals as utilized by the engineer-appraisers of the Federal Farm Loan Bureau was the subject of an article in *Engineering News-Record*, June 3, 1920, p. 1100. That article gave four definite classifications for the adequacy of water supply. The bearing of construction and drainage conditions on loan value was also discussed but no classifications were attempted. J. T. Whistler, engineer adviser to the Federal Farm Loan Board, has recently set up classifications for (1) what is termed construction service and (2) drainage conditions to cover the remaining factors. By construction service is meant character of service furnished by the constructed irrigation system in which generally cost of operation and maintenance is the principal factor and continuity of service a secondary factor. Mr. Whistler's classification of construction service follows:

Class A—Construction service in which the actual or estimated average annual cost of operation and maintenance per acre, plus the estimated annual hazard of loss per acre through break in service, does not exceed 5 per cent of the average annual mean value per acre of the three principal or staple crops of the district, on the basis of Class I water supply. By mean value per acre of the three principal crops is meant the total value in the district of the three crops divided by the total acreage in the three crops.

Class B—Construction service in which the cost of operation and maintenance, plus hazard of loss, exceeds 5 per cent but does not exceed 10 per cent, as defined for Class A.

Class C—Construction service in which the cost of operation and maintenance, plus hazard of loss, exceeds 10 per cent but does not exceed 20 per cent, as defined for Class A.

Class D—Construction service in which the cost of operation and maintenance, plus hazard of loss, exceeds 20 per cent, as defined for Class A.

Construction classification for applications in considering loans covers not only good or poor construction, as ordinarily considered, but also operation and maintenance of construction. A high operation and maintenance cost may be directly the result of poor design, but is often entirely due to natural conditions which make low operation and maintenance cost impossible, however good the design may be. For this reason the construction factor was combined with that of operation and maintenance and denominated construction service.

The relative weight that these factors bear to each other in the character of construction service will vary with conditions: (1) The degree of need for irrigation, that is, rainfall available for crops and it.

variation from normal; (2) character of crops—for example, the loss from water failure one season might not only lose an entire season's yield from an orchard or from alfalfa but might also result in loss of the orchard or of the alfalfa stand itself; (3) value of crops and dependence of farmers on irrigation of lands; (4) cost of construction as compared to value of land; (5) cost of normal operation and maintenance.

A replacement cost, as of a wood-stave pipe line, wood flume, or other structure of a perishable nature, might be considered to constitute another factor. But it is held by Mr. Whistler that such cost is properly a matter affecting operation and maintenance (except as it may affect also the factor of continuity of service), and that it should be distributed to operation and maintenance cost. Similarly, the possibility of failure of a dam, for example, from faulty design or insufficient spillway capacity is not covered by either factor, but it will affect operation and maintenance cost and may materially affect the factor of assurance of continuity of service.

The following illustration is given: In a system involving little or no hazard of failure, operation and maintenance may have a relative weight of from 75 to 100 per cent. In a system depending wholly or largely on storage, in which the failure of a dam might possibly result in abandonment of the project, the assurance of continuity of service may have a relative weight of from 50 to 100 per cent. In a system depending on a pipe line comparatively inexpensive to replace but which (because of location or inaccessibility) cannot be replaced during the season, the factor of continuity of service may have a relative weight of from 10 to 20 per cent or even greater, depending on the value of crops which would be lost and plants destroyed.

Three principal or staple crops, instead of one as originally proposed, are used as the basis for computing the classification, since it was realized that there should be included not only the principal farming crops of forage and grain but also one or more of the intensive crops, in order that the labor conditions which so affect land values might be brought out.

The relative value of the different classes of construction service will vary with conditions, such as (1) labor supply, affecting crops grown, (2) climatic conditions, both as to temperature and as to rainfall, and (3) transportation and market facilities. This variation in value is true also of the water-supply classification. In a general way, however, there is an irrigation value of irrigated land separate and more or less distinct from what may be termed the "dry land" value. In a region of low humidity and little rainfall, as in most of the Southwest and the larger part of the Great Basin, the irrigation value is for all practical purposes the entire value. In regions of high humidity and of from 10 to 20 in. of rainfall during or available in the growing season, the irrigation value is less.

Classes of Drainage Conditions

Definitions for drainage conditions are necessarily more complicated because there are two distinct kinds of drainage troubles. One is due to alkalification, the other to simple drowning of the plants. Alfalfa, clover, timothy and grains may thrive on land where the ground water is within 2 ft. of the surface, but some lands with ground water 5 ft. from the surface may be absolutely barren. The four classes for drainage conditions adapted by Mr. Whistler are as follows:

Class "Good"—Drainage conditions are "Good" where permanent natural drainage or satisfactorily operating artificial drainage (or both) are now and will continue such that there will be no harmful accumulation of alkaline salts on or near the surface of the ground through capillarity, and such that the soil is and will continue otherwise so drained that there will be no loss therefrom in excess of 5 per cent of the average annual mean value per acre of the three principal or staple crops grown or adapted to the district, on the basis of Class I water supply and Class A construction service.

Class "Fair"—Drainage conditions are "Fair" where they would be in class "Good" except that adverse conditions are and will continue such that the crop value as defined in class "Good" is reduced more than 5 per cent but not more than 20 per cent. Drainage conditions are also "Fair" where they would come within class "Good" as defined but where the ground water is slowly rising not more than 1 in. per year, provided that the water table at the present time is not closer than 8 ft. from the surface at any time of the year, that the district is well established and has practiced artificial drainage successfully for several years and provided that it is estimated the land may be drained, if it becomes necessary, at a reasonable cost.

Class "Poor"—Drainage conditions are "Poor" where they would be in class "Good" except that adverse conditions are and will continue such that the crop value as defined in class "Good" is reduced more than 20 per cent but not more than 50 per cent, or such that the same effect is produced by limiting the choice of crops to those adapted to insufficiently drained soils, such as the short-rooted crops and "wild hay" and "salt grasses." Drainage conditions are also "Poor" where they would otherwise come within class "Good" at the present time, but where the ground water is slowly rising not more than 2 in. a year, provided that the water table at the present time is not closer than 6 ft. from the surface at any time of the year, that the district is well established and has practiced artificial drainage successfully for several years and it is estimated that the land may be drained, as it becomes necessary, at a reasonable cost.

Class "Bad"—Drainage conditions are "Bad" where the mean crop value as defined under class "Good" is reduced more than 50 per cent on account of the adverse drainage conditions, where the ground water is closer than 6 ft. from the surface and is slowly rising, where the ground water though lower than 6 ft. but not lower than 8 ft. from the surface is rising at the rate of more than 2 in. a year, or where it is probable that the development of adjacent or nearby land will within the period of the loan bring about such conditions.

The definitions undertake to provide not only for drainage conditions as affected by alkalification but also as affected by high or threatened high-water table and waterlogging, where there may be no excessive alkalies either in the soil or in the water. Even where objectionable alkalies exist either in the soil or in the water to a harmful extent, conditions as to water supply for leaching, or as to character of soil permitting it, may materially modify otherwise adverse conditions and change the classification. The amount of rainfall is an important factor since with from 15 to 20 in. of rainfall on average soils objectionable alkalies are likely to be leached out naturally.

Water-Supply Classification

Class I—Water supplies which have no shortage during ordinary years.

Class II—Water supplies which have some shortage in normal years, but which furnish sufficient water to mature crops. Where storage is involved, those providing two-thirds or more of a full supply are in this class if not in Class I.

Class III—Water supplies which furnish water only during the normal flood season. Where storage is involved, those providing one-third to two-thirds of a full supply.

Class IV—Water supplies which furnish during the irrigating season a full supply for not to exceed 30 days in normal years and none in years of low run-off. Winter irrigation supplies and those providing less than one-third of a full supply where storage is involved.

The engineer-appraisers are primarily employed as engineers but they also are required to appraise lands. It has developed that they are called upon by the banks to approve or otherwise comment on all irrigated land appraisals before loans are finally passed by the banks. The Farm Loan Board now requires engineer-appraiser reports on all irrigated lands with the exception of certain defined small areas that have been irrigated for ten years or more, and in which no change is likely to occur before the securities will be approved for bond issue.

Letters to the Editor

The Wall Street Explosion

Sir—Much has been printed in the daily press regarding the Wall St. explosion and two things are conspicuous: The immediate conclusion of the federal authorities that the Reds were at work, and the alacrity with which others switched to that solution. We are told that the movements of all dynamite wagons were traced and that the contents of all magazines checked, but that means nothing. Fischer's warning letters indicated a plot, but he is eliminated. The window weights seemed conclusive, but their presence may be explained, without a plot. No hole in the ground seemed to prove it was not dynamite, but those holding this theory overlook the fact that the explosive was several feet above the street with an air cushion below it to absorb the shock.

Colonel Dunn, whose opinion must be considered on all matters of explosives, believes, because of the character of the fragments, that it was not dynamite but a considerable quantity of a less powerful explosive in connection with gasoline. The regulations covering the use, transportation and storage of dynamite in New York City, embodied in Chapter 10 of the Code of Ordinances, provide adequate safeguards for our citizens when properly observed and strictly enforced. The Catskill Aqueduct from Yonkers to Brooklyn and all the new subways in congested city streets that used over a million pounds of dynamite yearly, were constructed without injury by dynamite to any one, other than the excavators.

The dynamite manufacturers and the responsible contractors mean to play safe, but much is left to subordinates. Magazines have been left unguarded, dynamite carried along our sidewalks and loaned and borrowed by contractors.

In one case children stole a box of dynamite from a magazine on Washington Heights, threw it over the cliffs and carried the scattered sticks home. A magazine in the Bronx, holding a thousand pounds of dynamite was found unguarded. Dynamite was taken from a magazine on Amsterdam Ave, while two policemen stood chatting on the curb. When things like that can happen it is not difficult to figure what may have happened on Wall St.

Wreckers have had permits to use dynamite to demolish buildings in congested New York streets. It is dangerous but has been done. Suppose they need dynamite and DuPont could not make an early delivery or they could not get a permit to blast? They would not get dynamite by the hundred pounds for they would not need that much and could not hide it from the inspectors. A few sticks, however, could be borrowed, placed in a wagon with a box of window weights removed from some other old building they were wrecking; add a couple of cans of gasoline for the air drill compressor and the detonators loose in the wagon. An auto hits the wagon, the window weights roll from the box, hits the exploders and detonate the dynamite, which explodes the gasoline.

Has anyone had experience enough with dynamite and gasoline exploding simultaneously to state as an expert, that there was no dynamite in this explosion? A bomb would simplify matters for all but the Reds, and it does not involve liability.

JOHN R. HEALY.

New York City Sept. 29.

[Mr. Healy was formerly on the engineering staff of the Catskill Aqueduct and later served as Inspector of Combustibles, Fire Department, New York City—EDITOR.]

Investigating Highway Bridge Impact

Sir—Impact in highway bridges, discussed in your editorial of Sept. 9, 1920, is in my opinion well worthy of investigation. I do not believe that the failure of state highway departments to make provision for impact is as serious a matter as the tone of your editorial appears to indicate; but present practice is not scientific and should be remedied.

As you state, tests have shown a very considerable impact on railroad bridges. Railroad bridges generally carry the full load for which they are designed, and sometimes they are overloaded. Therefore any increase in loading over the theoretical load is a serious matter. The trusses of highway bridges, however, are rarely called upon to carry anything like the loads for which they are designed, though the floor systems occasionally do carry loads approximating the assumed load. While there probably would be considerable impact under the load of a traction engine, this load would be only a small portion of the total capacity of the bridge, though it might be practically the full assumed load for the floor system.

If a study were made and the effect of impact produced by various highway loadings determined, it would be possible to design our bridges to meet conditions much more closely than is at present practiced, and I believe the necessary investigation should by all means be made.

M. W. TORKELSON,

Bridge Engineer, Wisconsin Highway Commission.

Madison, Wis., Sept. 21, 1920.

Waterproofing the Steelwork of Buildings To Prevent Corrosion

Sir—The interesting case of steel column corrosion described by E. H. Eardley on page 442 of your issue of Sept. 2, 1920, is a good illustration of the dangers attending the absence of waterproofing in metallic structures likely to be in contact with water and moisture. Engineers were not so alive to the importance of protecting metallic structures against corrosion at the time in which the Detroit Savings Bank Bldg. was built as they are now, though even at present proper attention is not always paid to the protection of steel in contact with damp foundations. The corrosion of the column in the Detroit Savings Bank Bldg. can be traced to contact with the seepage water used to wet the cinders, whose acidity caused local galvanic action.

Steelwork likely to be in contact with water ought to be carefully protected with suitable coatings of asphaltic materials, applying first a primer which penetrates the pores of the metal and insures the adhesion of the asphalt enamel applied in the molten state over the film of primer (or asphalt paint). Steelwork thus protected will withstand any causes of corrosion for a very long time.

The utmost care must be exercised in the application of the coatings of asphalt solution and enamel so as to avoid leaving even a minute space without protection. Imperfect and careless work will only increase cost without affording adequate protection.

BAXERES DE ALZUGARAY.

New York City, Sept. 21, 1920.

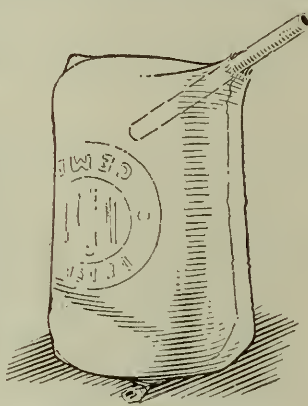
Hints for the Contractor

Taking Cement Samples From Bags for Testing Purposes

By S. Warren
New York City

SAMPLING cement for testing is ordinarily a slow and dirty job. It is frequently done by untieing the bags and removing some of the cement from the top of the bag. The bags are usually carelessly retied. resulting in loss of cement in further handling. Sampling can be easily and quickly done by taking advantage of the fact that most cement bags are now filled through a valve in the bottom of the bag after it is tied. This valve is made by sewing a flap over a hole left in the stitching of one corner of the bag.

To get test samples secure a piece of thin brass tubing having a diameter of 1¼ in. and a length of 14 in. Stand the bag on the tied end, that is upside down. Insert the tube into the valve, then pull out the tube, holding the palm of the hand over the end of the tube. The contents of the tube can then be dumped into the sample bag.



TUBE IN PLACE FOR TAKING SAMPLE

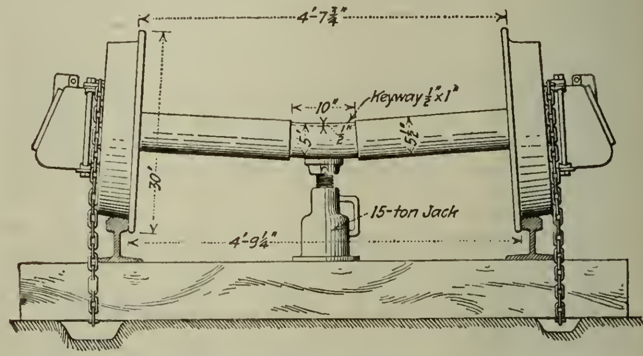
Bent Axle of Railroad Steam Shovel Straightened in Place

By Morgan Cilley
Cumberland, Maryland

A BENT AXLE of a railroad steam shovel was straightened by a railroad yard crew in the field without removing the axle from the truck. Less labor was expended on the job than probably would have been necessary in putting in a new part and the cost was under $50. The shovel was a Marion type 1778, the property of the Vang Construction Co., and the work was done in the car yards of the Western Maryland R.R. near Cumberland.

The truck was run out from under the shovel, the axle spotted over a tie with the bend of the axle down. Holes were excavated under the tie beneath the journal boxes an dthe axle securely lashed to the tie with a 1-in. car chain passed over the journal boxes close to the wheel. The axle is 5½ in. in diameter except for a 10-in. length in the center which was turned down to 5 in. with a ½ in. x 1-in. key way cut into it. All the bend was in this portion and was sufficient to make a 1½-in. difference in the gage of the wheel, as shown by the cut. The cut also shows a general arrangement of the work together with various dimensions.

The bent portion was heated to an almost white heat with a crude oil burner, a boxing of sheet iron and wood having been built around the bent portion to confine the heat. A 15-ton jack was then placed under the axle by means of which the bend was straightened. It was a compound bend, two applications of the jack being necessary, but only one heating being required.



METHOD USED IN TAKING OUT BEND IN RAILROAD STEAM SHOVEL AXLE

The work was started at 2.30 p.m., the heat applied at 3.45 p.m., the pressure from the jack applied about 4.15 p.m., and the cooling started at 4.35 p.m. The truck was in place under the shovel at 5.30 p.m. Water was used to hasten the cooling and to temper the axle.

Accident to Temporary Railroad Trestle During Construction

THE necessity of careful inspection of temporary structures used during railway improvement work is illustrated by an accident which occured some time ago on the Chicago, Indianapolis & Louisville Ry. near Greencastle, Ind. To permit of rebuilding a culvert the track was supported on a pile trestle and the embankment was removed. The piles of the second bent were driven till they struck the footing of the old stone arch. and as it was necessary to excavate the new founda tion below that level these piles were cut off and supported on blocking built up of bridge stringers.

Before the concrete could be poured for the foundation there was a very heavy rain, and the end of the fill on the south side of the excavation became thoroughly saturated. After the water had subsided, the foreman examined the work but saw nothing which led him to anticipate trouble. A little later, however, the south end of the fill slipped and knocked down the bent of piles which had been supported on blocking. This slip occurred when a freight train was within a few hundred feet of the bridge and although an attempt was made to flag it, the train could not be stopped and the engine was derailed on the bridge. As the structure was short, the front truck was supported by the bank bent on the south side and the rear end of the engine was supported by the bent on the north side of the excavation. Damage to the engine amounted to less than $100, but it was necessary to detour traffic while the engine was being got back on the track and the trestle rebuilt.

NEWS OF THE WEEK

New York, October 7, 1920

Federal Highway Council Discusses Transportation

Plans Considered at Akron Meeting for Closer Co-ordination Among Several Interests Involved

A meeting of the Federal Highway Council, presided over by its chairman, S. M. Williams, was held at the Portage Hotel and City Club, Akron, Ohio, Sept. 27 and 28.

Approximately 150 members representing all classes interested in the development of the nation's highways were present and took active part in the conduct of the meeting. Evidence of a growing realization of interdependence of steam and electric railways and waterways with the highway development of the country was shown by the attendance of M. S. Conners, general manager of the Hocking Valley Railroad, representing the American Railroad Association; S. S. Holbrook, vice-president and treasurer of the American Railway Express Company; G. T. Seeley, vice-president and general manager of the Penn-Ohio Electric Co., representing the American Electric Railway Association, and Dr. R. S. MacElwee, director of the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington.

Committees were formed to study the country-wide situation with a view to making future recommendations looking toward closer co-ordination and co-operation among the various transportation interests.

Recognizing the fact that one of the primary considerations in the development of the highway system of the country is the betterment of foundation and sub-grade conditions, the committee on sub-grade and its relation to road surface and traffic made a progress report covering the thorough and widespread investigation of all factors entering into the study of sub-foundations and their relations to the integrity of the entire highway structure.

A progress report was rendered by W. J. L. Banham, chairman of the transportation committee, on the relations of highway to railroads and waterways, the object of which is to effect co-operation with railways, waterways and other forms of transportation. Sub-committees of the transportation committee reported on studies of short haul and terminal problems.

The rural motor express sub-committee reported upon studies of this committee under the general transportation committee, looking toward more

Am. Soc. C. E. Vote on Amendments Canvassed

Result Announced Last Night at Meeting of the Society in New York — Seven Proposed Changes in Constitution Involved

At the meeting of the American Society of Civil Engineers held last night in New York City the vote on the seven proposed amendments to the constitution, which have been under consideration since a letter ballot was issued to the corporate membership Aug. 28, was canvassed. By delaying the printing of its last form *Engineering News-Record* is able in this issue to present the results of the referendum. Lack of time, however, prevented the inclusion of such details as the number of votes "for" and "against" each question or an analysis of the vote by districts. It is planned to publish all of this information in detail next week.

The passage of an amendment to the constitution requires a two-thirds majority of the votes cast. The outcome of the balloting was as follows:

Amendment A—Enlarging scope of society to include co-operation in economic and civic affairs.
Defeated

Amendment B—Establishing Local Sections and assigning all members thereto.
Defeated

Amendment C—Increasing annual dues.
Carried

Amendment D — Election of Honorary Members.
Carried

Amendment E—Forbidding members of nominating Committee to be candidates for office.
Carried

Amendment F—Reducing number of directors from the New York District.
Defeated

Amendment G—Making changes in the method of nominating and electing officers and providing for conference of Local Section representatives.
Defeated

extensive adoption of rural motor express service.

David Beecroft, directing editor of the Class Journal Publishing Co. and president of the American Society of Automotive Engineers, reported the activities of the committee for study of highway transport functions of state highway departments, including traffic surveys, traffic control and snow removal from highways. Recommendations by this committee to the Federal Highway Council covered forwarding of questionnaires to the highway departments of the several states to learn what each is doing in connection with conducting traffic census and highway transport surveys, looking toward development of a uniform system of gathering and tabulating of highway traffic data with a view to applying information thus gained to the construction of future highways.

Recommend Transport Engineer

Recommendation was made to the Council that effort be made to secure the creation of a highway transport engineer in each of the state highway departments, whose duties would be the making of highway transport surveys for the purpose of co-ordinating all factors entering into future development of the nation's highway service.

Prof. A. H. Blanchard of the University of Michigan reported activities of his committee toward the co-operation of universities and schools in the development of highway engineers and for the general dissemination of accurate information on highway subjects.

W. A. Allsdorf, Columbus, Ohio, chairman of the committee on international highway development, submitted a progress report covering highway activities in foreign countries, particularly stressing the fact that the Federal Highway Council, through this committee, is constantly receiving from foreign countries requests for assistance and advice based upon experience in the United States.

Dr. R. S. MacElwee, chairman of sub-committee on store-door delivery laid emphasis upon the necessity for the perfection of the store-door delivery movement as a means for reducing congestion at railroad and steamship terminal points.

During the session there was presented a film prepared by the Federal Highway Council, entitled "Virginia's New Hour," depicting the existing conditions in Virginia. This film is now being shown throughout the state of Virginia, awakening a tremendous interest in the development of its highways to a position more nearly commensurate with the development of the industrial and agricultural needs of the state.

The members of the Federal Highway Council attending the conference were guests of the Akron Chamber of Commerce at the Portage Country Club, Sept. 27, at which time addresses were made by M. S. Conners, general manager of the Hocking Valley Railroad, on the need for greater co-operation between highway interests and the railroads and S. F. Taber, president of the Ohio State Grange, on the urgent need of better highways in the rural districts for the transportation of farm products to the market.

Engineers in Relation to Port and Harbor Design

The close relations of engineering to port development along the varied lines of general economic planning, design of structures and handling of materials were brought out prominently during the convention of the American Association of Port Authorities, held in Chicago, Sept. 30 to Oct. 2. Local facilities, conditions, rates and commerce at several individual seaports were presented in one group of papers. Inland navigation and lake ports were the subject of another group.

Belt railways at ports should be owned preferably by the public, according to W. O. Hudson, New Orleans, and from his experience he preferred state ownership to city ownership, as being less affected by political influences. In regard to new ports, he pointed out that facilities alone will not bring ships, but ships will come if a port can offer cargo. When the discussion drifted into the technical features of the work at New Orleans, Mr. Hudson suggested that the meeting ought to have more papers on constructive subjects by engineers. He referred also to the new industrial canal as a step toward a new outlet to the Gulf independent of the Mississippi River. Belt railway service at San Francisco, Seattle and Montreal was touched upon. Warehouses convenient to piers and railways were advocated by several speakers in order that freight might be unloaded from cars promptly instead of having the cars held in storage yards until a ship is ready for cargo.

Wide Piers Preferred

Wide piers or quays with transit sheds, tracks and warehouses were considered preferable to narrow piers by R. S. MacElwee, U. S. Bureau of Foreign and Domestic Commerce. The author showed views and plans of numerous ports and port facilities. The provision of tracks along the sides of piers was discussed at some length, one opinion being that for a length of over 600 ft. there should be two tracks, so as to permit movement past cars spotted at vessels. One speaker referred to labor influences in preventing economical handling of freight, but others thought that labor must and will fall in line with improvements. As to general design of piers, it was suggested that economy and efficiency of service for general use should be the basis. In too many cases piers have been designed to suit some particular business or lessee; then when the business or lessee changes the pier is found unsatisfactory and blame is laid upon its design.

The "practical man" is superior to the engineer in port design, according to George F. Sproule, Director of Wharves, Docks and Ferries of Philadelphia, who attributed the secondary maritime position which the United States occupies to "the fact that the development of her ports and harbors has been entrusted to impractical and technical men." He said, too, that "the usefulness of the engineers lies largely in their carrying out scientifically the fundamental ideas of the practical man." Issue was taken promptly with his statements, and it was advanced not only that the engineer is the logical man to design port development works, acting in co-operation with commercial interests, but that unsatisfactory conditions have resulted where the "practical" man has insisted on having his ideas carried out.

Construction Methods Discussed

A monolithic reinforced-concrete construction for docks or bulkhead walls, proposed by John Ericson, Chicago, consists of interlocking face piles or grooved face piles with intermediate precast panels which are grouted in place. There was some discussion as to the practicability of keeping piles in line. Casting the panels in place behind sheeting driven outside of the face piles was suggested as a simpler method by F. M. Williams, State Engineer of New York. Mr. Ericson estimated the cost of his system at $57 to $86 per lineal foot, as against $79.50 for a timber bulkhead, $106 for timber with concrete coping and $292 for a gravity concrete wall.

Inland navigation was dealt with in papers on the Manchester ship canal, the New York State barge canal, the Illinois River waterway and some lake port developments. These latter included the Toronto harbor works, a rail and water terminal project for Detroit and the Calumet harbor project at Chicago to eliminate the Chicago River as a hindrance to both land and water transportation.

Amendments to the constitution were adopted which provide, among other matters, for a larger representation of engineers. Benjamin Thompson, of Tampa, Fla., is the new president; M. P. Fennell, Jr., Montreal, Can., is secretary. The next meeting is to be held at Seattle, Wash., in 1921.

Q. M. Construction Projects

The principal projects engaging the attention of the construction division of the Quartermaster Corps, U. S. A., at the present time are the following: Machine shop, Fort Worden; hangar, Aberdeen Proving Ground; Quartermaster shops, Fort Meyer; ingot yard, Watertown Arsenal; stables, Fort Wadsworth; machine shop, Fort Adams.

Progress Made in Standardizing Construction Accident Records

Definite progress in standardizing records of construction accidents was made by the Construction Section of the National Safety Council at its Annual Congress held last week at Milwaukee, Wis. Two reports on the subject were presented by the Statistical and Standardization Committee consisting of F. A. Davidson, Dwight P. Robinson & Co., Inc.; F. S. Robinson, General Builders' Association, Detroit; and J. E. Griffith, E. I. Du Pont De Nemours & Co. One report recommending a method of determining and recording rates of accident frequency and accident severity was accepted and the method recommended was adopted as standard. The second report on classification of accidents according to causes, was, after discussion, referred back to the committee for revision. The objection raised to the second report was that it failed to conform in classification to the practice of the National Safety Council and the U. S. Bureau of Labor. Instruction was given the committee that it conform its classification to that generally adopted with a sub-classification of causes peculiar to, or particularly prevalent in, construction operations.

In the discussion of the reports, stress was laid on the facts that until uniform methods of accident determination and recording were practised, constructors could not directly compare their statistics nor bring statistics in a compelling form to influence the rates of liability insurance companies. At present these rates for construction work are based on partial and irreconcilable data and constructors have nothing better to offer in urging rate revision, either for the construction industry as a whole or for the less hazardous kinds of construction.

Adoption of accident prevention methods by the small contractor was the subject of active discussion following the paper by O. H. Ulbricht, secretary, Master Builders' Association of Wisconsin. In referring to the subject stated, Mr. Ulbricht said: "We feel that the Master Builders' Association of Wisconsin has to a very large extent solved the problem of how to interest the contractor in safety. Our association consists of over 1,100 members, who are located in over 100 cities of Wisconsin. We issue a monthly 12-page publication, *The Builders' Bulletin*, devoted to the interest of the members and to the building trade in general, also to safety propaganda, but our crowning achievement, one which has accomplished more than anything else for the contractors of the state in educating them to observe safety measures in all of their undertakings, is our Builders' Insurance Co. The loss ratio of this company, as well as its premium rates, are the lowest of any similar company in Wisconsin. It writes compensation and automobile liability insurance for builders only, who are members of the state association and in addition to preaching and spreading safety and accident prevention information constantly, undoubtedly thereby saving many a life and limb, it has saved its members thousands of dollars by providing for them insurance at cost."

Without developing formal action the conclusion reached as the result of the presentation by a number of speakers of the limitations and difficulties of the small contractor in practicing scientific accident prevention was: Accident prevention work by the small contractor must be a group enterprise; local contractors' organizations acting for all their members and charging these members pro rata must organize accident prevention work either in conjunction with mutual liability insurance or separately as purely an accident prevention measure.

To Form Cornell Engineering Society

At the annual meeting of the Cornell Society of Civil Engineers, to be held at the Cornell University Club, New York City, Oct. 19, 1920, amendments to the constitution are to be voted upon which will change the name of the Society to the Cornell Society of Engineers. This move is a result of the joining of all the engineering colleges at Cornell under one head. Hitherto only graduates of the civil engineering college have been eligible for membership in the society and there has been no other engineering society. It is hoped that the new association will attract a large number of the graduates of Sibley College.

At the annual meeting the new dean of the combined engineering schools, Dexter S. Kimball, will deliver an address, and Clifford M. Holland, chief engineer of the New York State Bridge and Tunnel Commission, will speak on the new Hudson River highway tunnel.

Glasgow Prepares for Engineering and Shipbuilding Exposition

The Glasgow Corporation, according to a recent issue of *Commerce Reports*, is making preparations for the engineering, shipbuilding, and electrical exhibition that is to be held in the Kelvin Hall, Glasgow, from Nov. 8 to Dec. 4. This hall has an area of over 200,000 sq.ft. and is well adapted for such an exhibition, and will contain, when the show is open, 3 mi. of passageways with stands on both sides. A moving picture hall is being planned in connection with the exhibition to show films devoted to the engineering, shipbuilding, and electrical industries. The exhibitors are to include most of the well-known British engineering firms. It is reported that over 15,000 personal invitations have been dispatched to foreign visitors, for whose benefit, during their stay in Glasgow, advisory bureaus are to be set up by the corporation at the principal Glasgow stations.

New Plan for Solution of Imperial Valley Problems

Both flood control and increased water supply for additional areas to be brought under cultivation in Imperial Valley, Cal., are provided for in a plan contemplating the storage of Colorado River flood waters in Volcano Lake which was announced by J. C. Allison at a recent meeting of the Los Angeles Section, American Society of Civil Engineers. The plan represents the results of several years of investigation conducted by Mr. Allison in conjunction with other engineers. The work, he stated, would cost only one-third to one-fifth as much as the All-American canal scheme, which he declared to be impracticable.

The new plan provides for the creation of a storage reservoir in Volcano Lake to impound about 1,200,000 acre-ft. of water. This supply could be used to irrigate 500,000 acres of additional land in Imperial Valley, most of which lies on the American side of the international boundary. Surveys for the necessary high line canals have shown that these can be so located that the cost of the entire project will be less than $10,000,000. Under this plan the Colorado River would be returned immediately to its old channel. One result of the construction of the Volcano Lake reservoir, Mr. Allison stated, would be a high bank of silt 25 miles long that would constitute a permanent barrier between Imperial Valley and the main river channel thereby affording protection against the annual flood menace.

Attack on Pittsburgh Steel Price Basing to Get Rehearing

It is reported that the Federal Trade Commission has decided to give a rehearing to the complaint recently brought before it by the Western Association of Rolled Steel Consumers, attacking the practice of basing steel prices on Pittsburgh regardless of where the steel is produced. This case on its recent hearing was decided against the complainant, and the practice of fixing prices by adding the freight charge to the Pittsburgh base no matter where the steel is made was approved. The rehearing is to begin Nov. 15, 1920.

To Manage Toronto's Street Railways

In preparation for the taking over of the street railways by the City of Toronto, Ont., the Transportation Commission of the city has appointed a board of consulting engineers and a general manager. The board consists of R. C. Harris, commissioner of works of Toronto; E. L. Cousins, general manager of the Toronto Harbor Commission, and F. A. Gaby, chief engineer of the Hydro-Electric Power Commission of Ontario. H. G. Couzens, manager of the Toronto Hydro-Electric System, has been made general manager of the new city transit work.

Military Affairs Committee of Engineering Council Reports

Urging greater co-operation among military and civilian engineers through the medium of temporary interchanges of duties, the Military Affairs Committee of Engineering Council has recently submitted a progress report signed by Col. William Barclay Parsons, chairman, and Col. George D. Snyder, secretary. The other members of the committee are Paul G. Brown, H. W. Buck, George Gibbs, Spencer Miller, Dr. Leonard Waldo and Cols. R. D. Black, F. J. Miller, F. A. Snyder, F. A. Molitor, B. W. Dunn, J. J. Carty, Captain (Navy) A. B. Fry, Lt.-Col. F. E. Humphreys and Major A. S. Dwight. After emphasizing the importance of military training for the civilian engineer and the features of the Officers Reserve Corps the report suggests that regular army officers should receive temporary assignments to civilian engineering and construction organizations. The report, in part, follows:

But the bringing together of the two great divisions of engineering science, military and civil, is only partly done when there is extended to civilian engineers the opportunity for gaining experience as military engineers. The full result will be attained when the military engineers, in a corresponding manner, are given the opportunity to become experienced as civil engineers. To enable the members of the Corps of Engineers to gain experience in all branches of civil engineering, they should have opportunities for service on as much as possible of the general construction work done by the Federal Government, and not be confined to river and harbor improvements, as has been the custom. In addition to this members of the Corps should be assigned for temporary employment with state highway commissions or private corporations such as railway companies, metallurgical establishments, large contracting firms or factories where machinery, electrical devices and other forms of manufactured articles, in which engineers are interested, are produced and where members of the Corps can become acquainted with all phases of practical operation.

Not even the best technical schools, where the course of four years follows a previous collegiate education of at least two years, can do more than give the students the rudiments of theoretical training. How much less, therefore, can the Military Academy, where the larger part of the course is necessarily devoted to subjects other than engineering, turn out broadly trained engineers with practical experience? The War Department has established line and staff schools where officers can take post-graduate courses in military subjects. The opportunity herein suggested would provide the corresponding post-graduate courses for engineers and on the soundest basis.

Your committee believe that arrangements can be made without difficulty whereby officers of the technical services would be received as members of the operating staffs of transportation companies and engineering corporations. The advantage in thus broadening the experience of army engineers in fields of which they must know much in times of war are obvious. If while they are temporarily withdrawn from military duties there are insufficient engineers to meet the requirements of the War Department, the advantage would be presented to give junior officers the experience of exercising judgment and assuming authority at an age much earlier than would otherwise be the case, while the temporary vacancies in lower grades could be filled by assignments from the Reserve. Should some officers, after trying work in civil life, decide to remain in the new field of employment the army and the country would be the gainers. Permanent promotion would be accelerated, a most desirable thing in time of peace, and there would be added to the Reserve, ready for call in case of war, engineer officers well trained in military knowledge.

We therefore recommend that the question of the proper utilization of engineer officers and the means to adopt whereby the best type of engineers from civil life can be attracted, be taken up with the chiefs of the technical services where the power of initiative lies. The present moment appears to be highly propitious. For nearly two years engineers from civil life, some holding temporary commissions as officers of the Army, others still retaining civil status, have worked with the officers of the Corps of Engineers and other technical services, both in the United States and in the field in France. There exists as never before a mutual respect between the officers of the technical corps of the Army and the great body of professional engineers based on close intimacy and common service. That mutual feeling possesses a great force of latent momentum. Before it is dissipated by time it should be intelligently directed for the better service of the country.

To Discuss Merits of Steam and Electric Locomotives

A joint meeting to discuss the relative merits of modern steam and electric locomotives will be held by the New York Section of the Am. Inst. E. E., the Metropolitan Section of the Am. Soc. M. E. and the Railroad Section of the Am. Soc. M. E., Oct. 22, 1920, at the Engineering Societies Building, 29 West 39th St., New York City. Papers will be presented by J. R. Muhlfeld, Railway and Industrial Engineers, Inc.; W. E. Woodard, vice-president, Lima Locomotive Works; A. H. Armstrong, chairman, electrification committee, General Electric Co. and F. H. Shepard, director of heavy traction, Westinghouse Electric & Manufacturing Co.

Virginia Board of Examiners Is Appointed

The appointment of members of the Virginia State Board for the examination and certification of architects, professional engineers and land surveyors has been made by the governor. The law was approved on March 19. The appointments are as follows: P. B. Winfree, engineer, Lynchburg; James F. MacTier, engineer, Roanoke; John Kevan Peebles, architect, Norfolk; Fiske Kimball, architect, University of Virginia; W. C. Noland, architect, Richmond; Thomas M. Fendall, surveyor, Leesburg; L. B. Dutrow, surveyor, Peyersburg; W. D. Tyler, engineer, Dante; C. G. Massie, Amherst. At an organization meeting Sept. 17, Mr. Kimball was elected president and Mr. Dutrow, secretary *pro tem.*

Illinois Society Offers Prizes for Papers

To stimulate interest among its younger members the Illinois Society of Engineers has opened a competition for technical papers in the five divisions of drainage, roads and pavements, sewerage, surveying and miscellaneous civil engineering. A prize of $25 and a certificate of merit will be awarded to the best paper in each division, the papers to be from 1,500 to 2,500 words in length. This competition is limited to authors who have been members of the society for not more than five years on Jan. 1, 1921.

Consulting Engineers Condemn City for Unprofessional Practice

An advertisment appeared in North Tonawanda, N. Y., and presumably in other cities in the western part of New York State, reading as follows:

NOTICE TO ENGINEERS

Sealed proposals, endorsed "Proposal for Sewerage and Drainage Survey and Report" and addressed to Fred C. Goltz, City Clerk of the City of North Tonawanda, N. Y., will be received and opened at the office of the Board of Public Works at 8 p.m. on the (12th) twelfth day of April, 1920, in accordance with the specifications on file in the office of the City Clerk. All bids must be accompanied by a certified check or bid bond to the City of North Tonawanda, N. Y., in the sum of ten per cent (10%) of the total amount of the bid, as a guarantee of good faith. An additional Surety Bond of 50% of the contract, must be furnished by the successful bidder. The Board of Public Works reserves the right to reject any and all bids if they deem it for the best interest of the City to do so. Specifications can be seen and proposals obtained from the City Engineer.

BOARD OF PUBLIC WORKS.
By Carl L. Oelkers,
City Engineer.

This matter was taken up by the Committee on Relations of the American Institute of Consulting Engineers, which made a report on the subject and recommended the following resolutions which were adopted by Council at its meeting Sept. 15:

Whereas, it has come to the attention of the Council of the American Institute of Consulting Engineers that the City of North Tonawanda advertised in March and April for sealed bids to be sent to the City Clerk of that City for undertaking the professional engineering work of a sewerage and drainage survey and report, the said bids to be accompanied by a certified check or bid bond in the sum of 10 per cent of the proposed contract price, and an additional surety bond for 50 per cent of the contract price to be furnished by the successful bidder; and

Whereas, the conducting of such surveys and the designing of sewerage systems is professional engineering, and it is important to the welfare of the public that it shall be dealt with only in professional manner by experienced and capable sanitary engineers; and

Whereas, the procedure of the City of Tonawanda is detrimental to the public interest in that (1) it subordinates the professional aspects of this engineering work to commercial considerations, and that (2) professional engineers of the best standing cannot enter upon work in the competitive manner herewith proposed; therefore

Resolved, that the method of arranging for engineers for its sewerage and drainage survey and report utilized by the City of North Tonawanda is contrary to the public interest and must be condemned by the engineering profession; and

Resolved, that a copy of these resolutions shall be sent to the City Engineer and City Clerk of the said city and that the resolutions also be given general publicity.

Five San Francisco Contractors Indicted by Grand Jury

Five San Francisco contractors were last week indicated by the grand jury as being involved in the "inner ring," or contractors' trust, accused of combining to raise bids on grading work in that city. The five contractors named are William S. Scott, William H. Healy, Frank Mordecai, Frank O'Shea and R. A. Farrar. A statement of the charges of conspiracy appeared in *Engineering News-Record*, Sept. 23, p. 826. Investigations are to be continued to expose the entire system.

A. S. M. E. Names Representatives for American Engineering Council

The Council of the American Society of Mechanical Engineers has appointed the society's representatives on the American Engineering Council, the governing body of the newly created Federated American Engineering Societies. The delegates appointed will hold office for two years beginning Jan. 1, 1921, and will also represent the society at the organization meeting of the American Engineering Council to be held at Washington, D. C., Nov. 18 and 19. The list of representatives appointed follows:

L. P. Alford, formerly editor *Industrial Management;* E. S. Carman, secretary and chief engineer, the Osborn Manufacturing Company, Cleveland; R. H. Fernald, professor mechanical engineering, University of Pennsylvania, Philadelphia; A. M. Greene, Jr., professor mechanical engineering, Rensselaer Polytechinc Institute, Troy, N. Y.; W. B. Gregory, professor experimental engineering, Tulane University, and irrigation engineer, U. S. Department Agriculture, New Orleans; W. A. Hanley, master mechanic and chief engineer, Eli Lilly & Co., Philadelphia; D. S. Kimball, professor industrial engineering, Cornell University, Ithaca, N. Y.; Charles T. Main, consulting engineer, Boston, Mass.; Fred J. Miller, president of A. S. M. E.,.1920; L. C. Nordmeyer, secretary and treasurer, Tait and Nordmeyer Engineering Company, St. Louis; V. M. Palmer, engineer of industrial economy, Eastman Kodak Co., Rochester, N. Y.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Valparaiso, Ind.; St. Louis, Oct. 12-15.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION, Chicago; Atlanta, Ga., Oct. 26-28.

NATIONAL DRAINAGE CONGRESS, Chicago; Atlanta, Ga., Nov. 10-12.

The Association of Professional Engineers, Province of New Brunswick, held its first meeting, after the passing of the act regarding registration of engineers by the Provincial Legislature last spring, at St. John, Sept. 10. By-laws were adopted and the following officers and members of council were elected: President, C. C. Kirby, St. John; vice-president, C. B. Brown, Moncton; councillors, St. John District, J. A. Grant, 1922, F. P. Vaughan, 1921; Moncton District, S. B. Wass, 1923, J. Edington, 1921; Fredericton District, B. M. Hill, 1923; Chatham District, Geoffrey Stead, 1922. A nominating committee was elected to draw up a slate for the annual meeting next January, and A. R. Crookshank was appointed secretary-treasurer and registrar.

The Western Society of Engineers has listed the following subjects for October: Oct. 11, "Bascule Bridges at Home and Abroad," by Philip L. Kaufman, Strauss Bascule Bridge Co.; Oct 18, "Development of the Illinois River for Navigation," by M. G. Barnes, chief engineer of the State Division of Waterways. On Oct. 20 there will be a joint meeting with the Chicago Section of the American Institute of Electrical Engineers for the annual lecture by Dr. Charles P. Steinmetz. On Oct. 21 there will be a joint meeting with the Chicago Section of the Railway Signal Association, with a paper on "Automatic Train Control" by W. P. Borland, Interstate Commerce Commission, and W. B. Murray, engineer of the Miller Train Control Co.

The City Managers' Association will hold its seventh convention Nov. 15-17 at Hotel Sinton, Cincinnati, Ohio.

Candidates for Am. Soc. C. E. Offices Are Named

The American Society of Civil Engineers has just announced the Nominating Committee's selection of candidates for offices to be filled at the annual election Jan. 19, 1921. The ticket follows:

For President: George S. Webster, Philadelphia.

For Vice-presidents: Andrew M. Hunt, New York, and Edward E. Wall, St. Louis.

For Treasurer: Otis E. Hovey, New York.

For Directors: John P. Hogan and Ira W. McConnell, New York (Dist. 1); Richard L. Humphrey, Philadelphia (Dist. 4); Baxter L. Brown, St. Louis (Dist. 9); Frank T. Darrow, Lincoln, Neb. (Dist. 10); George G. Anderson, Los Angeles (Dist. 11).

PERSONAL NOTES

JOHN GREER has been appointed assistant engineer of the Portland Division, Grand Trunk Ry., with headquarters at Portland, Me. He succeeds R. F. Nicholson, resigned.

CARL C. THOMAS, consulting engineer, Los Angeles, Cal., has been appointed Western representative of Dwight P. Robinson & Co., New York, with offices in the Electric Equipment Building, Los Angeles.

WILFRID S. LAWSON, Ottawa, Ont., has been appointed bridge and structural engineer for the Department of Railways and Canals, Ottawa.

MAJOR E. N. JOHNSTON, Corps of Engineers, U. S. A., in charge of work in the Wilmington District, has been directed to take over, in addition, the direction of the work of the Baltimore District. The recent retirement of Colonel J. P. Jervey left the latter district without a head and, due to the shortage of engineer officers, it has been necessary to place double responsibilities on Major Johnston.

J. W. FOX, valuation engineer of the Central of Georgia Railway Co., and chief engineer for the corporation during Federal control, has resigned to become associated with the Lawrence Construction Co., general contractors, Augusta, Ga.

BANKS & CRAIG is the name of a new firm of consulting engineers and chemists established by Robert Hall Craig, formerly sanitary engineer with the Surgeon General of the Army and more recently sanitary and hydraulic engineer with the Construction Division of the Army, and Henry Ward Banks, 3d, formerly research chemist with the Harriman Laboratory, New York, and the National Biscuit Co. The offices of the firm are at 131 E. 44th St., New York.

EISENHARDT-CONKEY Co. Evansville, Ind., is a new firm organized by Karl J. Eisenhardt, recently division engineer of the Indiana State Highway Commission, at Terre Haute, and V. P. Conkey, civil engineer, Evansville. The firm will specialize in highway, drainage and mining engineering.

GEORGE L. BURTON, of South River, N. J., has been appointed a member of the New Jersey State Highway Commission. He was nominated by the Governor as a member of the commission Sept. 8, with seven others. The Senate then confirmed all of the nominations except that of Mr. Burton, who was rejected on the ground that he had patented paving connections.

L. O. BERNHAGEN, who has been connected with the Texas State Board of Health as sanitary engineer, at Austin, has resigned to accept a similar position with the City of Beaumont.

S. S. GANNETT has completed his duties as chairman of the Arkansas-Mississippi Boundary Commission, to which he was appointed by the U. S. Supreme Court, and resumed his work as a topographer with the U. S. Geological Survey.

C. C. HOLDER, of the Topographic Section of the U. S. Geological Survey, has been sent to Houston, Tex., to assist in the revision of the map of that city.

IRA O. BAKER, professor of civil engineering, University of Illinois, has been acting head of the civil engineering department of the university, succeeding Prof. Frederick H. Newell, recently resigned.

ARTHUR CUTTS WILLARD professor of heating and ventilation, department of mechanical engineering, University of Illinois, has been appointed head of the department to succeed Dean C. R. Richards, who, since his election as dean of the college of engineering and director of the Engi-

neering Department station, has continued to serve as the acting head of the department of mechanical engineering.

LT.-COL. JAMES FRANKLIN BELL, Corps of Engineers, U. S. A., at New Orleans, has been appointed to take charge of the Pittsburgh District. The office has been vacant since Colonel E. E. Ferguson left for Washington. Colonel C. W. Otwell, of the Wheeling District, has been temporarily assigned to this district.

HICKS, CRADDOCK & MCKAY is a new firm of engineers who will conduct a general engineering business in Centralia, Wash. The members of the firm are C. P. Hicks, who has had twelve years' experience in logging, railway location and general engineering; F. Harper Craddock, until recently located in Oklahoma engaged in municipal engineering and appraisals, and Neil E. McKay, recently in the city engineer's office at Olympia.

JOSHUA B. F. BREED, former city engineer and for a number of years chief engineer for the old sewer commission of Louisville, Ky., has been appointed chief engineer of the new sewer commission of that city.

W. C. ALLEN has been appointed assistant valuation engineer of the Fort Worth and Denver City Railway Co. and the Wichita Valley Railway Co.

OBITUARY

SAMUEL M. SOUDER, formerly superintendent of the R. D. Wood Iron Works, of Millville, N. J., died in that town Sept. 27. During the Civil War Mr. Souder was engaged in shipbuilding at Cramp's shipyards. Later he constructed the water-works at Manchester, N. H., and a similar plant at Lynchburg, Va. He was also in charge of the building of the dam at Millville. Mr. Souder was born at Millville in 1837.

RICHARD L. O'DONNEL, vice-president of the Pennsylvania Railroad Co., at Pittsburgh, died, Sept. 22, at New York. He was born in New York Nov. 5, 1860, and received his civil engineering education in the Polytechnic College of Pennsylvania. In 1882 he entered the service of the Pennsylvania Railroad Co. as civil engineer; three years later he became assistant engineer in the principal assistant engineer's office at Altoona and later was stationed at Hollidaysburg and Lancaster. Mr. O'Donnel was on duty at Johnstown after the flood in 1889, and after serving in various capacities at other points in Pennsylvania he was transferred to the Pittsburgh division as assistant engineer in 1894. After several further promotions, he was made assistant general manager of the lines east of Pittsburgh, in 1917, with a promotion the following year to the position of general manager, and on March 1 of last year he was made vice-president of the central region with offices at Pittsburgh. When the trouble arose on the Mexican border Mr. O'Donnel was general agent of the American Railway Association at Governors Island, and served in the same capacity during the World War. He had jurisdiction over the rail transportation of troops from the various states to the border, and later between the camps and embarkation ports in the movement overseas.

WILLIAM HENRY DIETRICH, resident engineer at Bombay, India, of the U. S. Steel Products Co., died in that city Aug. 11. He was born near Waynesboro, Pa., in 1874. He attended the Mercersburg (Pa.) Academy and later graduated in civil engineering from Princeton University, in which he afterward was an instructor in the department of civil engineering. The greater part of Mr. Dietrich's professional career was spent with the American Bridge Co. and the U. S. Steel Products Co. In the early part of his connection with the latter company he had charge of erection of bridges in Peru. Later he was sent by it to Shanghai, China, in the capacity of resident engineer and in January of this year was transferred to Bombay.

GEORGE W. COOLEY, for more than ten years state engineer and secretary of the Minnesota Highway Commission, died in Minneapolis, Sept. 25. Mr. Cooley was one of the pioneer highway engineers of the state, having laid out the present road system.

DR. ADOLPH GEHRMANN, professor of bacteriology and hygiene, College of Physicians and Surgeons, University of Illinois, and founder of the Columbus Laboratories, died, Oct. 3, at Chicago.

BUSINESS NOTES

A. G. HARKINS, for fourteen years associated with the sales department of the Carnegie Steel Co., the last eight years having been in charge of its Baltimore sales offices, has resigned to assume an active partnership in the Maryland Steel Products Co., Calvert Building, Baltimore. During the war Mr. Harkins was connected with the American Iron and Steel Institute's Washington office handling the distribution of various steel products for the Government.

WHITING CORPORATION is the name of the new organization formed by consolidation of the Whiting Foundry Equipment Co., Harvey, Ill., and the American Foundry Equipment Co., New York. J. H. Whiting, president of Whiting Foundry, becomes chairman of the board, and V. E. Minich, president of American Foundry, will be president. It is the intention to continue and enlarge the presen offices of the latter concern in New York as the Eastern sales and expor office of the combined lines.

THE SANDERSON-CYCLONE DRILL CO., Orrville, Ohio, has ap pointed W. F. Nothacker as vice president in charge of its Eastern an export office, 30 Church St., New Yor

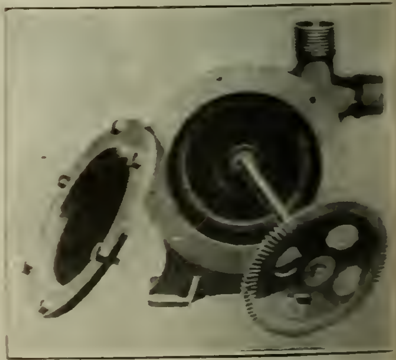
J. CHANDLER SMITH, for th past six years associated with th sales department of the Carnegie Ste Co. as assistant manager of its Balt more sales offices, has resigned to a sume an active partnership in t Maryland Steel Products Co., Calver Building, Baltimore.

R. H. BEAUMONT CO., of Phila delphia, contractor for conveying an hoisting systems and complete powe plants, has recently opened an office 330 Fifth Ave., Pittsburgh, Pa., wi Thomas Waldrop in charge.

CONVEYORS CORPORATIO OF AMERICA is the new corpora name of the American Steam Convey Corporation, Chicago. The change name is due to the addition by th company of new lines of business an the purchase at South Bend, Ind., of large machine shop. The new nam more nearly describes the present bus ness of the organization, its lines cluding steam jet conveyors for han dling ashes, soot, combustion ash, etc trolley carriers for handling coal, lim stone, sand, gravel and like loose bul materials; ash pit doors; flood oil bea ing sheaves and other conveyor su plies.

Pump With Disk Impeller

A centrifugal pump which has be the intake and discharge openings the periphery and in which the revol ing element is a disk having one more blades or projections on its ci cumference is being introduced by th Western Pump Co., Davenport, Iow



DISK IMPELLER PUMP

under the name of the Westco pum The disk or impeller revolves at hi velocity, drawing in water through t intake to fill the chambers between t projections and discharging it throu the adjacent outlet. This pump, show in the accompanying illustration, made in various sizes up to a capaci of 60,000 gal. per hour.

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. Mehren, Editor

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The Amendment Ballot

THERE is little to be said with reference to the amendment ballot of the American Society of Civil Engineers. The issues were well presented to the society, and the important ones lost by relatively small margins, ranging from 224 to 448 (see details in News Section this issue.) The defeated issues had majorities, but not the required two-thirds votes. The result accords exactly with the wishes of the 182 signers of the "Appeal." With them must rest much responsibility for initiating necessary changes. To that they have pledged themselves—a pledge all the more solemn because it has carried weight with many members of the society. The signers of the "Appeal," by proceeding with moderation, by contenting themselves with the exercise of their influence only in directions attended with little dispute, can do a great service to the society. That service is none other than the pulling of the contending factions together. In taking this position of moderation they should bear in mind that they are the representatives of the minority—a victorious minority, it is true, but a minority nevertheless.

Public Service and an Opportunity

VALUABLE public service was performed by the engineers who testified for the defense in the Boston molasses-tank trial, as reported last week, in making known the fact that tanks still in service are less safe than the ill-fated Boston tank. But it is not enough if the service is to stop there; further service is called for. Stresses well over 30,000 pounds per square inch tell a story of impending disaster that is well understood by the technical mind, yet means little to the general public. Clearly it is necessary to get these dangerous tanks out of service at once. There are ample means to accomplish this, in the law's machinery, but the machinery must be set in operation. The legal guardians of the public's safety and rights must be advised of the facts and their meaning, and this is the part of engineers. If association—or federation—for the common good has any meaning, it here finds ready to hand an opportunity and a duty.

The Philadelphia Water-Supply Report

IN ADVISING ultimate recourse to the tributaries of the Schuylkill and Delaware rivers for the water supply of Philadelphia, but with a continuance, improvement and some extension of the present supply works and rapid instead of more slow filters for additional filter units (see p. 751) the Board of Consulting Engineers has acted in accordance with the logic of events, as tempered by local conditions. Twenty-one years ago it was equally logical, considering the status of water supply engineering and of public opinion, for Messrs. Hering, Gray and Wilson to advise a continuation of the use of the Schuylkill and a large development on the Delaware, with slow sand filtration for the major part of the water from both sources. Both reports had in mind the utilization of as much as might be economically of existing plant. The present report looks forward to the time when the Schuylkill and Delaware will be polluted beyond safe use and when public sentiment will demand comparatively pure original sources of supply but will wish even those to be made safe beyond possible question by the best means known to the art of the time. As so often happens elsewhere, a change in the source of supply at Philadelphia will relieve, although in this case it will not entirely remove, the burden of pumping. Like the report of 1899 (see *Engineering News*, Oct. 5, 1899, p. 230) the present engineering board advises the adoption of a universal meter system. Had the recommendations of the earlier commission in this respect been carried out Philadelphia's high water consumption would have been reduced to reasonable figures years ago, and large expenditures for additional works now required would have been postponed.

Well Over a Hundred Million

WE ARE a nation of 106,000,000. More accurately, on Jan. 1, 1920, according to the Census Bureau's announcement, just made, the population of the United States, excluding Alaska and other Colonial possessions, was 105,683,108. Considering the effect of the war and of the influenza epidemic, it is not surprising that the numerical increase from 1910 to 1920 was less than that for the previous decade (13,710,842 against 15,977,691) and the percentage increase but 14.9 for 1910-20 compared with 21 for 1900-10. A falling percentage of population increment is to be expected as the decades go on and the population base increases, but in normal times the fall would not have been from 21 to 14.9 per cent. To engineers particular interest lies in the growth of our urban population, which has now passed the rural. Specifically, the population in incorporated places of 2,500 or more is now 54,816,209 or 51.9 per cent of the total. The corresponding percentage in 1910 was 46.3. If all incorporated places are taken into account then 9,864,196 people are added to the urban population, making a total of about 65,000,000 urban and only 41,000,000 rural, or percentages of some 61 and 39, using round numbers. What this means in terms of municipal utilities, which it is the function of the engineer to design, build and, to a large but not yet sufficient degree, to operate, is a subject for reflection. But the engineer is called upon to help supply various needs of the rural as well as urban populations, as witness particularly the railways, the highways, besides irrigation and drainage works. Highway engineering, in the past decade, has increased out of all proportion to the increase in population. Doubtless this disproportionate growth will increase. In other fields, too, the demands for engineering service, between

now and the next census, will grow faster than the population. All this the engineer and his profession should prepare for—not forgetting a bounden duty to raise the quality as well as to meet the increasing quantity of engineering work.

New York's Transit Plans

ONE of the most significant statements made by Mr. Turner in his report on the comprehensive transit plan for New York City, discussed in greater detail on page 754, is that "it has averaged about ten years from the inception of previous general transit projects to the date of operation of the lines." To the resident of New York familiar with the enormous congestion on existing trunk line subway routes during rush hours, the timeliness of this warning should be apparent. The need for additional transit facilities is here now, and the important thing to remember is that, due to the length of time required for the preparation of detailed designs and for the building of the subway structures themselves, relief cannot possibly be provided quickly. The same line of reasoning applies to other public utilities, such as water supplies. Here, also, it is necessary to look well into the future and to foresee the needs of a growing population before those needs are actually existent. In the case of its additional supply of water from the Catskills, New York City, by beginning work more than a decade ago, acted wisely, with the result that today the supply of water is ample. The city has to thank its engineers that this condition exists. Especially in New York, where the population has reached its present great numbers, the provision of adequate rapid transit facilities is second only to furnishing a sufficient supply of water for drinking and industrial purposes. Those officials responsible for public works policies must realize the supreme importance of advance planning for such time-consuming projects as the construction of subways under city streets. Mr. Turner has looked ahead and has presented recommendations for extensions to existing routes and for new trunk lines and feeders which, as far as conditions now can be foreseen, will serve New York's increasing population until the year 1945. The report should be considered not as a document containing merely interesting technical detail, but as a clear warning to begin work now on carrying out the comprehensive rapid transit plan for which, unless all past signs are wrong, there will soon be a critical need.

A Neglected Transit Problem

NEW YORK CITY is just now completing its mammoth system of rapid transit begun seven years ago after many more years of planning, but already the duly appointed body has announced the fundamentals of the next new network of lines which may not be begun for some years, but which proper judgment already foresees. Such planning ahead is necessary in municipal matters as in private business. But New York's transit needs are by no means completely cared for by the machinery now provided. To the west of Manhattan Island, and separated from it by a wide river, lies a large proportion of the so-called metropolitan district. From and to that area come and go daily tens of thousands of people who help to make New York what it is and who now, by virtue of the New York income tax, contribute directly no little to the income of the State. For their ready crossing of the Hudson there has been no new means provided since the completion of the tortuous Hudson & Manhattan Ry., nearly fifteen years ago, though travel has been increasing at a rate corresponding to the growth of rapid transit traffic throughout the city. Worse still, the ferry service, on which most of the travelers depend, has, if anything, grown less. Rush-hour congestion in the Hudson River crossing, particularly in the tubes, has already reached the limit of endurance, but except for the new highway tunnels, which can hardly do much to relieve commuting congestion, no planning whatever is being done for the future. The metropolitan district has no political entity and has therefore no one to do its planning or thinking. For some years an effort has been made to provide an interstate body to consider the port of New York, but so far local selfishness has prevented its formation. Possibly such a body, if or when formed, may be able to undertake passenger as well as freight transportation. But if it cannot, it is high time that some steps be taken toward the formation of an interstate transit planning body. New York needs its Jersey suburbs, and the suburbanites need New York, but the time is not so far distant when both will suffer unless better transportation is provided.

Railway Labor and the Camp Train

TO WHAT extent are the railways improving the housing accommodation for construction and maintenance gangs, or profiting by the numerous indications of the growing necessity of such improvement in order to meet labor conditions of the near future? Undoubtedly, some railways are taking action, but is the movement as general as it should be? These questions are suggested by the continued apppearance of the typical pre-war boarding train or camp train, even on important railways. Such a train is composed of dirty and more or less dilapidated box cars, with a few small windows knocked in the sides and a minimum of equipment, and while serving as a camp the surroundings are littered with paper and refuse.

An excuse given sometimes is that the men are foreigners and prefer to live in their own way. As to methods of living and cooking that may be correct. But it is doubtful if any laborers prefer to live in dirty and ill-kept quarters or would object to simple matters of cleanliness and tidiness if anyone took the trouble to instruct them. They may have been used to bad conditions abroad and therefore find no great fault with them in the new country. In order to make good Americans of these men, however, they should be shown the advantages which they may enjoy here. This is not simply a patriotic or uplift idea; it is distinctly practical and economical. If a railway organization will not see the signs of the times and is content to follow old and slipshod methods when better methods mean better work and better men, then it will have no ground for complaint if it finds its forces are of low caliber and poor discipline, its labor turnover is excessive and its work is poorly done.

Many contractors have recognized the signs and now provide camp accommodations far superior to what was considered adequate five or six years ago. They do this because it pays and is in fact necessary in order to maintain a force of satisfied and competent men. Perhaps some have a higher motive also.

Livening Society Meetings

EVERY ENGINEER who has attended engineering-society conventions knows how tiresome they are apt to be. Every society officer who has made up the program of such a meeting knows the difficulty of the job. The former remembers how often the program is a long list of a dreary papers presented in an uneasy manner by men unaccustomed to public speaking; the latter is usually bound by the tradition that such a program is a necessity which he cannot avoid. In the specialist societies, such as those devoted to water-works, testing materials and concrete, long lists of papers are to be expected. They need not be dreary, in fact they rarely are, and the men who deliver them and those who listen are equally expert and equally interested. But in the general societies, particularly the local ones whose members are of all branches of engineering and whose bond of sympathy is the fact that they are all members of the same profession, the problem is different, albeit the solution is generally the same. The consequences are that only a minority of those present are interested in any one paper and that the papers have to be multiplied interminably to offer something to everybody.

The Engineering Institute of Canada seems to have taken a step forward in its so-called "professional meetings" which well may be looked into by other societies. These are held in various parts of the Dominion and are under the direction of the local branch. They attract engineers of every specialty. Instead of trying to present a rounded survey of the state of the art and science of engineering, the program is centered on one or two of the outstanding engineering works of the district, which are made the subject of complete explanatory papers and the scene of actual inspection. At Niagara, for instance, two weeks ago, the Welland canal and the Queenston-Chippawa power project, both of such importance that no engineer worthy of the name can afford to be ignorant of their details, were the only subjects discussed outside of a short session devoted to purely professional matters which also had universal appeal. The consequence is that those who attended the meeting learned something about these two great works and at the same time were not bored at any of the sessions. Better everything about something than something about everything.

In addition, the Canadian engineers emphasize the social side of their meetings. To be sure, in the past there have been criticisms that certain of our technical-society meetings are nothing but junkets, which only those with abundant leisure can enjoy. But there is a happy medium which permits the fullest of social intercourse, the necessary mingling of men of a common interest, and at the same time provides enough solid technical matter to justify a busy man spending his time and money. So at Niagara there were luncheons and dinners and smokers—in fact, only at breakfast was the visitor required to seek out food on his own resources. At the end of the three days these engineers knew each other better, which is a requisite of professional integration, and they had learned besides some things which were useful in their work.

There is no intention of claiming that only in Canada are these things done, or that there they are always done. But this is a recent instance of a pleasant and profitable society meeting which stands out among the many that it is the duty of a technical editor to attend. Now that the winter season is coming on, with its sectional and state society meetings all over the country, it seems a good time to call the attention of program makers to the possibilities before them. Let them not be bound down to the tradition of having only dry descriptive papers, but seek out some subjects which will interest everyone and emphasize them. Then if they provide opportunities for the men to get together between sessions, they will find that their members will go home better pleased and more inclined to come again.

Consider the Annual Snow Problem

THE snow-handling problem is too frequently an emergency that finds cities, railways and other utilities unprepared. With winter approaching, therefore, it is pertinent to call the attention of engineers and municipal officers to the great desirability of giving early and earnest attention to the subject. Here is a field in which the engineer may take the initiative.

In a majority of cases this preparation is a matter of getting out the old equipment and applying old methods. But this is no reason why the engineer should not try to look at the matter in some new light, to recall his experiences, to introduce new ideas, or to promise himself that he will tackle the problem more seriously or more successfully than ever before. It is a poor policy to wait for trouble to come before considering it. A few snow-removing machines are on the market. Experimental machines reposing in sheds should be put in working order with a view to getting actual service out of them. Old equipment should be overhauled and made ready long before snow falls.

Of great importance is the preparation of a plan of action. What additional equipment is needed? Can it be obtained? Where shall snow be deposited? How can rules for sidewalk clearing be enforced? How about clearing gutters and around hydrants? What are the special points of difficulty, such as steep grades or congested streets? What is to be the system of organization? Who is to have responsible charge? How are regular and emergency forces to be recruited? What co-operation can be effected with street railways or with trucking contractors? The engineer may well draft his own questionnaire and proceed to answer it.

It will be a wise move also to discuss the matter with the higher officials, the mayor and aldermen, explaining diplomatically the needs and conditions, pointing out former unpleasant experiences and showing that efficient handling of the difficulties will be duly appreciated by the people.

For the railway superintendent and maintenance engineer having charge of city terminals there are difficult problems and hard experiences in clearing passenger tracks and freight yards and keeping driveways open in order that freight may be brought to and from the freight houses. Is there nothing to be done but to wait until the snow comes and then try to hire gangs of hand shovelers for slow and tedious and more or less ineffective work? In both municipal and railway experience the best laid plans may go astray, or perhaps the snow problem may not prove serious next winter. But in either case something will be gained and nothing lost by the mere mental and physical activity of preparation. Much has been heard about the advantages of preparedness. Why not prepare, now, for next winter's snow fighting?

New Chicago Freight Terminal of Alton Railroad

Track Layout on Restricted Area—Double Deck Freight House—Team Yard Approached By Inclines —Warehouse and General Offices in Main Building—Elevator Connections with Freight Tunnels

IN UTILIZING to the best advantage a site of limited area and irregular shape for a new city freight terminal at Chicago, the Chicago & Alton R.R. has adapted the track arrangement to the peculiar restrictions of shape and size of the site and has designed buildings which form an unusual combination of double-deck freight house, warehouse and office building. This freight terminal the general layout of which is shown in Fig. 1, is on the west side of the river, between Polk and Van Buren Sts. It will take the place of old local freight houses and team yards that have to be removed to make way for improvements in connection with the reconstruction of the union passenger station.

Two buildings are provided, arranged in tandem but separated by Harrison St., and having their principal entrances on that street. On the north side will be the steel framed main building with six stories in the office section fronting on Harrison St. and three stories in the freight house section at the rear. The other building will be a two-story freight house, having the lower part of steel and the upper part of reinforced concrete. Prominent features in the steel structural design of the larger building are unsymmetrical arrangement of columns and the introduction of trusses, girders and cantilevers as supports for upper story columns. In both buildings there is an extensive use of plate girders in the floor framing for the purpose of getting large panels and reducing the number of interior columns. Upper floors to accommodate the general offices of the railway company have been provided in order to eliminate the present expense for rented quarters in an office building. A description of the main building appears in the article which follows.

Double-Deck Terminal

Since the streets in the vicinity are elevated to approximately the level of the bridges across the river and all tracks are on the original ground surface, which is practically the basement level of the buildings, the freight terminal itself will be a double-deck station, as shown in Fig. 2. Thus the tracks and car platforms of the station will be in the basement, with the rails about 3½ ft. above the normal water level of the river. The team driveways and platforms will be on the upper or first floor, at the street level and about 25 ft. above the water. Large automatic electric elevators will connect the upper and lower platforms and will extend to the second or warehouse floor in the main building.

Both through and stub tracks are included in the layout of the track floor of the buildings, as the yard arrangement makes it impracticable to have all tracks continuous. For inbound freight there will be four tracks of varying lengths, served by a 27½-ft. platform. Two of these will be stub tracks and one will have both a stub end and a ladder connection. For outbound business, seven tracks will be arranged in two groups, separated by a 31½-ft. platform, the inner group being served also by a 10-ft. trucking platform between the inbound and outbound tracks.

Each building will have a double driveway on the first floor, opening from Harrison St. and extending between the inbound and outbound platforms, which are parallel with the train platforms below. In the larger building the driveway will be divided by a row of columns and will be continued beyond the building on a viaduct extending to Van Buren St., thus giving a through connection between the two streets which cross the terminal. A separate short driveway on the west side will serve the office section of this building. At the smaller building, the driveway will extend about 40 ft. beyond the platforms, to form a turning place for teams and trucks.

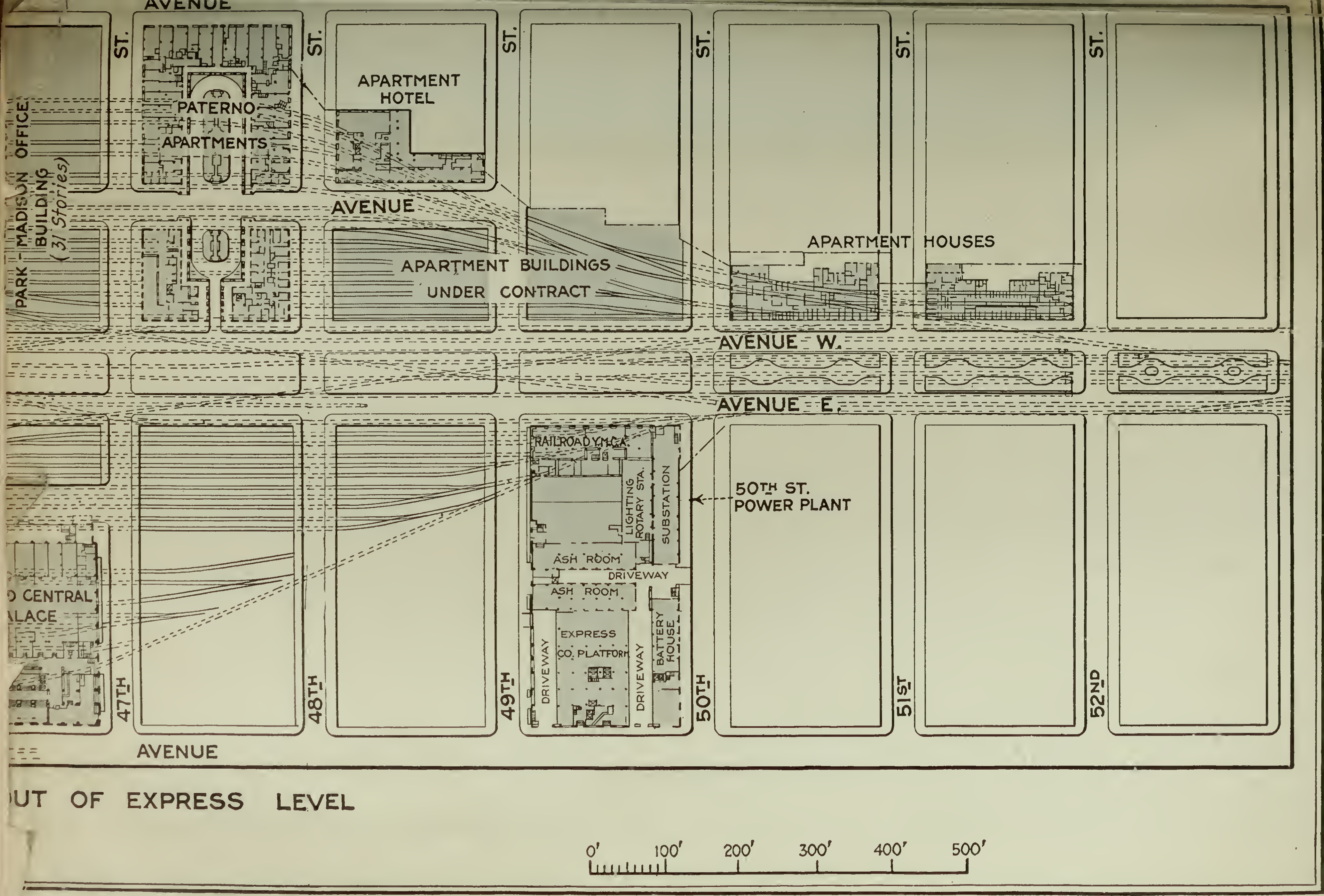
Of particular interest is the provision for a future driveway viaduct along the west side of each building and above the tracks which run parallel with it. The wall columns and wall girders of the buildings are designed with attachments for girders or floor beams to carry this driveway, the outer ends of the girders being attached to columns on the joint right-of-way line. The latter will support a parallel but independent viaduct extending over the main tracks running alongside the freight terminal.

Track Layout of Terminal

Fig. 1 shows how the entire track layout has been governed and restricted by the shape of the terminal site. The site is approximately a right-angled triangle, the side on the west being formed by the main line approach to the Chicago Union Station, the diagonal side being the river and the base being formed by the great freight station of the Pennsylvania System, which fronts north on Polk St. In the acute angle of the base are two private warehouses which are served by yard tracks. The entrances to the site are limited to very narrow spaces at the right angle and at the apex, giving two main track connections at the former and only one at the latter. There are 32 body tracks, with a capacity for from 2 to 34 cars each, and a total capacity of about 460 cars. In maximum dimensions the triangular site is about 1,750 ft. long and 475 ft. wide.

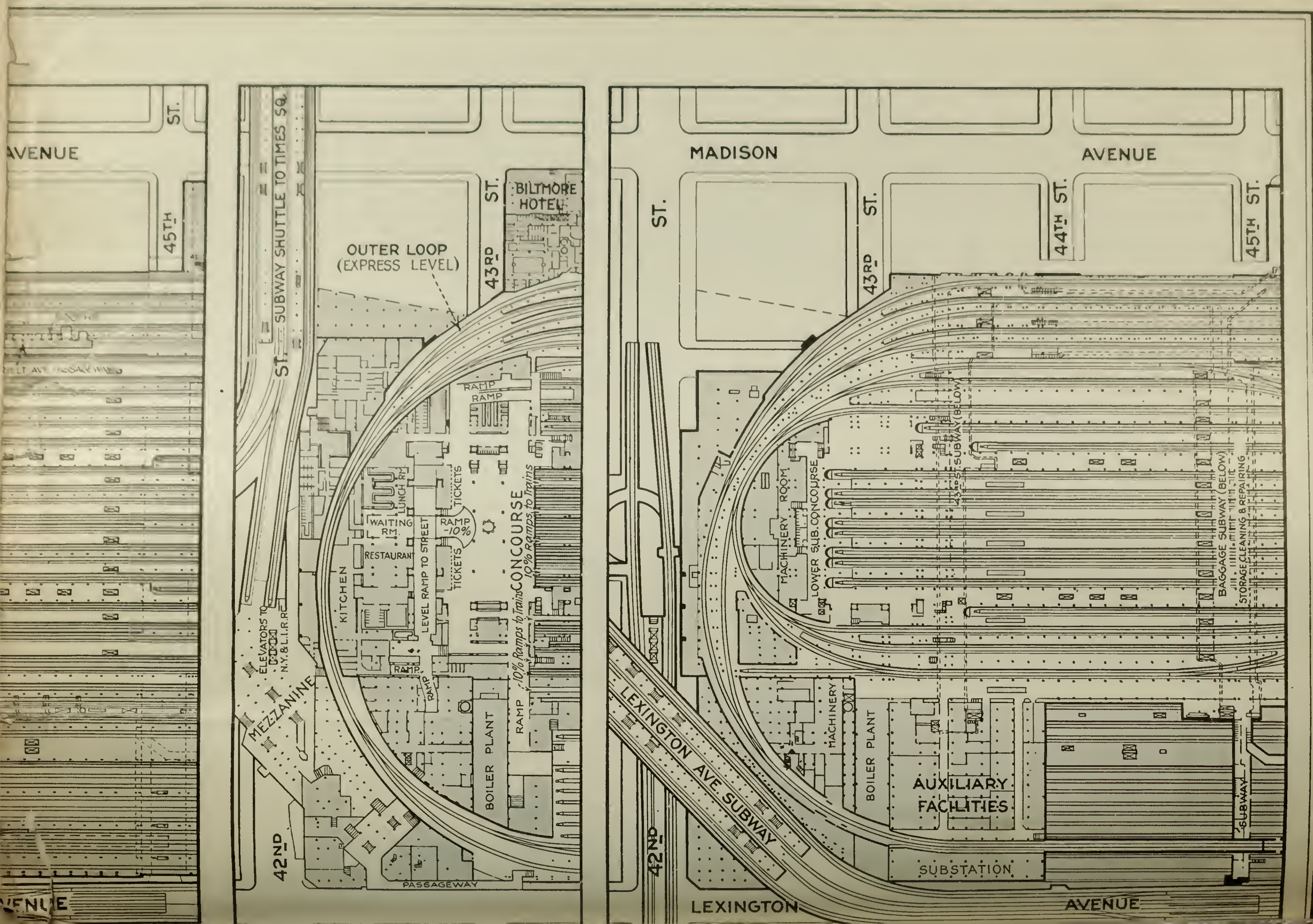
The major portion of the space is occupied by the freight station, with the team yard between the building and the river. This team yard will have five driveways and eleven tracks, two of which will be connected at both ends, the others being stub tracks. One driveway will be extended to serve a group of three tracks at the south end. An inclined driveway of 3 per cent grade will lead down from Van Buren St. to the team yard, alongside the driveway viaduct approach to the first floor. At the south there will be access from this yard to Polk St. by a driveway extending between the warehouses and then turning into an incline on a viaduct parallel with the street, which it will reach by a grade of 4.17 per cent. This incline will pass through the warehouse, as shown in Fig. 1. Both warehouses are to be entered by tracks and the dock on the river front will have a short track to serve barge and steamship business. A dock shed will be built under the driveway incline. The driveways will be paved with concrete and the inclines with granite block.

Most of the house tracks are connected with the track system at both ends, but two of them are stubs



d Adjacent Property, New York City

man's Maps" cf New York Central Railroad



AVENUE
45TH
ST.
SUBWAY SHUTTLE TO TIMES SQ.
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OUTER LOOP
(EXPRESS LEVEL)
43RD
ST.
BILTMORE
HOTEL
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10% Ramps to Trains
LUNCH RM.
WAITING RM.
RESTAURANT
KITCHEN
LEVEL RAMP TO STREET
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BOILER PLANT
ELEVATORS TO
N.Y.&L.I.R.R.
MEZZANINE
42ND
PASSAGEWAY
MADISON
AVENUE
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43RD
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45TH ST.
MACHINERY ROOM
LOWER SUB. CONCOURSE
43RD ST. SUBWAY (BELOW)
BAGGAGE SUBWAY (BELOW)
STORAGE CLEANING & REPAIRING
LEXINGTON AVE. SUBWAY
MACHINERY
BOILER PLANT
AUXILIARY
FACILITIES
SUBWAY
SUBSTATION
42ND
LEXINGTON
AVENUE

owing to the necessity of carrying two entrance tracks and a driveway from the north end diagonally along the narrow space between the building and the river. Parallel tracks are spaced usually 13 ft. c. to c. except at platforms and driveways, the spacing in the latter case being generally 40 ft., but 23 ft. in one restricted location. Ordinarily cars are not weighed here, but one of the through tracks in the team yard is fitted with a 100-ton scale having a 40-ft. table to provide for weighing freight in carload lots when necessary.

Yard and house tracks will be laid with 80-lb. rails and owing to the restricted end connections the frogs will be mainly No. 7 and No. 6, with No. 5 at a few points. In general the sharpest curves will be of 14 deg., although one of 18 deg. is required. As the subgrade is little more than 3 ft. above water level the tracks will be ballasted with broken stone 12 in. deep under the ties and drainage of surface water will be provided for by a system of transverse drains.

Steel and Concrete Freight House

The two-story structure south of Harrison St. is for freight purposes only, with no upper floor for storage. On the lower floor are seven tracks for outbound and four for inbound service, the tracks and platforms being continuous with those in the main building. On the upper floor, level with the street, are two parallel buildings, 460 ft. long, the outbound house being 38 ft. wide and the inbound house 46 ft. wide. Between them is a 64-ft. driveway. Longitudinally, these buildings have 20 ft. bays, with steel rolling doors in each bay on the driveway side. A sectional elevation and framing plan are shown in Fig. 2.

Steel construction is used for the lower or track story, the framing of each building consisting of two rows of wall columns supporting transverse plate girders, so that the freight house space is unobstructed by intermediate columns. A fifth or central row of columns under the middle of the driveway carries the driveway floor beams, whose outer ends are framed against the wall columns of the buildings. Longitudinal I-beams extend as stringers between the girders and also as struts between the columns. In the south end bay of the outbound house the interior line of single 10-in. I-beams is replaced by a pair of 15-in. channels which extend outside the wall to form the support for a freight-handling derrick. Some of the girders and other steel parts are shown in Fig. 3.

Concrete pedestals for single columns and footings for pairs of columns are supported on 35-ft. timber piles. All columns are of H-section, built up of a 12-in. web plate and four angles 6 x 4-in. but the outer wall columns of the outbound house are reinforced by 13-in. cover plates on the outside face as they have connections for future 60-ft. box girders which will allow of carrying an additional driveway along the west side of the building by supporting it over the tracks. The farther ends of these long girders will be carried by columns erected on the joint right-of-way line and supporting a similar and parallel driveway or viaduct (not for the Chicago & Alton R.R.) over tracks parallel with the viaduct.

A light reinforced-concrete construction was adopted for the upper story, as being more economical, especially as no provision is made for additional stories in the future. Concrete casing is applied to all steel work, the 4-in. casing of the columns being extended as part

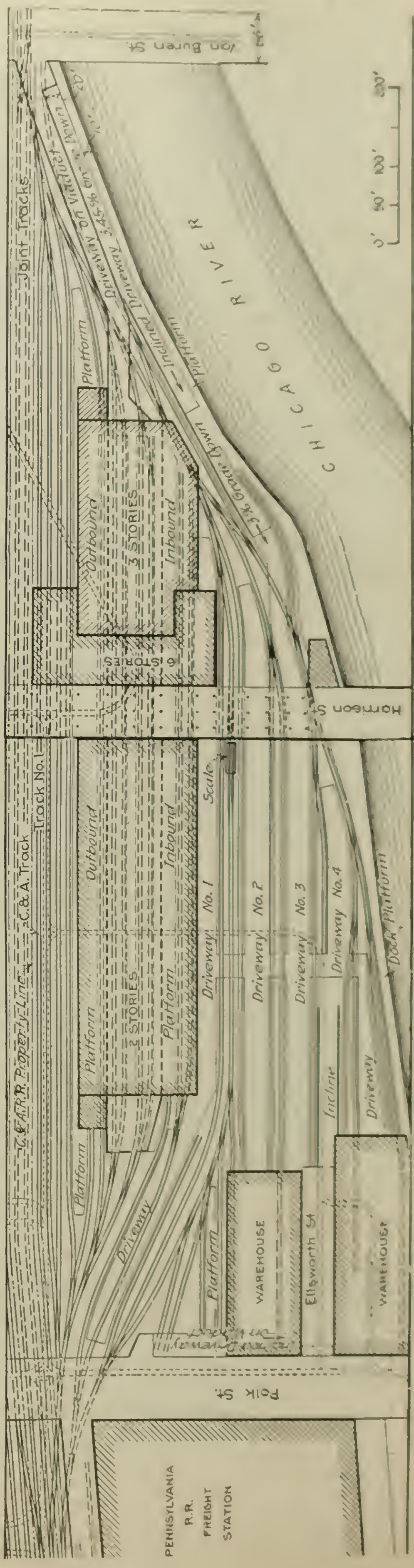


FIG. 1. LAYOUT OF CHICAGO FREIGHT TERMINAL, CHICAGO & ALTON R.R.

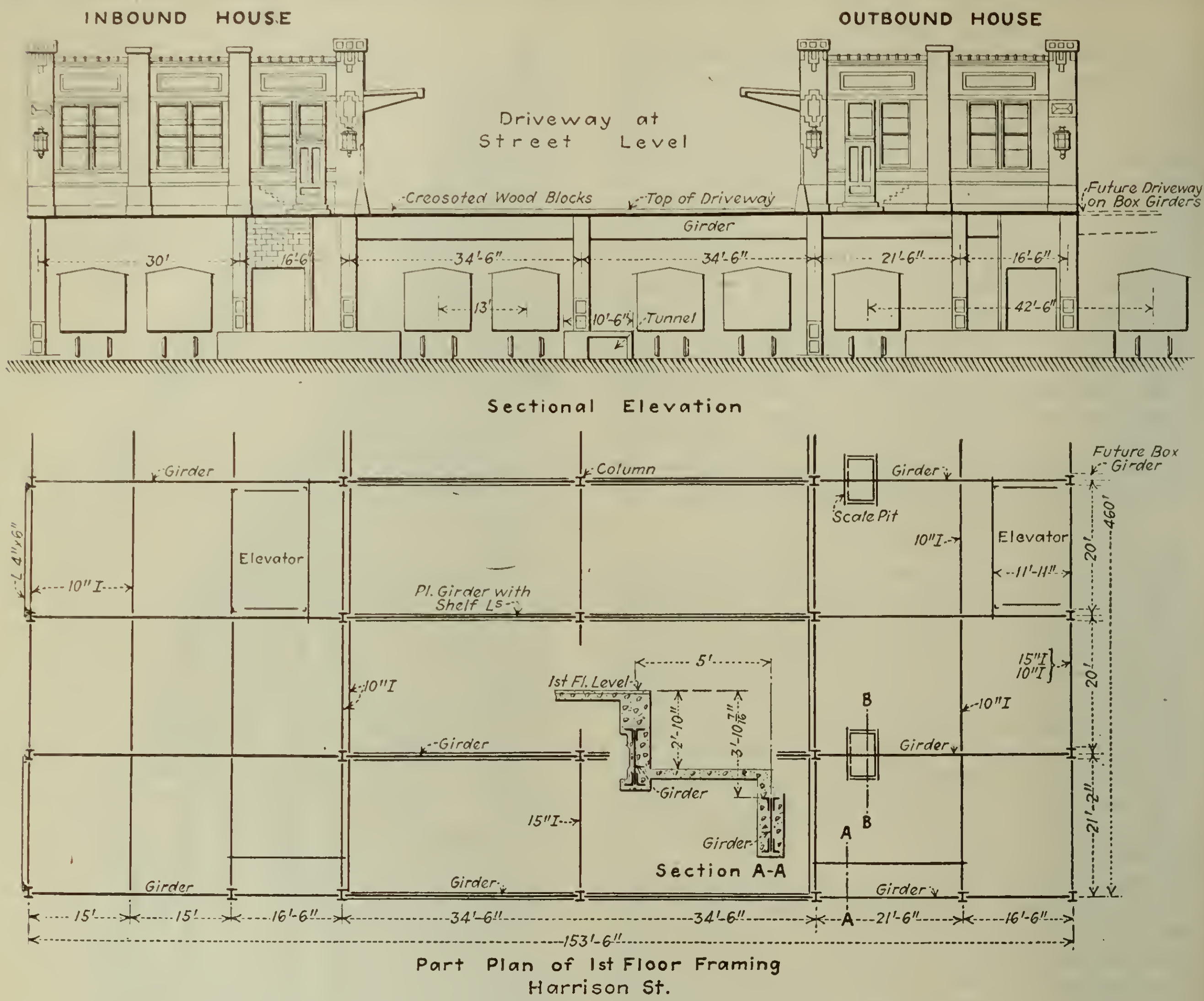


FIG. 2. DOUBLE DECK FREIGHT HOUSE WITHOUT INTERIOR COLUMNS

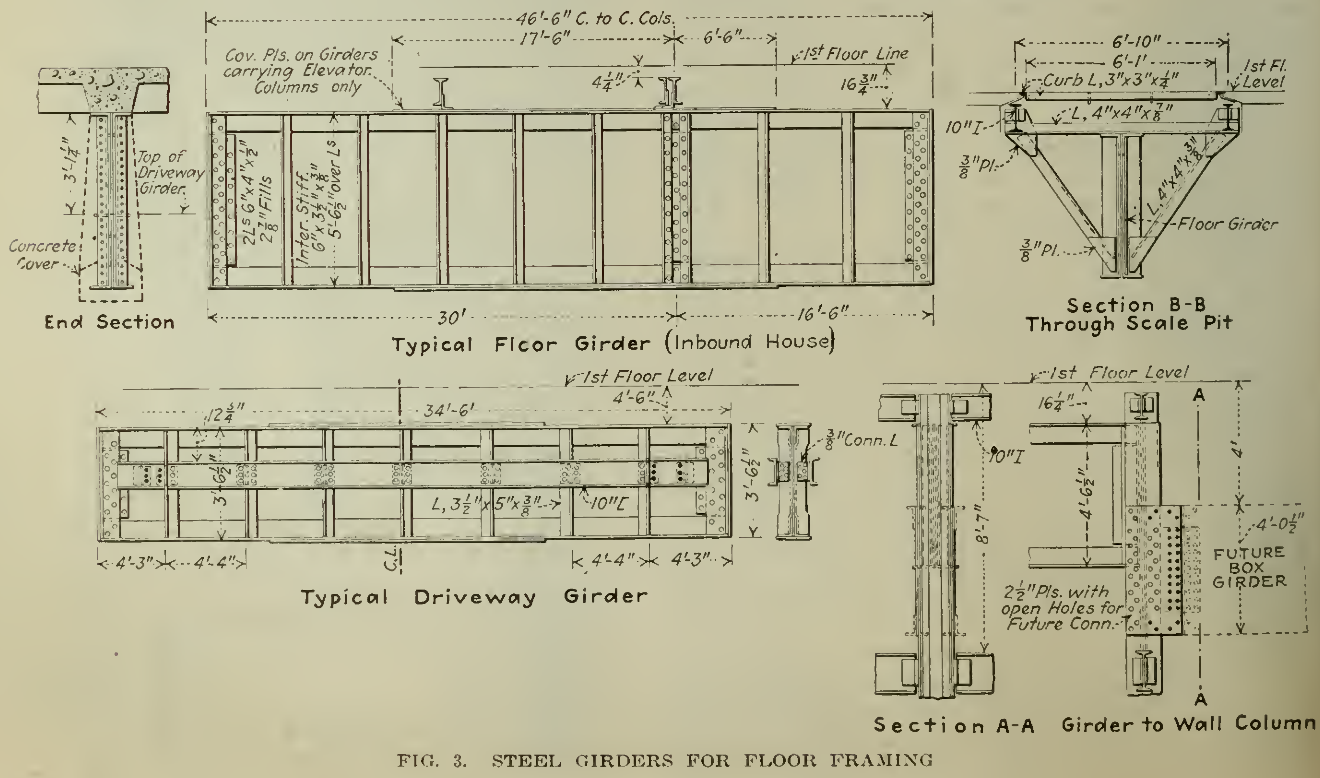


FIG. 3. STEEL GIRDERS FOR FLOOR FRAMING

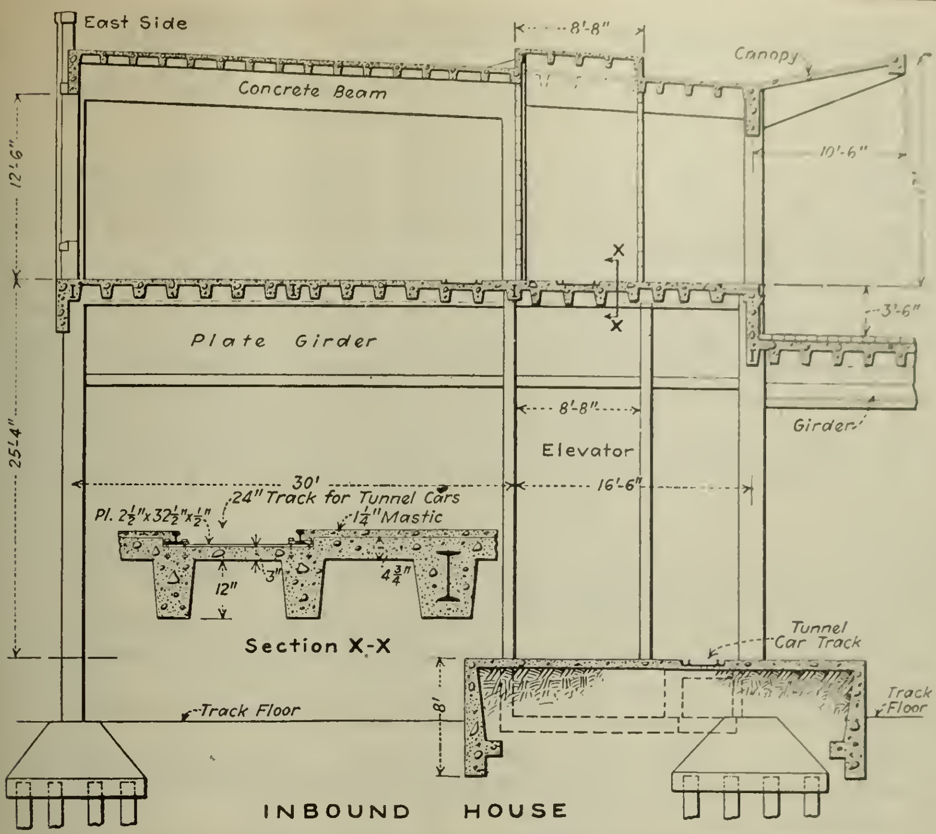


FIG. 4. COMBINED STEEL AND CONCRETE CONSTRUCTION OF FREIGHT HOUSE

of the concrete columns of the upper floor, at the street level.

Ribbed concrete slabs are used for the floor or platform and for the roof, the former resting on the plate girders and the latter being supported on concrete cross girders, as shown by the section, Fig. 4. These concrete girders extend as cantilevers 10½ ft. long to carry a flat slab canopy over the driveway to protect goods while being loaded and unloaded. A longitudinal beam or strut connects the ends of the cantilevers. The edge of each platform is protected by a 10-in. I-beam attached to brackets on the tops of the steel columns and faced with a continuous bumping timber. A similar ribbed concrete deck construction is used for the driveway, but here the end beams of the concrete panels rest on shelf channels on the webs of the girders, instead of upon the top flanges. The driveway has a 6-in. slab and is paved with creosoted wood blocks. The floor and driveway slabs are designed for a live load of 300 lb. per sq.ft.

Narrow-Gage Freight Tracks

On the platforms at each floor will be tracks of 2-ft. gage for the cars of the underground freight-handling system of the Illinois Tunnel Co., these cars being handled by elevators in deep shafts. For the inbound house there is a single oval shaft 14½ x 8½ ft., but the outbound house has a double shaft of the same shape, 28 x 8½ ft. The tracks on the platforms are of 20-lb. rails bolted to flat transverse plates which are spaced 36 in. c. to c. and are laid upon the concrete. There is no concrete filling between the rails, but on the outside the mastic floor is level with the rail heads. Freight elevators between the two floors are provided at every third bay in the outbound house and every fourth bay in the inbound house, these elevators having cars 10 ft. 6 in. x 17 ft. 9 in. Platform scales are provided in every second and fourth bay of the outbound and inbound houses respectively. A description of the larger warehouse and office building is embodied in the article which follows.

The building is unusual in combining a freight house, a warehouse and an office building, embodying special structural features. Heavy trusses are used to support the floors over the freight platform and driveway. Special girders, carried on columns so spaced as to clear the tracks, support columns of different spacing for the upper floors, details of which are shown.

This terminal was designed under the direction of H. T. Douglas, Jr., chief engineer of the Chicago & Alton R.R., the structural details being worked out by W. F. Rech, bridge engineer. The steel work was fabricated by the American Bridge Co. The contractors are W. J. Newman Co., Chicago, for the foundation piers; the Mellon-Stuart-Nelson Co., Chicago, for the smaller buildings, and the Dwight P. Robinson Co., New York, for the superstructure of the main building.

$139,000,000 Cost of Catskill Development

The first stage of the Catskill water supply development for New York City having been essentially completed, J. Waldo Smith, chief engineer, in his annual report for 1919, summarizes the extent of the operations of this project from the beginning of the preliminary investigations in August, 1905, down to the present time:

On Oct. 9, 1905, a complete plan for the development of the Catskill watersheds was submitted to the Board of Estimate and Apportionment. This plan was approved by that board on Oct. 27, 1905, and by the State Water Supply Commission on May 14, 1906. The first contract for aqueduct construction was awarded on March 27, 1907, and the first sod was turned by Mayor George B. McClellan on June 20, 1907. Thereafter contract followed contract and the work was advanced so that storage of water in the Ashokan reservoir was begun on Sept. 9 1913, and Catskill water was first delivered into the distribution systems of the city on Dec. 27, 1915.

The work of exploration and construction was done under 69 agreements and 140 contracts aggregating, together with the work done by force account, a total of $103,013,905.64. Other expenses, including administration, engineering and police, equipment, supplies, acquisition of land, damages and taxes to the end of 1919, bring the total cost for the first part of the Esopus development to $139,050,889.55.

Double-Deck Freight Station in Six-Story Building

Steel and Concrete Structure—Trusses and Girders Eliminate Interior Columns—Upper Floors for Company Offices—Structural Provision for Future Driveways

An unusual combination of freight house, warehouse and office building, involving special structural features in the way of trusses and girders, is provided in the main structure of the city freight terminal now being built at Chicago for the Chicago & Alton R.R. This terminal is described on p. 728 of this issue. The novel but logical purpose of the office section is to provide the railway company with general headquarters on its own property and thus eliminate the expense of rented offices.

This building will be 340 ft. long, with a six-story section having a frontage of 236 ft. on Harrison St., other accommodation. A sectional elevation of the six-story office portion of the building is shown in Fig. 1, together with a typical portion of the first-floor framing plan.

Steel frame construction is used throughout, and in the lower floors it consists largely of plate girders, with girder and cantilever supports for upper columns over tracks and open floor spaces. Trusses and longwall girders carry one part of the building over a group of tracks. The structural scheme will be understood from Fig. 1 and the general first-floor framing plan, Fig. 2. Ribbed concrete floors, ribbed and flat slab roof, con-

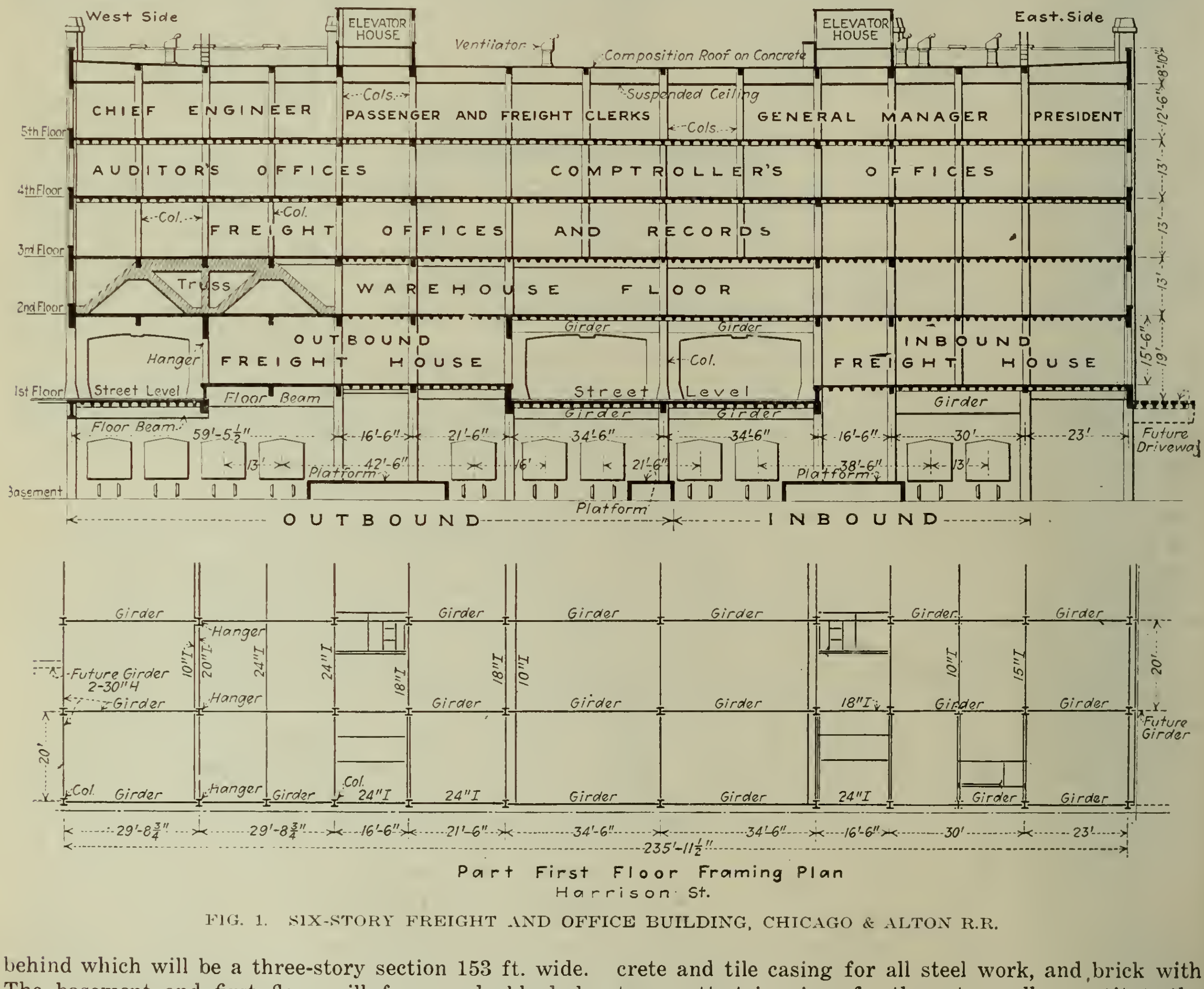


FIG. 1. SIX-STORY FREIGHT AND OFFICE BUILDING, CHICAGO & ALTON R.R.

behind which will be a three-story section 153 ft. wide. The basement and first floor will form a double-deck freight house, with tracks at the lower level and with the entire first floor (at the street level) for team driveways and freight platforms. The greater part of the second floor will be for warehouse purposes. In the office portion of the building, the third floor will have the freight department, filing and storage rooms for freight records and also a lunch room. On the fourth floor will be the financial departments. On the fifth floor will be the offices for the president, general manager and chief engineer, with drafting room and crete and tile casing for all steel work, and brick with terra cotta trimmings for the outer walls, constitute the other structural features of the building.

In addition to the broad interior driveways, attention may be called to the provision for future outside driveways on both sides of the building, these to be carried by girders attached to the structural framing, as indicated by the plan in Fig. 1. For the driveway on the west side, which will be over tracks running longitudinally under it, there will be pairs of 30-in. H-beams framed against wall girders in the building and against an outer line of girders carried by columns on the

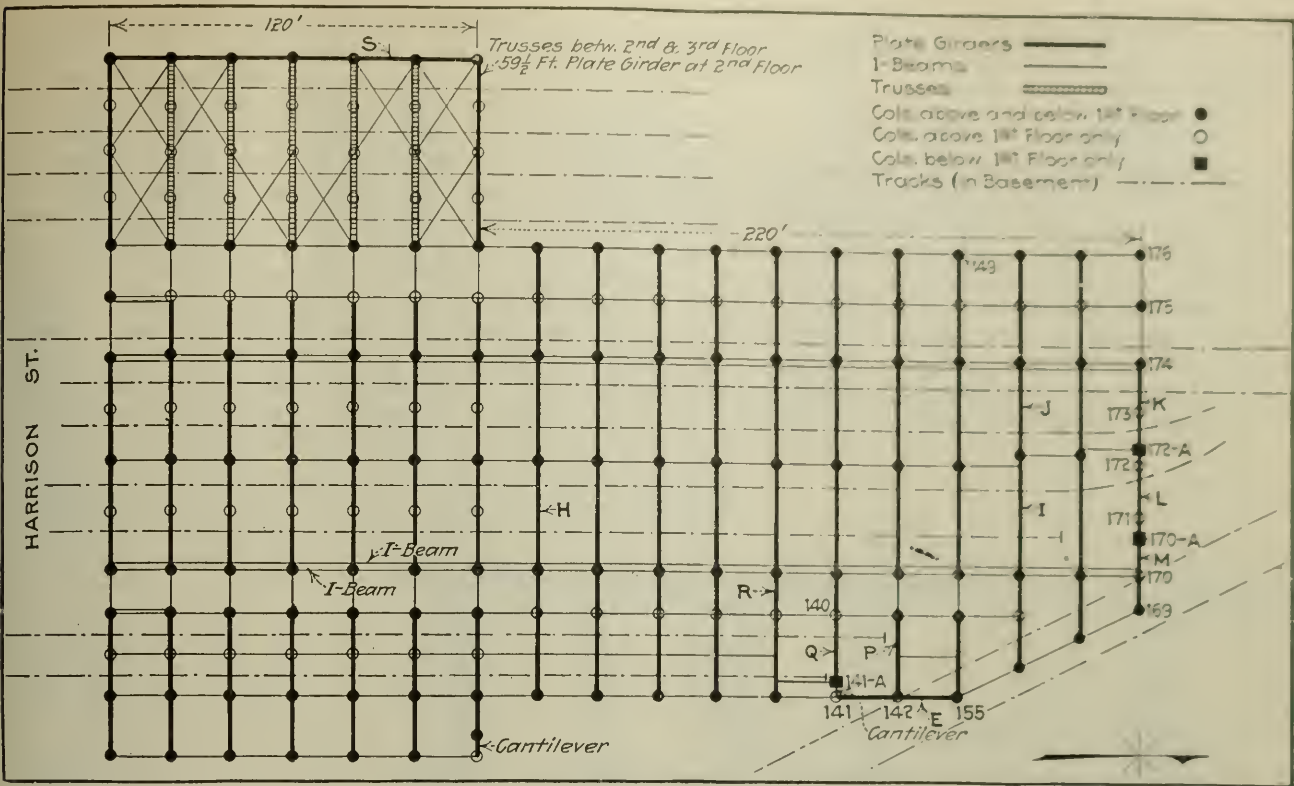


FIG. 2. FRAMING PLAN OF FIRST FLOOR

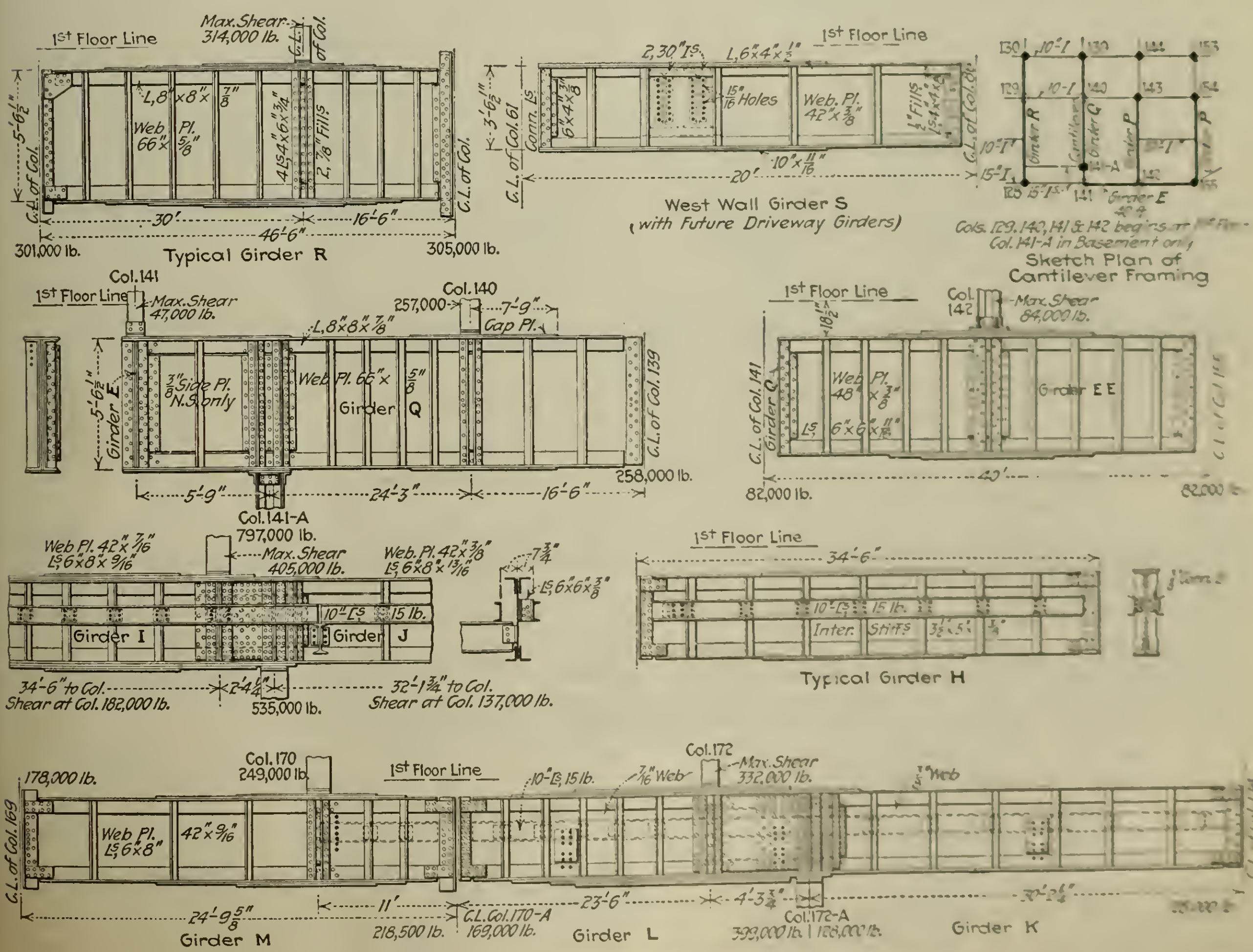


FIG. 3. SPECIAL AND TYPICAL GIRDERS OF FLOOR SYSTEM

railway company's property line. For the east-side driveway there will be single 40-in. girders riveted to the wall columns of the building.

Girders Carry Columns

Unsymmetrical arrangement of columns occurs at several points in the basement, this being necessitated by the track layout and in turn necessitating special arrangements of girders to support the columns of the upper floors. Thus a cantilever girder is required at a point on the east side where two wall columns would obstruct a diagonal track if placed at their normal locations. In the basement or track floor, therefore, one of these columns (No. 141-A, see Figs. 2 and 3) is set back to give the required clearance for cars and upon it is placed a 46½-ft. transverse girder having a cantilever projection of 5¾ ft. to support the wall column in its proper position at the first floor.

The other wall column (No. 142) is omitted entirely in the basement. At the first floor level it is seated on a 40-ft. two-bay wall girder which has one end attached to column and the other end framed against the cantilever girder mentioned above. In the north wall, also, there is an unsymmetrical arrangement to provide for tracks on curves. Here four columns of the basement are so spaced as to clear the tracks and these columns carry girders upon which are seated columns of different spacing for the upper floors. Some of these special girders are shown in Fig. 3.

A truss arrangement for supporting the upper floors in the southwest part of the office building, which extends over the four outer tracks, calls for special attention. Owing to the necessarily close spacing of these tracks it was not practicable to place columns between them. Trusses 59½ ft. long were introduced, therefore, to span these tracks and to support the interior columns for the upper floors. But the trusses could not be placed at the first floor, as the driveways made it necessary to leave this space unobstructed. For this reason the trusses are placed with their lower and upper chords just below the second and third floors respectively, as shown in Fig. 1. To carry this part of the first floor over the track space beneath it, transverse plate girders in two sections are used. Each girder has its outer end riveted to a column which supports the truss and its inner end riveted to a hanger depending from the center of the truss. Horizontal diagonal bracing is introduced to give lateral rigidity to this semi-suspended floor.

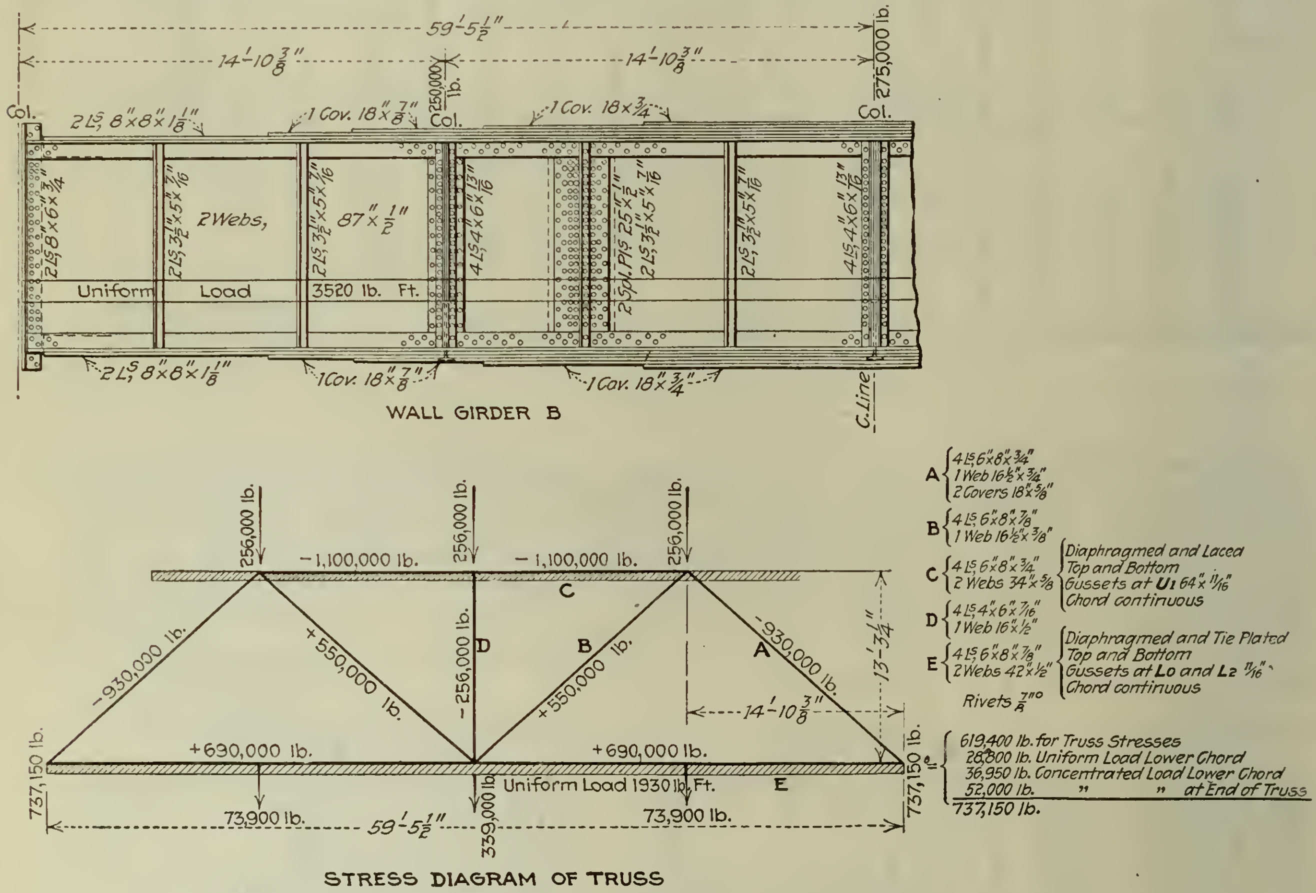


FIG. 4. TRUSSES AND WALL GIRDERS TO SUPPORT UPPER COLUMNS

These trusses are 13¼ ft. deep, with chords of double channel section and web members of I-section. Their dimensions and loading are shown in Fig. 4. Tile fireproofing will be applied to all the truss members, being arranged as shown in Fig. 5. Web plates will be plastered with cement mortar flush with the flange angles, so as to make a smooth surface against which the tiles can be laid. The tile covering will be wrapped with wire and plastered.

Double-web plate girders 87 in. deep and 59½ ft. long will be placed at the second story level in the end walls of that part of the building in which the trusses are used for interior framing. These girders will support the upper wall columns over the driveway and will carry hangers to support the portal framing of the first floor,

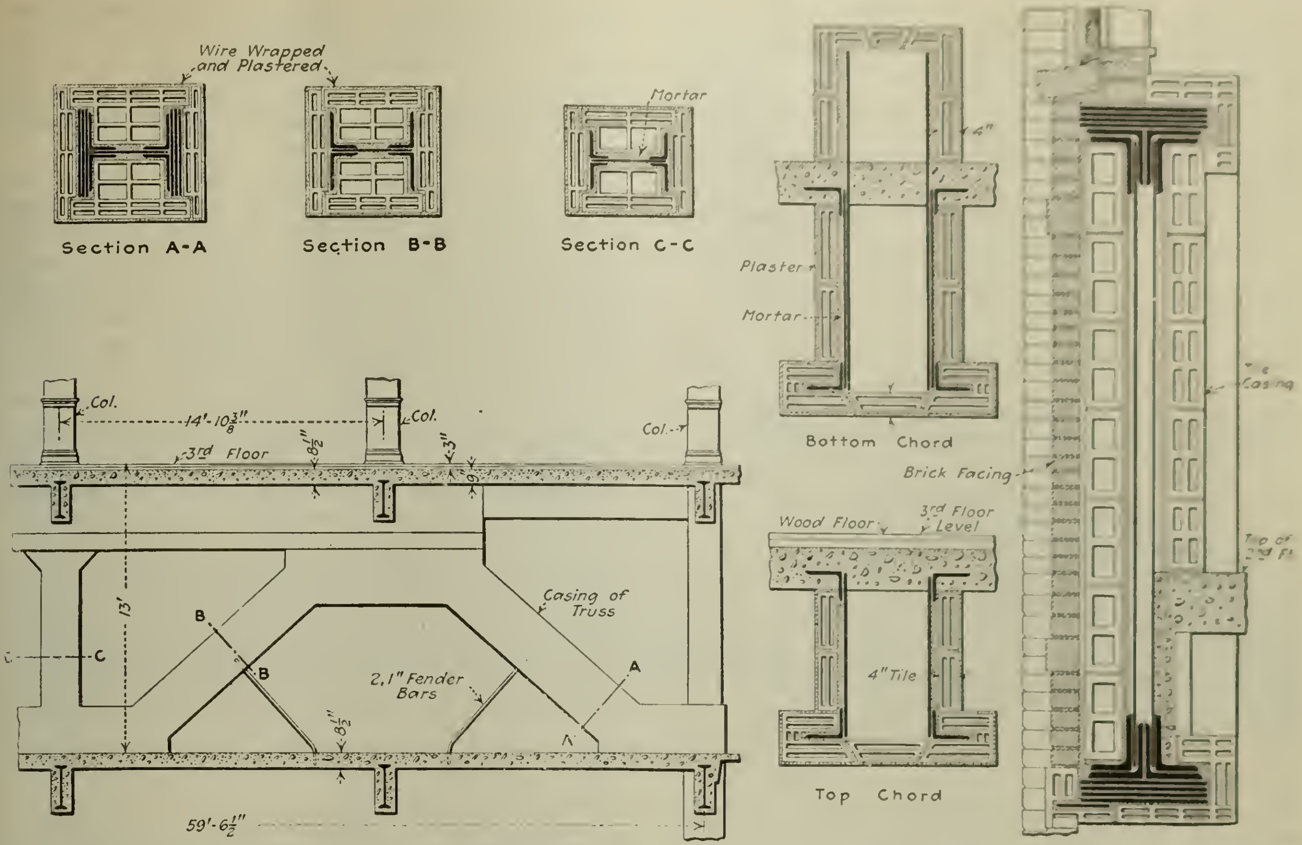


FIG. 5. TRUSS AND GIRDER DETAILS AND FIREPROOFING

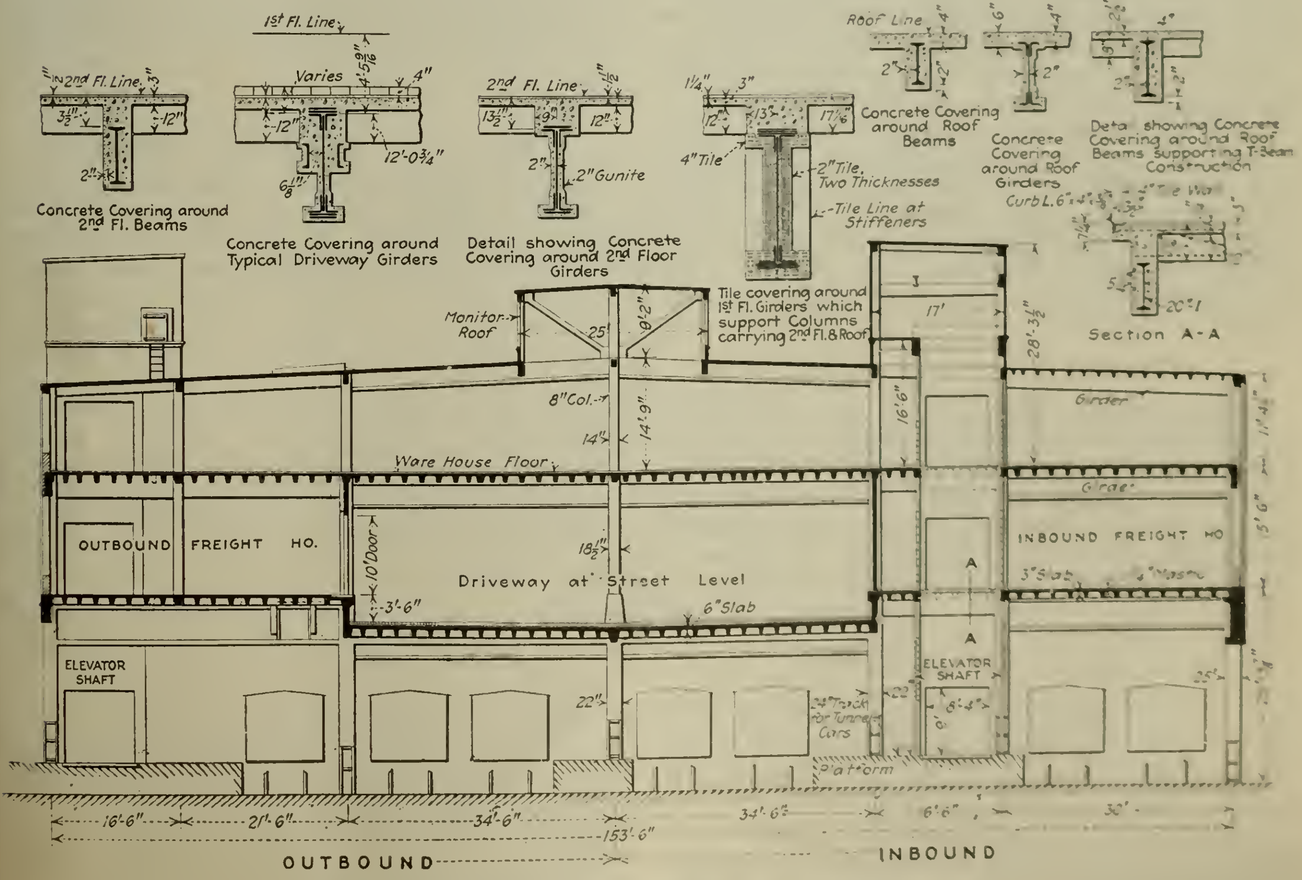


FIG. 6. CROSS-SECTION OF THREE-STORY FREIGHT HOUSE

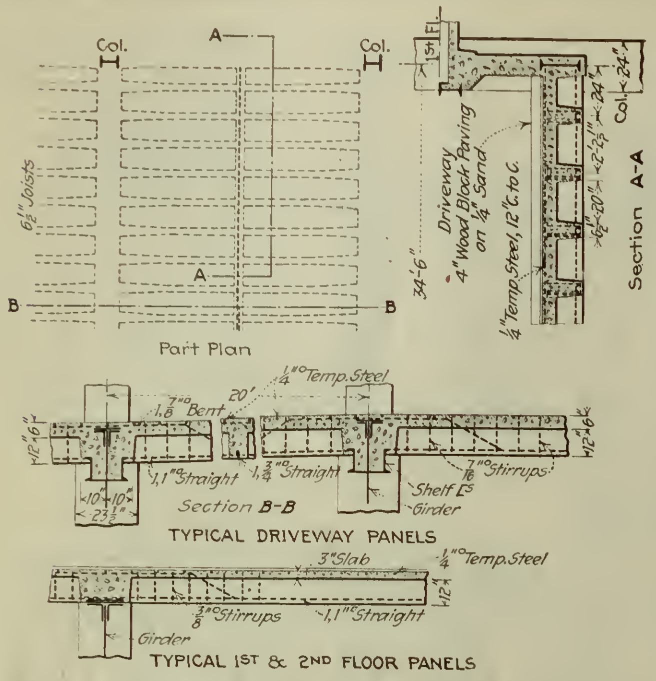


FIG. 7. CONCRETE FLOOR AND DRIVEWAY CONSTRUCTION

across the tracks. Each girder (Fig. 4) will have four cover plates and four flange angles for each chord. The two web plates will not be spaced as far apart as in a box girder, but will be riveted against the T-shaped rib formed by the inner flange angles, the outer flange angles being riveted to the webs. This is shown in the detail, Fig. 5.

Plate girders are introduced extensively throughout the framing of the first and second floors in order to obtain long spans and to eliminate interior columns as far as possible on the floors where freight is handled. A large part of the area will have panels 20 x 34½ ft. The exceptional facilities for driving and trucking on floors, driveways and platforms unobstructed by columns is indicated by Fig. 6, which shows the cross-section of the three-story section of the building. Some of the typical girders are shown in Fig. 3. In the upper office floors there is a closer spacing of columns and the framing is to be largely of I-beams, since there is not the requirement for large unobstructed spaces on these floors.

Concrete Floors and Platforms

Reinforced concrete floors are to be of the ribbed slab or slab-and-joist type, as shown in Fig. 7. In each panel, the ribs or joists extend longitudinally between concrete end beams which are seated on 6-in. shelf channels on the webs of the transverse plate girder or are seated directly upon the girders and I-beams in the framing of the smaller panels. The slab thickness will be 2½ in. for the office floors, 3 in. for the freight house and warehouse floors and 6 in. for the driveways. Wood block paving with 4-in. creosoted blocks on ¼-in. sand cushion is to be used on the driveways, asphaltic mastic on the freight house platforms and warehouse floors and hardwood in the offices. No pavement will be laid on the basement floor, the tracks being ballasted with broken stone.

On the first and second floors, the platforms will have tracks of 24-in. gage for the cars of the freight handling tunnels operated by the Chicago Tunnel Co., as described in the article on p. 728 on the general design of the terminal. A flat slab will be used for the main part of the roof. Live loads used in floor design are 80 lb. per square foot for offices; 200 lb. for office filing space and 300 lb. for the driveways and for the platforms and warehouse floors of the first and second stories.

All steel floor framing is to be cased in concrete having a minimum thickness of two inches, this being placed in forms around the beams and girders. For girders which support columns, however, two layers of 2-in. tile will be used, the web plates being plastered with cement mortar to make a surface flush with the flange angles. Against this mortar the tile will be laid, as in the trusses described above.

Cylinder pier foundations of the type so generally employed in Chicago will support the office section of the building, the concrete piers being built in open wells or caissons sunk to hardpan at an average depth of 60 ft. Timber pile foundations will be used for the three-story warehouse portion of the building.

Freight will be handled between the floors by eleven 2-ton automatic electric elevators 9 x 17 ft. These will require no attendants, but any freight handler can operate them as desired by means of push buttons at the elevator doors. On the outbound platform there will be an elevator in every third or fourth bay and a freight scale in every sixth bay. The inbound platform will have an elevator in every third bay and a scale in every third or fourth bay.

This building was designed under the direction of H. T. Douglas, Jr., chief engineer of the Chicago & Alton R.R., the structural design being prepared by W. F. Rech, bridge engineer. The W. J. Newman Co., Chicago, has the contract for the foundation piers, and the Dwight P. Robinson Co., Chicago, has the contract for the superstructure. The steel work has been fabricated by the American Bridge Co. and is ready for delivery.

Triple-Track Main Lines in France

The addition of a third track to double track lines to facilitate special movements of traffic under war conditions was carried out at several points on the Northern Railway of France, as described in the "Revue Generale des Chemins de Fer" by Mr. Moutier, assistant superintendent. In one case, the new track was especially for military traffic, as the loaded trains had an opposing grade of 1.2 per cent for about seven miles. On this grade the heavy trains moved slowly, thus limiting the traffic capacity. With the third track, the military traffic was kept clear of general traffic and if either of the two ascending tracks should be blocked the other was available to keep traffic moving. Between Lapugny and La Pol, about 16 miles, a third track was laid to provide extra facilities for movements in both directions on a stretch of line having long and severe grades on opposite sides of a summit. Movements of troops had to be made in one direction and a heavy coal traffic in the oppposite direction was imposed on the line owing to the regular route being near the front. Ordinarily, the troop trains were handled on the extra track during the day and the coal trains during the night. Besides these triple track lines there was much doubling of both single-track and double-track lines in order to increase the traffic facilities and to open new routes as alternatives to regular routes threatened by the enemy or given up to military movements.

Multiple-Unit Plan for Compact Factory Plant

Six Steel and Concrete Buildings Form Single Unit—Engineer Handled Design, Machinery Layout and Construction

BUILDINGS of different types and materials for different purposes, but all in contact so as to form practically one structure, instead of being separated by light courts and yards, constitute a noval arrangement in a new bolt and nut forging and galvanising factory at 12th St. and 54th Ave., Chicago. The special purposes of this arrangement are to reduce the area of site required, to minimize the travel of material through the several stages of manufacture and to insure that all movements are made under cover. As the buildings are only one and two stories high, ample light and ventilation of the interior spaces are obtained by extensive window area and large monitor roofs with side lights. The main front of the plant is shown in Fig. 1.

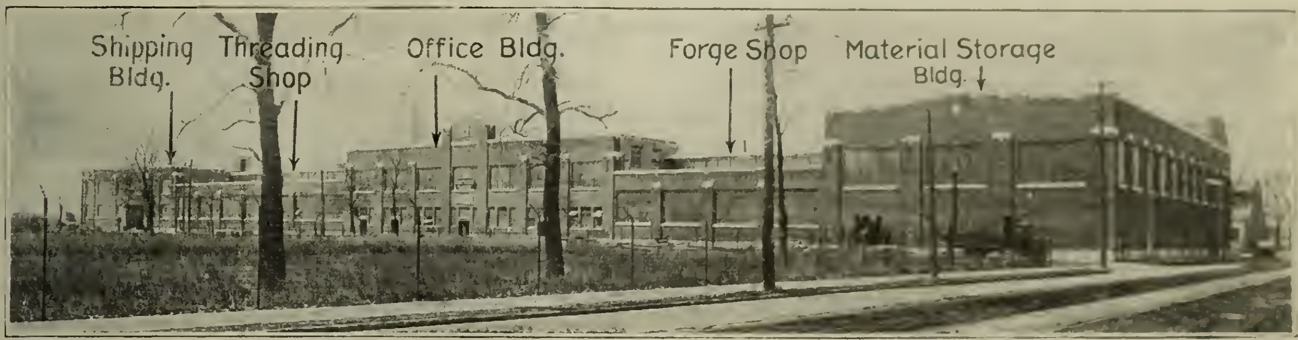


FIG. 1. MAIN FRONT OF FACTORY

A novel feature in the construction was that the engineer supervised the construction by contractors, no general contract being let.

At the time the plans were being prepared it was evident that the prices of building materials were on the increase. The engineer, therefore, secured the consent of the owner to purchase for immediate delivery the sand, stone, cement, lumber, brick and reinforcing steel. Thus a large supply of material was on hand before the work commenced, thus saving considerable expense (in increased prices) and avoiding delays in construction. No general contract was awarded, but separate contracts were let from time to time for the several trades and specialties. Under this arrangement, the engineer acted as general contractor, since it was necessary for him to lay out the work, purchase materials, supervise the various contracts and audit all accounts.

The engineer's work included the design and arrangement of buildings, selection and location of mechanical equipment, special galvanising furnaces using oil fuel, handling of raw material, routing of material in manufacture, shipping facilities, output, power plant and distribution, fuel oil system, heating plant, water and compressed air systems, plumbing and sewerage, conveniences for employees, general and detail plans and specifications, and supervision and inspection of work.

Of the six buildings, Fig. 2, four are one-story steel structures as follows: material storage, 73½ x 188 ft., with 73½-ft. roof trusses; shearing and forge shop, 160 x 171 ft., five bays of steel trusses; threading, nut and assembly building, 102 x 200 ft., three bays of roof trusses; galvanizing building, 68 x 200 ft., with 68-ft. roof trusses. The shipping building, 128 x 200 ft., and the combined office building and machine shop, 34 x 140 ft., are reinforced-concrete structures with two stories and basement. Their upper floors are designed

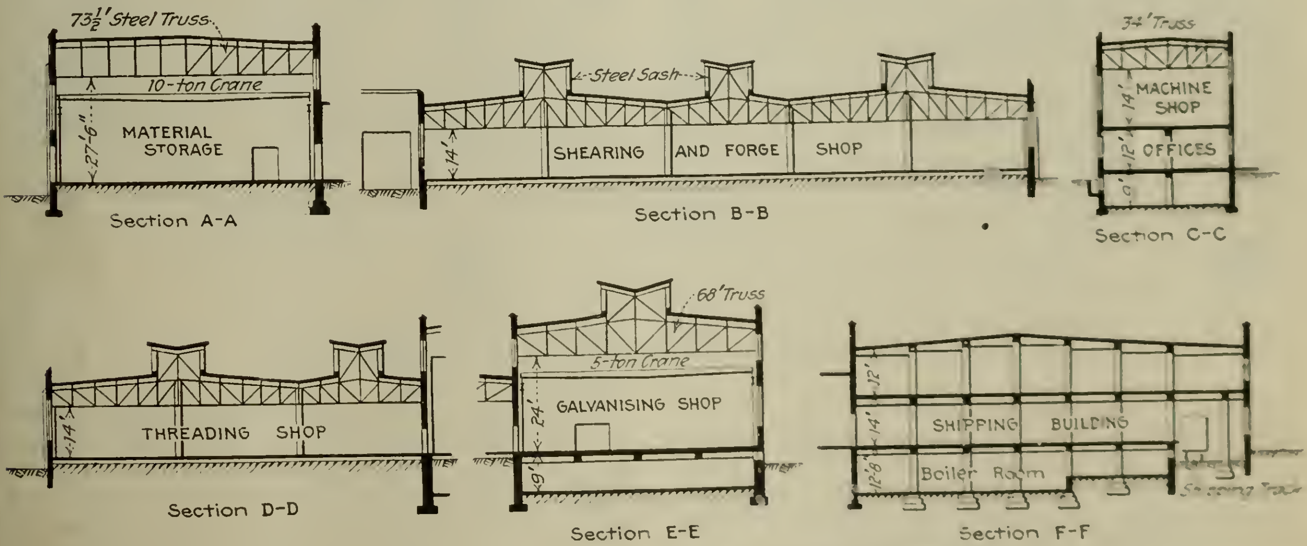


FIG. 2. SIX BUILDINGS FORM UNIT STRUCTURE

for a load of 250 lb. per square foot. Typical sections are shown in Fig. 3. All the buildings are faced with buff brick, and white terra cotta. Brick floors are used in the shops.

Steel and Concrete Buildings

In the steel buildings the principal features are the high and wide monitor roofs, the sides of which are filled entirely with wire glass in fixed or pivoted sash. The roof of the monitor is of the butterfly type, thus giving maximum height of face without obstruction of light by eaves and gutters as in the case of roofs of the umbrella type. Further, all drainage is taken care of by interior pipes instead of by exterior downspouts.

Typical truss construction is shown by the details of roof of the galvanizing building, Fig. 3. The chords and web members are of T-section, built up of pairs of angles. The truss spacing is 20 ft. Upon the top chords are purlins of I-beams and channels, supporting a cement tile roof which is covered with felt and gravel roofing. All columns are of H-section.

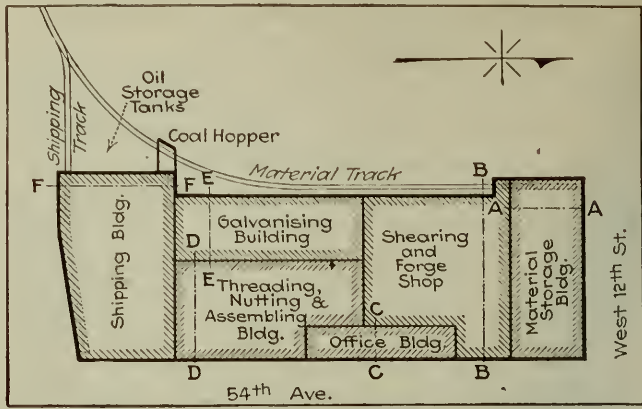


FIG. 3. SECTIONS OF FACTORY BUILDINGS

a 10-ton traveling crane which either stacks it or delivers it to the forge shop. In this latter shop and in the threading shop the roof trusses are designed to carry all shafting, piping, air ducts and motors, so as to give a clear headroom between the floor and the bottom chords of the trusses. The galvanizing building

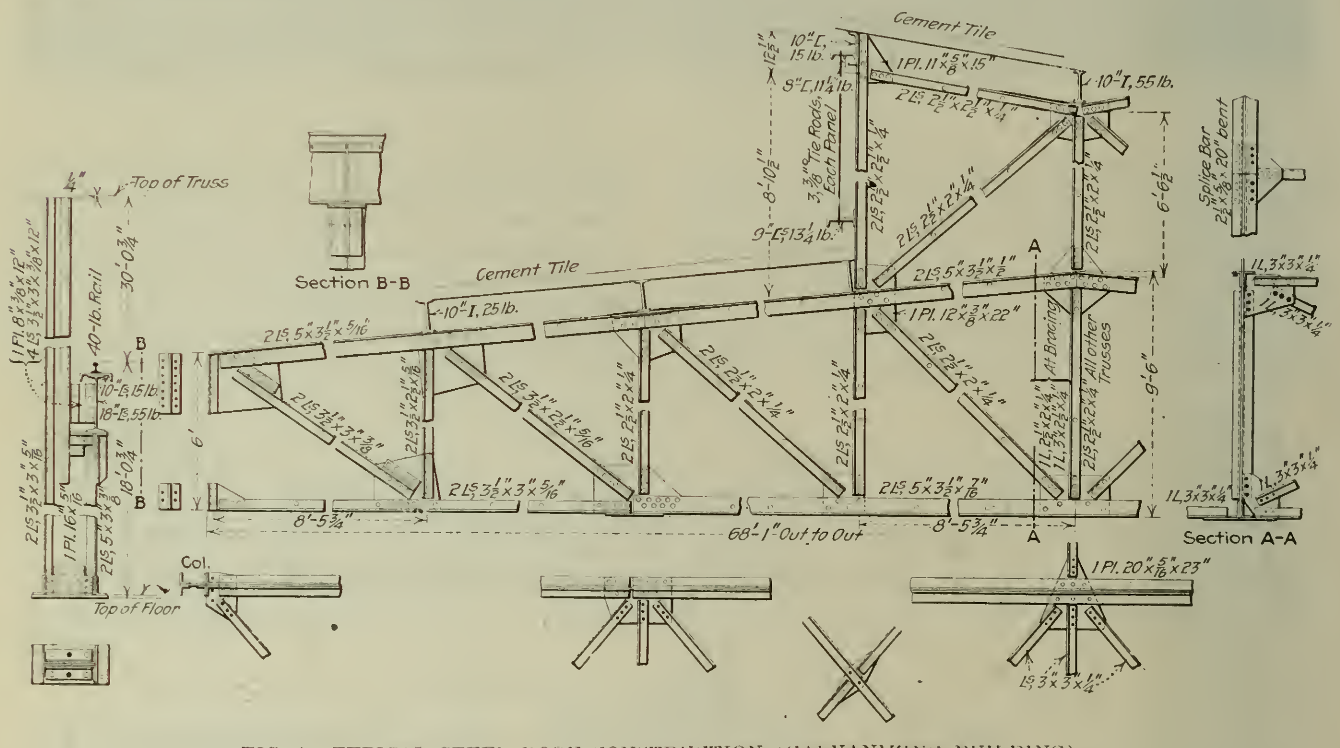


FIG. 4. TYPICAL STEEL ROOF CONSTRUCTION (GALVANIZING BUILDING)

Beam and slab construction, with two-way diagonal reinforcement in the slabs, is used for the floors and roofs of the two concrete buildings. In the larger shipping building the panels are mainly 16 x 17 ft., with 7½-in. slabs. A single row of columns in the lower part of the smaller office building divides the area into panels 17 x 20 ft., but the upper or machine shop floor is unobstructed, as it is spanned by steel trusses carried on brick pilasters.

Engineer Plans Equipment

The variety of matters to be considered by the engineer in the design of the plant, apart from the selection of manufacturing machinery, may be judged from the following notes of the equipment. Material received by car or wagon at the storage building is unloaded by is served by a 5-ton crane and has a basement for storage. General offices, locker and toilet rooms, hospital and filing space are arranged on the first floor and basement of the office building, the machine shop being on the second floor and served by a 5-ton elevator. In the shipping building is a depressed track so that the floors of cars are level with the floor of the building. Two elevators and a spiral chute for descending packages are provided. The first floor is for assembly and shipping, with the basement and second floor for storage.

Electric operation is used throughout, current at 2,200 volts being delivered to a substation on the roof of the shipping building, where it is transformed to 440 volts. In the basement is the main switchboard, together with three boilers for the vacuum return heating system.

Coal is delivered to a track hopper; ashes are removed by a skip hoist and dumped into cars. Fuel oil is unloaded from cars by gravity or by pumping and is stored in four underground steel tanks having a combined capacity of 75,000 gal.; all control valves are inside the building. Distribution is by pumping to overhead pipes, heaters being provided for the pumps and tanks. Meters are provided on the oil distribution and return pipes.

Cooling water is required in considerable quantity for the forge shop, but as it would be too expensive to secure this from the city supply or to drill a special well, it was decided to use a circulation system. The used water is drained to an underground settling basin and pumped to cooling tanks on the roof, whence it returns to the circulating pipes, any necessary make-up water being taken from the city main. This system is designed for a maximum supply of 600 gal. per minute.

Compressed air for the boiler burners and the forges is supplied at 1½-lb. pressure by three motor driven compressors in the boiler room, the blast ducts being carried in the bottom chords of the roof trusses. Sulphuric acid for the galvanizing process is delivered by an air pressure from tank cars to two vertical steel tanks of 15,000 gal. combined capacity, with gravity supply to the working room.

This factory was designed, built and equipped for Hubbard & Co., by J. L. McConnell, consulting engineer, Chicago. Construction was commenced Nov. 1, 1919, and the entire plant was completed by June 1, 1920.

Mesh Reinforcement in California Concrete Pavements

On county highway work in California the use of mesh reinforcing in concrete pavements has been rapidly increasing. To date about 300,000 sq.yd. of mesh reinforcing for county road work has been supplied in that state by one firm alone and the demand during the first eight months of this year was for three times the amount supplied last year. In general it is true among county engineers of California that where sufficient funds are available to permit its use there is no discussion as to the desirability of reinforcing, the only question being as to the most suitable kind and weight, its cost and the best method of placing it. In next season's road construction program the counties are planning more extensive use of mesh reinforcing. This means much in California because in that state last year fourteen counties voted a total of $20,604,000 for road bonds. Of this work 50 per cent is now under way and about 90 per cent will be paved.

Where mesh is used the amount varies from 22 lb. per 100 sq.ft. as a minimum to 41 lb. as a maximum, the average being about 26½ lb. About 26 or 27 lb. per 100 sq.ft. is believed to be sufficient to prevent longitudinal cracks and control the transverse cracks so that they have no injurious effect. In the method now preferred the fabric is laid with the longitudinal wires at right angles to the center line of the road. By giving the mesh a small lap on each width to insure bond, reinforcement is secured in both directions.

In general, three methods have been used for handling and placing the mesh. In the first, the mesh is placed directly upon the prepared sub-base, the concrete is poured upon it and the mesh is then pulled into the center of the slab with hooks. In the second method the mesh is placed upon sections of pipe laid on the sub-base lengthwise with the road. The pipes serve to keep the mesh in the center of the slab during the process of pouring, after which the pipes are withdrawn. A third plan, known as the two-operation method has not yet been used extensively but has thus far met with considerable success.

In the two-operation method the mesh is shipped to the job in flat sheets cut to the proper length. Mixing operations are then begun and the lower half of the slab is poured for a convenient length (section one). Where a spout mixer is used this first pouring is from the end of the spout. A gate in the middle of the spout is then opened and the space next the mixer (section two) is poured on the sub-base in the same manner. During this second operation the fabric is laid on section one and, without moving the mixer, the top half of section one is poured over the mesh from the outer end of the spout.

The mixer is then advanced a distance equal to the length of a section and while the lower half of section three is being poured from the gate in the middle of the spout, sheets of fabric are laid over the lower half of section two. The gate in the middle of the spout is then closed and the fabric of section two is covered with its top layer of concrete by pouring from the end of the spout. This process is repeated during the remainder of the job, two adjoining sections of half thickness, one at the top and one below being poured from each mixer position.

Advantages claimed for this scheme of placing are: the mesh is kept properly in the center of the slab, reinforcement does not have to be disturbed after it is once in place and pouring operations are interfered with to a very limited extent. This method was used by R. M. Morton, while engineer of the Sacramento County Highway Commission, to whom we are indebted for the following cost data.

On Sacramento County work the mesh used weighed 27 lb. per 100 sq.ft. and cost $1.53 per 100 sq.ft. delivered. Two men per gang were employed to handle and place the reinforcing. When laying 7,500 sq.ft. of pavement per day the cost of hauling and placing the mesh was 35 cents per 100 sq.ft. This cost includes a slight charge against the reinforcement for a slowing up of mixer operations. The total cost of reinforcement in place on this job was therefore $1.88 per 100 sq.ft., making a cost per mile of $1,566 for a 15-ft. roadway.

Progress on Shandaken Tunnel

Progress on the construction of the Shandaken tunnel of the Catskill water supply system for New York City was continued during 1919 and at the year's end, according to the latest annual report of J. Waldo Smith, chief engineer, all but one of the eight shafts had been completed and the tunnel heads turned. During the year 2,356 lin.ft. of shaft were sunk and 1,098 ft. of tunnel were driven. In connection with this work a transmission-line for the purpose of furnishing electrical energy to the various parts of the project was constructed from a point near Kingston to the intake shaft at the Schoharie reservoir, a total distance of 50 miles.

Industrial Wastes in Relation to Water Supplies

Abstract of a paper presented before the Sanitary Engineering Section of the American Public Health Association by W. Donaldson of Fuller & McClintock, New York City.

IT IS the history of industrial pollution of water that the nuisance and damage is brought into existence before remedial measures have begun to be applied. Although the problems of trade waste are not new to this country, certain results of the Great War, such as the building up of large urban populations and the remarkable quickening of industrial life, have greatly increased their importance. Already we witness some of the most important rivers so grossly polluted with industrial waste as to be hopeless of reclamation for water supply purposes.

The importance of preserving the purity of the streams and lakes of the United States is evident from the fact that probably at least 40 per cent of the entire population of this country is supplied with water from surface sources.

The effect of industrial waste on public water supplies is generally manifested in one or more of three ways: First, disagreeable odors and taste; second, foreign substances which make the water unsuitable for use or interfere with the functioning of purification work and, third, chemical substances in solution which may cause actual damage to water work structures or render the water less fit for domestic or industrial use. It is not surprising to note that often it is the principal or basic industries of the country which are responsible for water pollution.

Acid Wastes Damage Structures

Coal mine wastes which merely blacken the stream waters are, generally speaking, not serious because they are easily removed by the sedimentation and filtration processes. Acid wastes, however, which commonly drain from coal measures when exposed to the atmosphere may so strongly impregnate the waters as to make them unsuitable for either domestic or industrial use. Along the Monongahela River acid wastes are blamed for many thousands of dollars worth of damage to structures of the government dams and to shipping. Although the cost of treatment is a considerable factor, water purification plants on this stream are able to neutralize the acid effect by means of lime or soda ash treatment in connection with a filtration process before delivering water to the city main. There is, too, the claim that in the Pittsburgh district, for example, the wastes are not wholly detrimental in the streams, for they serve to sterilize the considerable sewage pollution and thus have protected from water-borne diseases many of the communities taking their water supply the stream without filtration.

The rapid increase in recent years of producer gas plants and by-product coke works has added materially to the problems of water supply by reason of the phenol and its derivatives found in the waste products from such plants and which persist in the water by reason of their relative solubility. Phenol waste usually acts indirectly by reason of the facilities with which phenols form substitute compounds with chlorine gas and calcium hypochlorite, which are in general use for water sterilization in this country. Substitution compounds so formed have odor and taste very much more intensive than the original unchlorinated substances which themselves might exist in water in high dilution without being noticed. Instances are on record of phenol attacking the oil preservative used on water pipes in such way that the result was the intensively aromatic tri-chloral-phenol.

The taste of treated water taken from Lake Michigan was traced to phenol waste after it was found that the intensity of taste did not depend upon the amount of chlorine used for sterilization but upon the amount of phenols present in the water. Often the taste is attributed solely to the sterilizing agent when in fact the real cause is the action of phenol waste on that agent. Another unfortunate effect due to the presence of phenol wastes is their effect of reducing or nullifying the efficiency of the chlorination process used as a safeguard against harmful bacteria. In numerous cases where phenols were present it has been impossible to get satisfactory bacterial reduction, except by excessive doses of chlorine and resulting disagreeable taste.

Ordinary processes of water purification have not been successful with phenol waste, but some recent experiments indicate the possibility of affecting a considerable removal before chlorination and thus reducing the probability of complaints from taste and the interference with chlorination as noted in the foregoing. (Other trade wastes which the paper discusses include oil-well operations, and wastes from oil refineries, tanneries, and wood distillation or paper industries.)

It can hardly be denied that the prosperity of a nation is fairly measured by its industrial development. It is obvious, therefore, that the proper solution of the problems of water pollution by industrial wastes does not lie in the forbidding of industry, but in a sane regulation whereby industries may flourish without detriment to the resources of the country. It is proper that the burden of preventing stream pollution should be placed on the industrial plants themselves. There has been too much carelessness by manufacturers in allowing obnoxious waste to enter streams, and too much disregard of the right of others, particularly the public, in the use of streams. The manufacturer often can, with little expense, prevent the pollution of streams and repeatedly it has been found that the unwilling adoption of a process for waste disposal has resulted in a clear profit to the manufacturer in the recovery of by-products.

On the other hand, it is apparent that the necessities of public water supplies have some times borne down rather heavily upon the industries, when remedies were at hand for offsetting the effects complained of. It must be admitted that water purification plants are very much sterotyped in design and fitted only for handling the older problems of removing sewage effects. In these matters it would seem that the "rule of reason" might often be put into effect, although it must be admitted that the structure of American law is not inclined much to the principle of "balance of conveniences."

Florida's Average Elevation

The highest point in Florida whose altitude has been determined is Iron Mountain, in Polk County, which stands 325 ft. above sea level, according to the United States Geological Survey, Department of the Interior. The average elevation of the state as computed by the Geological Survey is about 100 ft.

British Labor's Political Activity—An Editorial View

THE following paragraphs from an editorial in *The Engineer*, London, Sept. 10, have an interest for American readers because of tendencies in this country:

There are few indeed of our readers who will not agree with us that the most sinister aspect of recent labor movements is their political bearing. It is a growth of only a few years, and its origin may be traced to the first occasion on which the Government of the day intervened in a labor dispute. The whole status of the trades unions was changed by that untoward event. The foundations of their political power were greatly strengthened. Strikes, which before that time were business affairs between employers and and employed, became national affairs, for it was always in the power of labor to embroil Cabinets by extending the bounds of the dispute. It was only necessary for a strike or dispute to assume sufficiently large proportions to force the Government to intervene, and as intervention always meant compromise the unions were invariably the gainers. Hence we may say that the formidable proportions of the strikes of today are attributable directly to the interference or intervention of Governments in trade disputes. Many leaders of thought foresaw the danger. They perceived that the labor vote would gain a new and dangerous influence; that Cabinets, subject to a score of diverse forces, would be weaker than unions with a single object in view; and that small local affairs would be raised to the first magnitude by the solicitousness of Parliament. This is a non-political paper and we write with no political bias, but merely state a familiar fact when we say that one politician—the present Prime Minister—is more greatly responsible for the present condition than any other man in the kingdom. With a genuine desire to serve a class of the community which he believed stood in need of help he was led step by step from action to action, which gave ever increasing power to that section and has at length raised it to a position when it dares to defy the Cabinet, the country, and the constitution.

It may be doubted if there is any escape from the position to which the industrial affairs of the country have been brought. It may be doubted if ever again the country will be free from the menace of national strike. It may be doubted if ever again labor will be unable to daunt Governments. But if it be impossible to take from labor the lever which a mistaken policy has placed in its hands, it is still, fortunately, within the power of the country to see that it is not allowed to wield that lever with the indiscriminating mischief of a giant. We have not the least desire to see the trades unions crushed, for we recognize fully the good that they have done and the good they can do. But we do desire to see their powers restrained within appropriate bounds, and we wish above all to see their political influence destroyed. There is no parallel to them in the country, no body of men that can hold the kingdom to ransom for its own ends. They enjoy a power which was never anticipated, for they are able to upset the basal principles of democracy and to make the minority more powerful than the majority. It is against that we have to fight.

Chicago Buys Coal on B.T.U. Basis

Coal for the city of Chicago has been purchased for some time by competition bid on the B.t.u. basis adjusted within definite limits for the percentage of ash. The contractor in his bid offers so many B.t.u. for 1c. In the ash adjustment for coal, which by analysis contains less than a specified percentage of ash, a premium of 2c. per ton for each whole per cent is paid. An increase in the ash content of 2 per cent over the percentage of ash specified is tolerated, but for that which contains more than 2 per cent the penalty is 2, 4, 7, 12, 18 and 25c. per ton for each succeeding per cent of excess and 35c. for each ton that contains 8 per cent in excess of the percentage specified.

Digging Niagara's New Power Canal

THE airplane view herewith shows the stage of construction of the earth cut of the Queenston-Chippawa power canal in June of this year. This canal, as described in *Engineering News-Record*, Dec. 11-18, 1919, p. 1,0[illegible]0, is to carry 10,000 sec.ft. around Niagara Falls for the development of 300,000 hp. at a powerhouse below the rapids on the Niagara River. It is being built by the Hydro-electric Power Commission of Ontario on force account.

The section shown is in the earth cut at about Sta. 240 and is looking upstream toward the Welland River con-

AIRPLANE VIEW OF QUEENSTON-CHIPPAWA POWER CANAL UNDER CONSTRUCTION

nection out of the view toward the left. In the foreground the full earth section, about 60 ft. deep and 160 ft. wide at the top and 70 ft. wide at the bottom, has been completed and preparations are under way for the rock drills which are approaching from below but have not yet entered the field of view of the camera. A rock cut 48 ft. wide and approximately 60 ft. deep is yet to be made here. Beyond the bridge over the canal is working one of the 8-yd. electric steam shovels—which with their 63-ft. dipper lift are the largest in the world. This is removing the main earth section, which has been stripped by smaller shovels, and is emptying into the spoil train which can be seen running on the parallel tracks.

Rivets on Structural Steel Jobs Heated by Gas

Gas instead of crude oil or coke is being used for heating rivets on some structural steel jobs on the Pacific Coast. The custom has come into vogue following the use of gas for this purpose in shipyards.

Design of the New Canadian Niagara Power Project

Fundamentals Which Controlled the Design and Description of the Installation of the Queenston-Chippawa Hydraulic Development of the Ontario Power Commission

FOR about three years the Hydro-Electric Power Commission of Ontario has had under construction around Niagara Falls a water-power development which will utilize nearly the full drop between the two lakes and require for maximum capacity practically all of the flow now permitted Canada under the international agreement. The present scheme contemplates the development of 500,000 hp. at 305 ft. head, using ten 50,000 hp. turbines, five of which have already been ordered. The scheme, known as the Queenston-Chippawa Development, is by far the biggest power project under way today, but although there have been numerous descriptions of its general features, notably in this journal, there have never been published any of the fundamentals which governed the design nor have the details of the remarkable power house installation been published. At the recent professional meeting of the Engineering Institute of Canada, members of the staff of the power Commission delivered papers which covered hitherto unrevealed details of the work. From these papers the following matter has been gathered. The authors of the papers are H. G. Acres, hydraulic engineer; T. H. Hogg, assistant hydraulic engineer, and M. V. Sauer, hydraulic engineer of design.

The Queenston-Chippawa project takes water from the Niagara River about 1½ miles above the Falls and delivers it through a canalized river and dug canal, a total distance of 13½ miles, to a power house under the bluff on the lower river 5 miles below the Falls. The upper 4½ miles of the channel is in the Welland River, whose flow is reversed for that distance, and the canal section, partly through rock and partly in earth cut, is 8½ miles long. The design and particularly the economics of the canal were described as follows by Mr. Hogg:

The canal is divided into four sections. The first of these is the Welland River section 21,000 ft. in length, with a bottom slope 0.000119 and side slopes of 2 to 1. The earth section which follows the river section is 6,250 ft. long with a bottom slope of 0.0001208 and is to be riprap with finished side slopes of 1.5 to 1. For each of these sections a roughness factor of 0.0035 in Kutter's formula was used. The earth section of the canal was originally designed as a concrete lined section of much smaller cross-sectional area but a study of the economic, constructional and operating conditions indicated the advantages of the larger section with the riprap lining would be sufficient to compensate for the cost of the extra excavation. This portion of the canal has a capacity of over 15,000 sec.ft. with uniform flow at the assumed roughness factor of 0.035, and extreme low water in the Niagara River at Chippawa.

At the end of the earth section is located a transition 300 ft. long in which the trapezoidal cross-section is changed to the rectangular rock section of 48 ft. finished width with concrete sides and bottom. Beyond this are the control works.

The rock section proper is 36,252 ft. long and is divided into two parts by the Whirlpool section, which has a length, including transition, of 2,450 ft. The rock portion of the canal has the water section with concrete-lined sides and bottom with a finished width of 48 ft. The bottom slope is 0.0002113 and the roughness factor used in Kutter's formula 0.014. This value is conservative in view of the proposed method of placing the concrete lining. With the steel forms that are to be used and the special provisions being made for alignment of the forms, a smooth plane surface will be obtained on the concrete facing.

For 13,500 ft. the concrete lining will be carried up 32 ft. above the finished grade of the canal, for the next 11,500 ft. the lining will be 31 ft. high and for the remainder 30 ft. high, except in the Whirlpool section where it is carried up slightly higher. For the greater part of the time the water surface will be above the top of this concrete lining but the friction loss will be reduced by the lower velocities that will then exist in spite of the greater roughness of the unlined rock. Numerous hydraulic studies have been made to determine the surface slopes in the canal for various discharges and for various water levels in the Niagara River. In cases where the water surface was above the top of the concrete lining a composite roughness factor was used in which the proportions of the wetted perimeter on the lining and on the rock surface were taken into account. Roughness factors as high as 0.019 resulted in some of these instances.

Determination of Depth and Slope

The depth and slope of the rock section were fixed by an economy study and the decision to use a concrete lining throughout its length was also reached in the same way. The method of arriving at the economic section of the canal will be explained later.

The rock surface falls far below the grade of the canal in the Whirlpool section. Here it is necessary to carry the canal partly on fill and to use a trapezoidal cross-section on account of the foundation upon which the canal is carried. A concrete lining is essential on account of the high velocities. The bottom width is 10 ft. and the side slopes 1½ to 1. The slope of the bottom is the same as that of the rock section, viz., 0.0002113.

The Whirlpool section of the canal was designed to have the same cross-sectional area at the lowest possible operating water level as that of the rectangular rock section. This minimum water level would be somewhat above the elevation of the curtain wall at the screen house. The area of the cross-section below this elevation is the same for both, and for greater elevations the Whirlpool section has the greater area so that there is no danger of the canal capacity being "choked off" at this point.

In locating the Welland River section the river course was closely followed so as to take advantage of the area of the natural channel. This necessitated leaving in all the bends that occurred in the unimproved stream. As the deflection of these curves is not great they will not produce any appreciable loss.

The first important change in direction occurs at the beginning of the earth section at Montrose and is followed by a second bend at the Michigan Central R.R. crossing at Montrose. In addition to these there are only five changes of direction in the rock section of the canal, the deflections of which are 51 deg. 27 deg., 31 deg., 33 deg. and 46 deg. The radius of curvature in every case is 300 ft. and this radius is used for the inside and outside of the bend as well as for the center line. That is, the curves of the two sides and the center line of the canal are not concentric, resulting in a greater width of canal at the middle of the bend than at either end, the expectation being that the energy losses will be less than in a bend with concentric curves. It is probable that a shorter radius than 300 ft. would give even better results, but this minimum was fixed by the size of the electric shovels that are being used for the excavation of canal.

The question of surges of the water surface in the canal, due to changes of load on the plant, is of great importance. This problem has received an amount of study proportionate to its importance, but on account of the limited space of this paper, it will be sufficient to say that the sides of

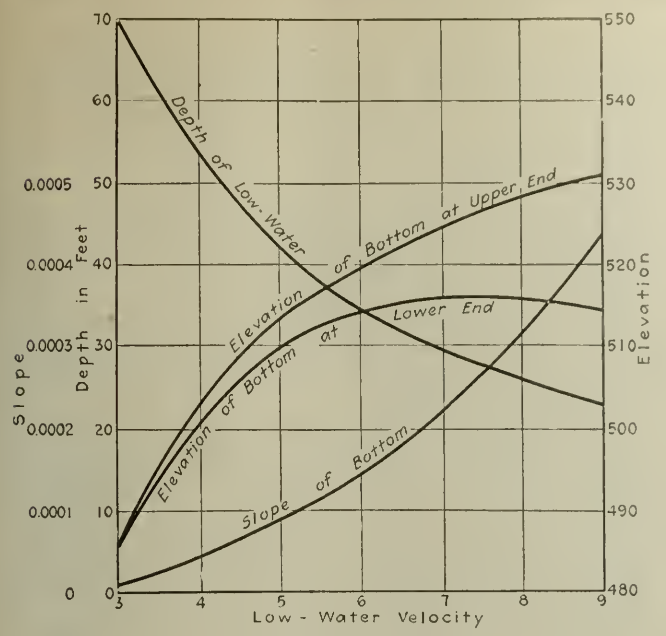


Fig. 1. Variable Functions of Canal.

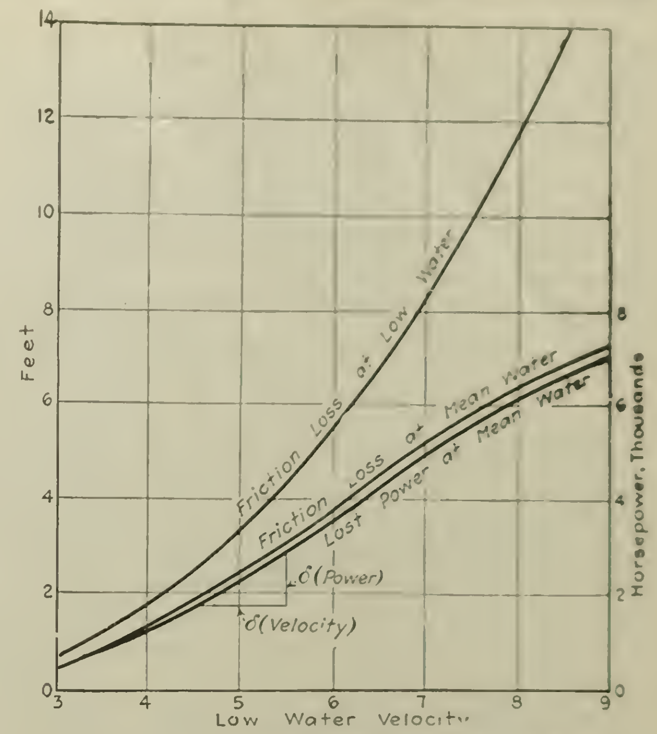


Fig. 2. Friction Loss and Lost Power Due to Friction.

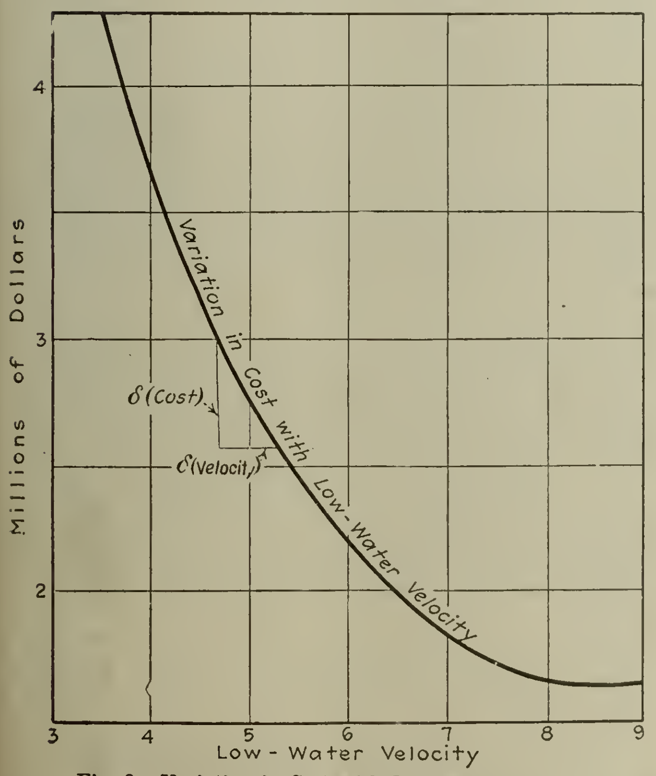


Fig. 3. Variation in Cost with Low Water Velocity.

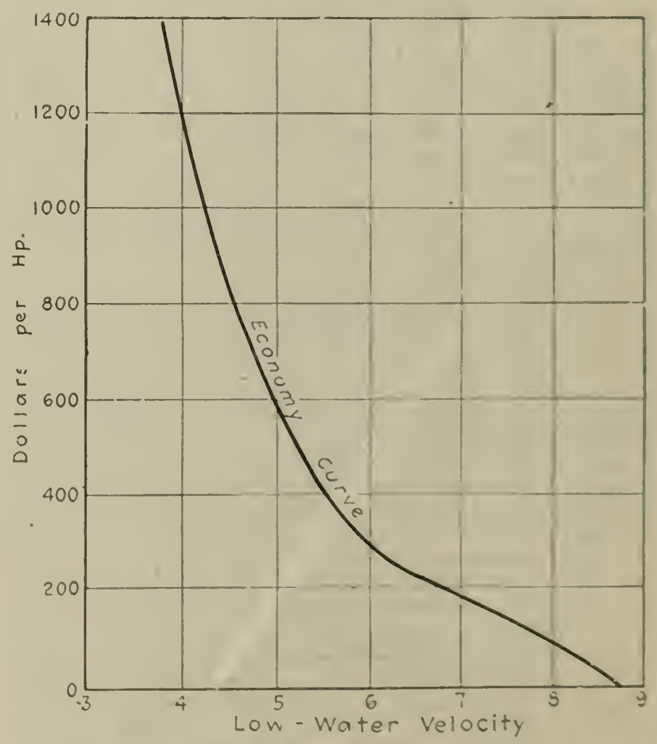


Fig. 4. Economy Curve.

FIGS. 1 TO 4. PROGRESSIVE CURVES IN ECONOMIC STUDY OF A ROCK-SECTION POWER CANAL

the canal and the floor of the screen house will be built to such an elevation that with the worst combination of conditions the water will always be contained within the sides of the canal.

Observations of river stage at Chippawa have been available since 1902 and show a minimum elevation of 558.5, which low stage was reached only on two days. An examination of the past records of Lake Erie stage indicate that as low a stage as 558 may be possible at Chippawa. This latter water level is therefore treated as extreme low water and the canal is designed to carry full load at this stage of the river.

While the low-water conditions control the size and slopes of the canal, on the other hand the mean water conditions were assumed to be those on which the economic proportions should be based.

Certain limitations were met with at the outset. The Welland River section of the canal had to be maintained as a navigable stream, and as the excavation is in earth this portion of the canal was therefore designed for a low non-scouring velocity. The minimum width of the rock section was fixed by the type of electric shovel used for excavating this portion of the canal and was placed at 48 ft.

The problem thus resolved itself into selecting the best proportions for the trapezoidal earth section and the best

depth and slope for the 48-ft. wide rock section. The procedure in the latter case is the one that will be described.

It is, of course, possible to design any number of canals 48 ft. wide, but with depth and slope varying so that all will give the same discharge at low water. For a low velocity the wetted cross-section must be deep but its slope may be moderate. For a high velocity the depth of the wetted cross-section will be small but the slope may be so great that the depth of the cut at the downstream end may be greater and the total cost of excavating greater than for the low velocity design.

The procedure in determining the economic depth was as follows:

First, the design of a number of cross-sections for veloci-

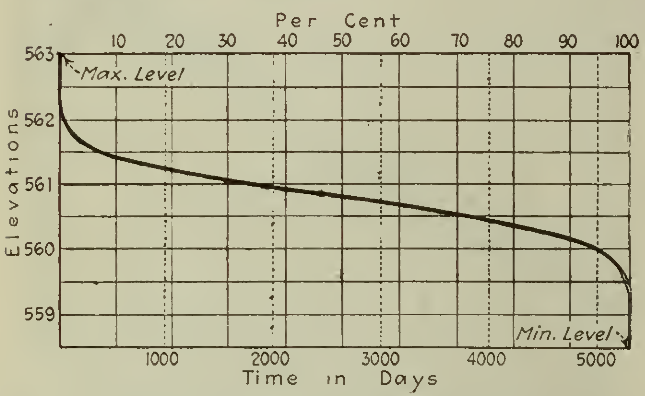


FIG. 5. DURATION CURVE OF WATER LEVELS, CHIPPAWA GAGE, UPPER NIAGARA RIVER, 1902-16

ties of 3, 4, 5, etc., feet per sec., the determination of the requisite slope of the bed in each case to give the full load discharge with uniform flow, and the determination of the variation in cost of these canals with low-water velocity.

Second, the determination of the friction loss in each of these canals with the river stage at its mean value. This friction loss represented so much lost power, which was, of course, small in amount for the lesser low-water velocities, and greater as the low-water velocity increased up to a certain point.

Third, the plotting of the differential curves for items 1 and 2, thus showing the variation in delta cost with low-water velocity and the variation in delta power with low-water velocity. From these two differential curves a third curve can thus be obtained giving the value of delta-cost by delta-power plotted against low-water velocity. Thus there is obtained what will be called an economy curve, showing for any given low-water velocity the rate at which further gains in power may be made at any low-water velocity by enlarging the canal slightly and so cutting down velocity and friction loss

Fourth, the selection of the best low-water velocity from this economy curve. This step will now be explained.

The gain in power which results from a slight enlarge-

designed ... canal comes as a result of the reduction in sectional area but a study ... for power-house equip- operating conditions indicated the adv... which we are working, section with the riprap lining would be ... then to compensate for the cost of the extra excavation ... charges of the canal has a capacity of over 15,00... gained form flow at the assumed roughness ... whole extreme low water in the Niagara ...

At the end of the earth se... ft. long in which the ... to the rectangular ... concrete sides ... works ...

the width of the rock cut being fixed the earth excavation does not vary with the various designs for the rock section and as a matter of fact in computing the cost of rock excavation only that below some assumed horizontal plane at a lower elevation than natural rock surface but above canal grade was considered.

Figs. 1 to 4 illustrate a typical economic canal study. The studies from which these figures are taken were for a canal of smaller capacity and greater roughness than the one being built so that the curves show the method only and do not apply to the present canal.

Fig. 1 shows the results obtained in designing for various low-water velocities. These designs can be made only when a previous study for the earth section has been completed so that the elevation of water surface at the end of the earth section is known.

Fig. 2 shows friction losses and lost power due to friction. The method of obtaining the first derivative of the lost power curve is also indicated. Only the variation in cost, not total cost, is shown in Fig. 3. It is evident that the shape of this curve is the same whether we include the whole cost or only that part which varies with low-water velocity. In either case the first derivative will have the same value. The determination of the form of the economy curve, Fig. 4, is explained above.

The procedure in the economic design of the earth section of the canal was similar to that for the rock section but somewhat more complicated by reason of the fact that certain changes in the design of the earth section involved changes in the excavation throughout the length of the rock section. The differences in procedure were thus largely a matter of properly taking care of all the variations in cost.

Pressure Tunnel vs. Open Canal

Early in the consideration of a new Canadian Niagara scheme the engineers of the Commission had decided in favor of the general location adopted for the Queenston Chippawa project, but there was considerable doubt as to the relative advantages of the pressure tunnel as against the open canal. Why the latter was adopted is well set forth in the following extracts from Mr. Acres' paper:

Having tentatively solved the intake and regulation problems, it remained to determine whether or not it was feasible to construct a suitable waterway between the Chippawa intake and the power-house location above Queenston. An exhaustive series of surveys and core-drill borings established the fact that it would be entirely feasible to connect these two points by either the open canal or the pressure tunnel type of waterway, and the next problem was to determine which of these two types of waterway would be the more suitable from the combined viewpoint of pure hydraulics, structural difficulties and hazards, and comparative cost.

In the matter of comparative cost, carefully compiled estimates indicated that throughout the full range of assumed carrying capacities the open canal had a decided advantage over the pressure tunnel.

Pressure Tunnel Disadvantages.—In the matter of structural difficulties and hazards the following main points were given consideration in the case of the pressure tunnel:

(a) The necessity of driving the headings at an acute angle through the various limestone, shale and sandstone formations, involving the certainty of a heavy overbreak and expensive timbering and lining.

(b) The unfavorable conditions as regards the disposal of excavated material.

(c) The unknown water hazard and the impossibility of predicting the cost of unwatering within reasonable limits of accuracy.

(d) The difficulty and hazard attending the driving of and maintaining a pressure tunnel of unprecedentedly large diameter in the clay formation of the Whirlpool ravine.

(e) The difficulty in connection with the construction of a distributing chamber in the shale and sandstone at Queenston.

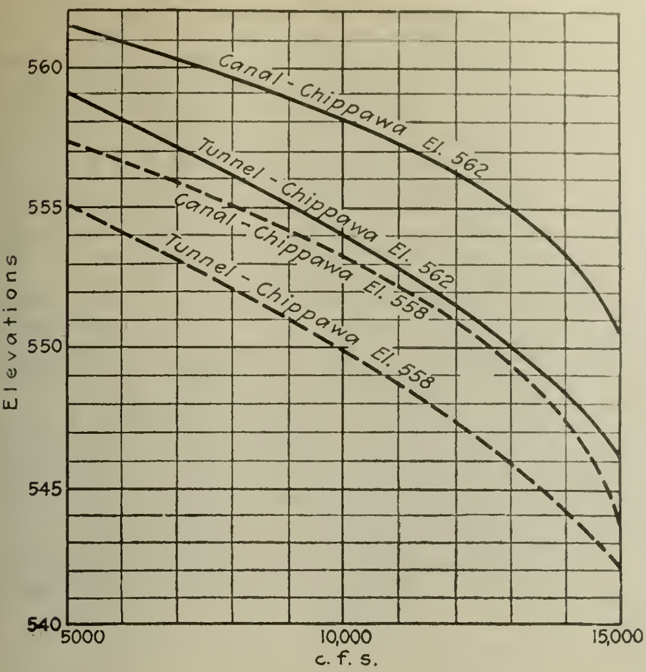


FIG. 6. FOREBAY ELEVATIONS FOR CANAL AND DISTRIBUTION ELEVATIONS FOR TUNNELS FOR VARIOUS DISCHARGES

As against the above, the difficulties and hazards in the case of the open canal were limited to two main points; first, the removal of the earth overburden in the canal prism, and second, the permanent holding of the slopes subsequent to such removal. While it may never be possible to establish finally the comparative importance of the above points on the basis of actual construction, the fact remains that the work already accomplished on the open canal has demonstrated beyond doubt that the overburden can be removed with no more difficulty than was anticipated and that the means originally devised will hold the banks safely within the limits of the predetermined slopes.

Hydraulic Comparison.—In the matter of purely hydraulic comparisons, the first point to consider is that both types of waterway of necessity would have the same point of intake at Chippawa and the same point of discharge at Queenston, so that they are exactly on a par as regards the utilization of available gross head, neither having any primary advantage over the other in this regard.

Since 1902 the water level at Chippawa has been observed and recorded twice daily and Fig. 5 shows the mean daily elevation for the ensuing period compiled in the form of a duration curve. The following facts are deducible from this curve.

(a) The mean level for the entire period is about El. 560.8.

(b) A level of El. 559.5 or higher is obtained for nearly 99 per cent of the entire period.

(c) A level of El. 561 or higher is obtained for a little more than one-third of the above period.

(d) That it is reasonable to assume that the effective operating range of levels lies between El. 559.5 and El. 561.

As to the possibility of the carrying capacity of either type of waterway being seriously affected by a permanent lowering of the natural levels of the Chippawa-Grass Island pool, due to present and future diversions of water therefrom, it is essential to consider two facts: first, that any diversion for power purposes from the pool itself will be largely compensated for by the intercepting effect of the diversion works, and second, that the level of the pool can be controlled independently to compensate for any diversion whatever, whether from the pool itself, from the upper reaches of the river, or from Lake Erie direct.

In Fig. 6 an effort has been made to show in graphic form a comparison of the head losses chargeable to each type of waterway under discussion. In making this comparison, a possible extreme low elevation of 558 has been assumed for head-water, and the open canal losses calculated on this basis for a carrying capacity of 15,000 sec.-ft. On the basis of this loss a tunnel was designed of the requisite diameter for the same capacity of 15,000 sec.-ft.

These curves have been computed for the extreme range of possible operating levels, El. 558 minimum and 561 maximum. The shape of these two pairs of curves illustrates clearly the basic difference between the two types of waterway. Under the assumed conditions the tunnel and canal curves for the head-water elevation 558 and 15,000 discharge drops off, however, it is seen that the canal delivers any fixed discharge to the forebay at a consistently higher elevation than in the case of the tunnel. This is simply due to the inherent characteristics of the two types of waterway. In the case of the pressure tunnel the discharge area is necessarily constant and any gain in head is due to decreased friction only. In the case of the canal the reduction in velocity not only reduces the friction losses, but the retardation of flow increases the effective discharge area of the canal section. By reason of this extra factor the open canal has an advantage over the tunnel ranging as high as 5 ft. of head loss. When the high discharges

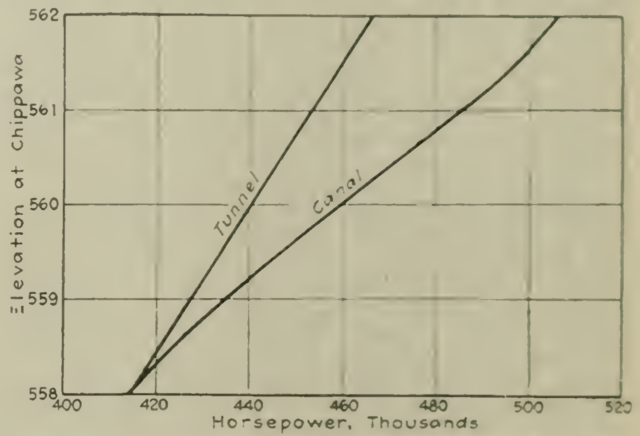


FIG. 7. HORSEPOWER CAPACITY AT CHIPPAWA FOR CANAL AND TUNNEL OF EQUAL LOW-WATER CAPACITY

involved in the problem are considered, it is evident that this difference in head loss is a very important factor.

The curves shown on Fig. 7 have been plotted on a different basis, but with the same factors involved. In Fig. 6 head-water level and carrying capacity have been assumed constant and forebay level the variable. In Fig. 7 head-water and forebay level are the constants and carrying capacity expressed in horsepower is the variable. In this latter curve forebay level is assumed constant at the fixed minimum elevation for peak load capacity and from this common point the comparative carrying capacities of the two types of waterway have been calculated for specified levels of head-water in the Chippawa-Grass Island Pool.

Here again the two curves have a common point of origin at the point of extreme minimum capacity, but from this point on the canal characteristically pulls away as the head-water level rises, until at the maximum operating level of El. 561 the canal has an advantage over the tunnel of 30,000 hp. in carrying capacity. This gain is due to the fact that the tunnel can only realize the gain of a trifling increase in gross head, and a resultant trifling increase in pressure gradient, as the level of head-water rises, whereas the canal gains a material increase in natural gradient and effective discharge section. This increase in carrying capacity is therefore gained by the canal without any reduction of operating head at the forebay, whereas the tunnel can gain the extra capacity only at the expense of a reduced operating head.

The conclusions which may justifiably be drawn from the above discussion are: first, that starting from the common basis of equal loss and carrying capacity at extreme

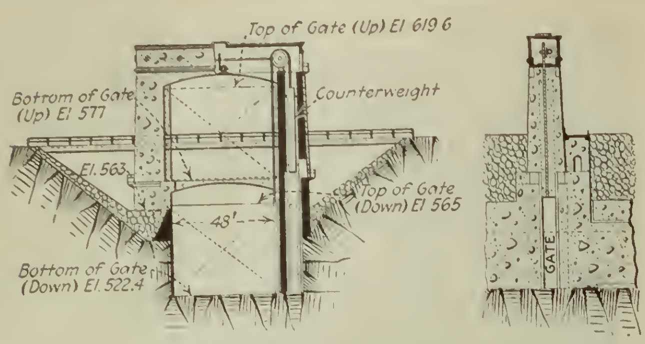


FIG. 8. CANAL CONTROL GATE FOR QUEENSTON-CHIPPAWA POWER CANAL

minimum head-water level, the open canal will deliver the required quantity of water to the forebay with a materially less loss of head than the pressure tunnel, for any head-water level above the assumed absolute minimum; second, that starting from the common basis of a fixed minimum forebay level, the canal will deliver a constantly increasing quantity of power in proportion as the level of head-water rises above the assumed extreme minimum level, which the pressure tunnel cannot do to any appreciable extent by reason of its inherent hydraulic characteristics; and finally, that the open canal is the only agency, under the above conditions, which can make automatically available the large quantities of excess power resulting from any temporary or permanent increase in the level of the Chippawa-Grass Island Pool, above the extreme minimum level which has been used as a basis of comparison.

Another distinct advantage of the open canal is the fact that it can effectively and inexpensively take advantage of any water which might now or in the future be available from the Welland Canal system. This open waterway would furthermore furnish the only means, in connection with the upper reaches of the Welland River, of reclaiming the unused 9-ft. of head in the Niagara River above Chippawa. This would involve a very heavy expenditure, but the value of power will not always be judged by present standards and the time may well come when this extra power may be considered worth reclaiming at a capital cost per horsepower ten times greater than is considered justifiable at the present time. These are more or less remote contingencies, but the fact remains that the choice of the open type of waterway, and the layout of the rest of the scheme will enable effective advantage to be taken of these conditions whenever the public need may become sufficiently acute. When this happens the extreme limit of conservation will have been realized in the matter of utilizing the gross difference in level between Lake Erie and Lake Ontario, and the anticipatory provision made in the present design will have justified itself.

Hydraulic Installation

The hydraulic installation of the new project is of extraordinary interest, not only on account of its record size but also because of specific details. The important features which diverge from practice are the huge single-leaf control gates near the beginning of the canal, the 50,000 hp. turbines which are the largest ever built, the record size Larner-Johnson valves, the location of the power-house floor at the top level of the generators so as to provide space beneath for ventilation and the special details of ice-skimmers and track racks. These points were described as follows by Mr. Sauer:

A single motor-operated vertical lift roller gate for the purpose of controlling or entirely shutting off the flow will be installed at the upper end of the canal near Montrose where the earth section of the canal merges into the rock section. The combination of span and head make this gate the largest ever built and particular attention is being paid to the roller design in order to secure bearing loads well within safe, structural and operating limits. The clear width is 48 ft. and the height of the gate is 42½ ft.

It is of course essential that the canal shall deliver sufficient water to the power plant under the most adverse conditions of water level in the Niagara River. The canal is therefore designed to deliver a quantity of water equal to its rated capacity when the river is at its lowest stage.

The general arrangement of the control gate is shown in Fig. 8. It will be noted that the lift is extended to a point 14 ft. above the water level and this has been done in order to permit a patrol tug to pass freely up and down the canal when the gate is in normal position, i.e., wide open.

The gate will be counterweighted and operated by a motor connected through a worm drive to the two main hoisting gears, and the motor will be provided with distant as well as local control so that the gate can be operated from the power house if required.

The gate itself will be made up with horizontal trusses spanning the opening and vertical beams to which the skin plate will be riveted. It is not important that the gate be absolutely watertight when closed although "stanching" bars will be provided to insert between the skin plate and the end guides which will make it practically tight.

A comparative analysis of costs and operating conditions was made on the single gate as against two gates with an

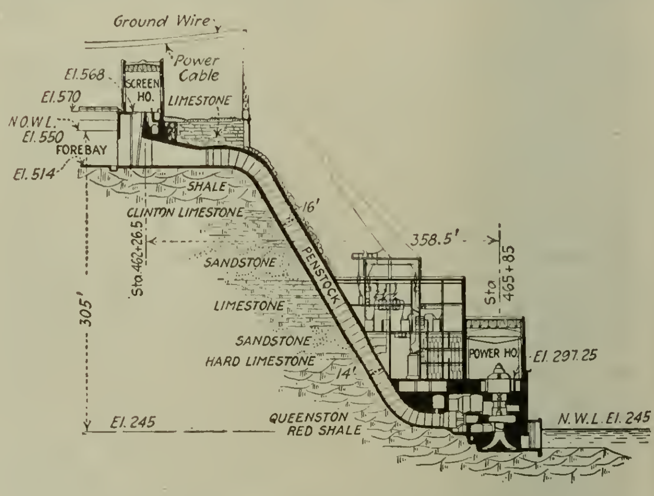


FIG. 9. CROSS-SECTION THROUGH 500,000 HP. POWER HOUSE AT QUEENSTON ON NIAGARA FALLS

intermediate pier, and it was found that the cost of a single gate and superstructure did not exceed the cost of the twin gates, on account of the additional construction required by the intermediate pier and the necessary widening of the canal to keep down the velocity to normal. When the added advantage of having a clear unobstructed waterway was taken into account as well as the simplified operation of a single gate in place of two, the decision was entirely favorable to the single large gate.

It is expected that the intake as designed will take in water from the Niagara River, absolutely free from floating ice, but to take care of any ice that may form on the surface of the canal or the Chippawa River channel a small ice chute is being provided at the lower end of the forebay. It consists simply of an opening through the screen house provided with a drop gate which can be lowered below the water surface for a depth of 12 ft. The discharge over the gate is carried through the screen house and down the cliff under the power house to the lower river in a reinforced concrete pipe 10 ft. in diameter.

An elaborate design of ice skimmer has been made up which if found necessary can be installed later on. This consists, in general, of a reinforced-concrete horizontal pivoted leaf which can be raised or lowered in accordance with the water stage so that floating ice will be skimmed off the surface to a discharge channel, at the same time allowing the clear water to pass underneath. Provision is now being made in the outer wall of the curve in the

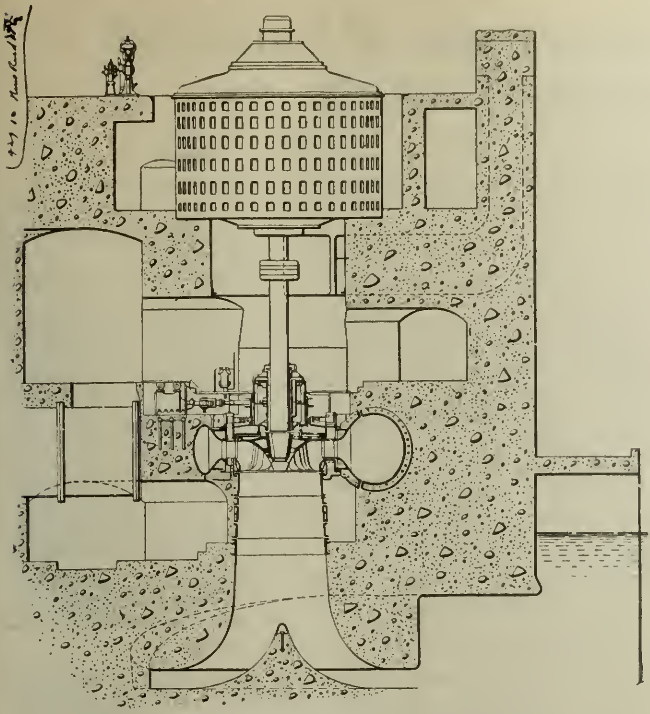


FIG. 10. SECTION THROUGH ONE OF THE 50,000 HP. WHEELS

canal immediately above the forebay so that this skimmer can be installed in the future if it is found that sufficient capacity is not provided in the smaller ice chute through the screen house.

The only features of the screens worthy of comment are the wide bar spacing of 4½ in. in the clear and the layout of the bars and frames which are so designed that the whole frame with the bars attached is removable thus leaving a completely unobstructed passage when they are removed. There are three bays of screens for each penstock and two frames in each bay. The tops of the screens are eight feet below the normal surface of the water and the maximum velocity of water through the screens is 2.25 ft. per sec. With these provisions it is not anticipated that another anchor ice will cause much trouble.

Penstocks

In view of the fact that a Johnson valve is to be installed at the lower end of each penstock adjacent to the turbine it has been decided to omit permanent gates in the screenhouse at the penstock entrance. To take care of any failure in the valves, removable structural gates made up in sections will be provided which can be lowered into any penstock entrance by means of an electric traveling crane in the screenhouse.

The quantity of water used by each turbine at full load and under normal head is approximately 1,800 sec.ft. and in the design of the penstocks, the diameter was fixed by plotting up various curves showing the value of lost power due to varying velocities and their consequent friction losses as against the carrying charges on the corresponding penstocks. By this means a diameter of approximately 15 ft. was found to give the best value, but so great a diameter at the lower end required a plate thickness of over 1½ in. and this was considered beyond the limit for safe field riveting. On this account the diameter of the upper two-thirds of the pipes was made 16 ft. and the bottom third 14 ft. which made the construction work feasible and at the same time gave the desired economical results. The total loss through the screens, penstocks and valves is 1.25 ft. using a value of C-110 in the Hazen & Williams formula. The loss is considerably reduced by the use of butt girth joints with an outside cover plate as against the customary practice of using inside and outside courses.

Five turbines are at present under contract, which is one-half the ultimate installation. They are each of 50,000 hp. rated capacity of the vertical, spiral case, single runner Francis type and will operate at a speed of 187½ r.p.m. This gives a specific speed of 36. The maximum guaranteed efficiency is 90 per cent, although in view of recent practice it is expected that this efficiency will be exceeded. On model runners of homologous design tested at Holyoke 91 per cent was obtained. The inlet diameter of the scroll case is 10 ft. and the diameter of the runner is 10 ft. 5 in. at the inlet. Fig. 10 shows the turbine setting and it will be noted that an open space has been left in the powerhouse foundations below the runner so that by removing a section of the draft tube the runner can be taken out from below, thus obviating the necessity of dismantling the generator when a renewal of the runner is necessitated. The runner is designed for a capacity of 61,000 hp. and is "gated back" to a maximum capacity of 55,000 hp. The reason for this is that the turbines, which will normally operate at or near full rated load, will also therefore operate at their maximum efficiency. Special taps have been provided in the crown plate and from the annular spaces around the discharge side of the runner to which gages can be attached and a record kept of the varying pressures at these several points. This will furnish an indication of the wearing away of the runner seal and show when renewals of seal rings are necessary. Connections from these chambers to the scroll case and draft tube will allow readjustment of the downward thrust when required.

The runners and spiral casings are cast steel and a test pressure of 260 lb. per square inch is required in the latter.

The centrifugal head, relay valves, and hand control for each governor will be located on the generator floor while the main automatic valve control will be located directly under the governor stand at the level of the turbine regulating cylinders. The advantages of this arrangement are the short piping between the main valve and the regulating cylinders and the separation of the two main parts of the governors, giving freer access for repairs and maintenance. The pressure fluid will be water, probably treated with bichromate of potassium, which will prevent rusting of the wearing parts and at the same time give a lubricating value to the water. A central pumping system will be used, with duplicate motor-driven multistage centrifugal pumps, either one of which will have sufficient capacity for all the governors. The pressure fluid will be piped to all the governors through accumulator tanks, one located near each governor so as to eliminate any inertia effects through the piping system. The pump motors are automatically controlled by relay switches which are controlled by pressure variation in the system. As a further safeguard for preserving continuous operation in the event of failure of the pumps or motors penstock pressure can be turned into the governor system. When the plant is finally extended to its full capacity a complete duplicate pumping system, similar to the one above described will be installed and interconnected with the present system.

Control Pedestals

A control pedestal will be set up adjacent to each generator, and on this will be mounted the various indicating instruments, and control room, together with the local control and indication, will be located in such a way that the floor operator can handle the machine while in touch with the chief operator.

A telegraph communication, similar to a ship telegraph and a loud talking telephone, both communicating with the control room will form the principal means of communication. In addition to this a signal lamp mounted at the top of the column over the control pedestal will enable the chief operator to call the floor operator to the unit as required. The air brake and Johnson valve control will also be mounted on this pedestal. The location of this pedestal adjacent to the governor places the control of all the pertinent features of the unit within easy reach of the operator, while at the same time he will be in communication with the control room. The various indicating instruments will at the same time be under his observation.

The Administration and Supervision of Industrial Housing Construction Projects

Condensation of a Chapter from a Book on "Industrial Housing" by Morris Knowles, Consulting Engineer, Pittsburgh, Pa., Just Published by the McGraw-Hill Book Co., New York

IN the development of an industrial housing project the effective organization and wise direction of a competent and experienced personnel is a prime requisite to success, if the result is to be judged on the basis of economy, attractiveness, saleability and good living conditions. To a large extent satisfactory results will depend, first, upon the selection of fully competent and experienced services, and second, upon the laying down of carefully considered and co-ordinated organization, planning and construction policies. The expert services of the engineer, the town planner, the architect, the realtor and the construction man are all required. And the several problems falling within the province of each are to be solved, so that the solutions may be not only technically correct, but also economically sound, and so that the way each thing is done may bear the proper relation to the scheme as a whole.

Group Management—The building of a housing project can neither be considered as wholly an architectural nor an engineering problem, but rather as a merging of opinions and talents of each profession into a consistent conception. As there are a multitude of elements which enter into the final plan, the factors of control and co-ordination become most important, and it is therefore necessary to work out a practical form of organization and to formulate the policies of procedure in accordance with which the work shall proceed.

Executive Control—A close contact between the owner and the organization provided to manage and supervise the development is essential. This can best be accomplished by the designation of an official by the owner upon whom the necessary authority is conferred, to fix policies, to make decisions, to execute contracts, to expend funds and to exercise similar important functions. The direction of the work and the immediate control of the housing organization should be centralized in an executive who possesses the necessary qualifications of leadership and who has had the necessary experience in directing the planning and construction of large projects. Special training in directing the design and in technical details will be most helpful, providing the man also has business experience and executive ability.

Method of Procedure—The controlling features, requirements and policies should be laid down at the outset and a program of procedure in preliminary form should then be adopted. The earlier the method of procedure is decided upon, the less likelihood there will be of incurring delays and costly mistakes. The object of working out a well considered plan of procedure is to assume the orderly and economic prosecution of the work at various stages, and to avoid loss of effort, duplication and conflict in authority. Such a plan may be considered as analogous to a routing plan in a manufacturing process; beginning with the making of the designs and working drawings, then passing from department to department and from shop to shop, all in accordance with a carefully prearranged scheme, the finished article finally emerging a completed product, conforming in all respects to the requirements.

Elements of Program—The ordinary procedure, after first having ascertained the general need of housing, is about as follows:

A. Determination of housing requirements, as to the number, general type and allowable cost of houses; the method of disposition, as to whether the house will be rented or sold, or held by a co-partnership company, or by a combination of methods; determination of the approximate amount that can be expended upon the development of the site and in providing street improvements and utilities.

B. Investigation of available sites, suitable for the number and type of houses determined upon as result of the previous study; this involves consideration of the relative advantages and costs of development of alternative sites; requiring comparisons between cost of land, of preparation of the sites, and of building and complete development.

C. Acquisition of site, including examination of title, property survey, preparation of map, and purchase.

D. Topographical surveys and detail map; preliminary study of the town plan and of lot subdivision; studies of types of houses, including development of preliminary sketches, floor plans and elevations and schedules of estimated cost, based upon local data; development of preliminary plans for lot grading, street improvements and utilities, to a sufficient extent to determine the general character and approximate cost; preparation of preliminary budget, based upon the information and data developed in the foregoing studies.

E. Review, criticism and revision of the preliminary plans and estimates, leading up to the adoption and approval of definite general plans; estimates of the cost of the several parts of the work and the preparation of a definite budget of cost.

F. Preparation of detailed construction and working drawings, together with construction specifications; filing and recording plans with proper authorities; arrangements with public utility companies.

G. Award of contracts; including invitation to bidders, receiving and comparison of bids, award, and execution of contracts.

H. Construction program, record of progress, accounting and supervision and inspection of work.

I. Preparation of record plans and drawings.

Necessity for Budget—The preparation of a budget is necessary both as a guide and criterion to follow, in working out the plans and designs for the development, and also as a means of financial control of construction.

Analysis of the budget from time to time will indicate the advisability of increasing the allotments for some and decreasing those for other portions of the work. The necessary degree of flexibility must be provided in the budget, to take care of variations in the labor and materials market and in business conditions. This is provided for by allowing a contingent reserve of from 10 to 15 per cent.

Suggested Budget—The following is a suggested form of budget for general use in the development of an isolated housing project. Certain items, such as the installation of water, gas or electric service, if supplied by and at the cost of a public utility company, would not be included, except to the extent that the builders or owners might pay in annual service charges:

1. *Cost of Land*—Including legal services, recording, property survey and purchase cost.
2. *General Site Improvements*—Clearing, grading, etc.
3. *Houses*—Listed by number and type.
4. *Building Other Than Houses*—Including stores, community and public buildings, schools, churches, etc.
5. *Lot Improvements*—Grading, seeding, sodding and planting; fences, housewalks.
6. *Street Improvements*—Grading; curbs and gutters; pavements; sidewalks; seedings, sodding and planting in planting strips and other open spaces on streets; catch basins and inlets, including connections.
7. *Parks and Playgrounds*—Boulevards and parkways, including grading, construction and adornment.
8. *Water Supply and Distribution*—Supply, including pumping stations, reservoirs, supply mains, filter plants, etc.; distribution system. 8*a*. *House Services*—House to curb and curb to main, may be separated in jurisdiction and chargeability.
9. *Sewerage and Sewage Disposal*—Collection system; outfalls; sewage disposal plant. 9*a*. *House Connections*—(Excluding any portion included in house contract.)
10. *Storm Water Drainage System*—Collection system, main drains, etc. 10*a*. *House Connections*—(Excluding any portion included in house contract.)
11. *Central Heating Plant*—Supply, distribution and house connections.
12. *Refuse Disposal*—Incinerators or other disposal equipment.
13. *Gas Supply and Distribution*—Supply, distribution system and house connections.
14. *Electric Supply and Distribution*—Supply, distribution system and house connections.
15. *Street Lighting*—Supply, circuits, poles, lamps, etc.
16. *General Overhead*—Including professional services, engineering, architectural and town planning; administrative, financial management and general expenses during organization and construction; contractors' profit and all charges which cannot be charged to any of the foregoing items, and for which a separate charge is not set up.

Where the work is done directly by the owner, or under some of the forms of cost plus contracts, it may be desirable to set up separate charges for such items as railroad siding and yards, temporary storage yards, and other general items of construction; otherwise, where not so charged,

these costs are distributed among the various items of the budget.

Construction Policies—An early decision should be reached as to the policy to be followed in carrying on construction, in order that the plans and specifications may be drawn in conformity therewith. In making this decision, a choice must first be made between having the owner do the work directly, or by force account, utilizing his own construction organization, purchasing materials, hiring labor and buying or renting plant; and having the work done by an independent organization under some form of construction contract.

Force Account—Construction by force account may be carried on where the owner maintains a permanent construction department with competent personnel, or where an engineering organization, which has demonstrated its capacity for handling work in this manner, is employed. In such cases the owner assumes all of the risks and performs all of the functions which would be divided between himself and a contractor on a contract job. His organization will therefore have to be practically as large as the combined organizations of owner and contractor, and under ordinary circumstances no advantage can be obtained by handling the work in this manner, sufficient to offset the superior organization, experience and plant of a reliable and experienced contractor.

On force account work, no contract need be drawn and general specifications need not be so formal, but if satisfactory work is to be assumed the plans and technical specifications should be fully as complete as on contract work, in order to guide and instruct those in immediate charge of the various portions of the job. In other respects, the discussion of construction problems below will apply to force account work, with due allowance for the identity of owner and contractor.

Contract—If the work is to be done by contract, various forms of contract are to be considered, each having particular advantages. The essential differences between them are in the method of payment and in the degree of risk and financial responsibility assumed by the contractor.

Assuming that the contractor is fully competent, and experienced and that he has adequate plant, capital and organization, and is in every respect dependable and reliable, there is, under present-day conditions, a general feeling that the cost-plus form of contract, or some of its modifications, will give better results and be more equitable to both parties than the lump sum or unit price contract. In this form of contract, the owner pays the actual cost of the work, plus a reasonable profit to the contractor for his services.

The cost-plus form of contract is more difficult to administer and supervise than others, and the success of the undertaking will, to a certain extent, be dependent upon the degree of confidence existing between the parties. While the contract, in general, provides that any losses or costs, due to the negligence, incompetence or carelessness of the contractor, shall be charged to and be borne by him, it is difficult to clearly establish responsibility when controversies arise, and it is therefore extremely important that discretion and judgment be exercised in selecting the contractor.

Supervision of Construction—The extent of the organization to supervise construction will depend upon the extent of the work and the form of contract under which it is to be executed. In any event, the force must be organized to give general supervision, to inspect the materials and workmanship, to give the necessary lines and grades for the construction, to keep records of progress and for certification of payments. Where the work is done on a cost-plus basis, there must further be provision for financial control, for time-keeping and checking of labor, materials and bills, and, if the materials are to be purchased by the owner, a purchasing department must be included.

It will be necessary that the owner have sufficient control over the work to insure that the contract is carried out in accordance with its terms and that his interests are fully protected. To this end it is necessary and advisable to supervise the construction with the same degree of care as that followed in the preparation of the plans and designs. A construction superintendent or manager should be placed in immediate charge of the work, and should report directly to the executive officer in general charge.

Construction Program—A program of the order in which construction is to be carried out should be devised at the inception of the work. This will provide for the work and sequence of the various operations, enable materials to be ordered and distributed without delay and confusion, and prevent the interference of one part of the work with other parts.

If construction economy and demand for early completion of the houses were left out of consideration, the most desirable plan would be to first execute the general grading of the site and complete the street improvments and utilities and thereafter build the houses, but it is ordinarily not feasible to follow this plan, as it will generaly require two working seasons. It will therefore usually be necessary to make reasonable provision for temporary construction roads and to proceed with the construction of houses, after the rough grading has been done, in one part of the tract, while street improvements and utilities are carried along in another part. By suitably dividing the work up into several sections, a continuous use of various sized gangs of labor and skilled workmen may be worked out, which will not only produce more satisfactory labor conditions, but will expedite and reduce the cost of the work.

Yards and Delivery of Materials—The expense of handling materials, in unloading, hauling, storing and delivering is a very appreciable item in the cost of construction. When the size of the work warrants, it will be advisable to extend a siding to and into the tract, provided the cost is not excessive compared with that of unloading and trucking from an existing siding. This siding should be extended in such manner as to enable a storage and unloading yard to be developed in a location which will be convenient for the delivery of material by trucks to the various parts of the tract.

Sanitation—Unless the project is a small one, and particularly when the site is remote from built up districts, the construction of contractors' camps will be required. The sanitation of the contractor's camp surroundings and food supply cannot be neglected without running a grave risk of having infectious diseases break out and spread. This will not only delay the work but may create a prejudice which will react against the success of the project.

Temporary Fire Protection—Fire protection becomes a very important feature in the construction of a large number of houses in isolated districts beyond the service of established fire departments. It will frequently be necessary in such cases to provide temporary means of fire protection until the installation of the water-supply distribution system has been completed and permanent fire fighting equipment has been provided and its personnel organized. Such temporary fire protection measures will include the designation of one of the construction men as fire chief, with a sufficient force of men readily available from the construction forces. Fire signals for giving the alarm must be provided and occasional drills held in order to familiarize the men with the facilities and equipment and methods to be followed. The equipment should consist of an ample number of barrels of water, with buckets suitably marked at each building, and a supply of chemical fire extinguishers located at specified points. An important provision in the fire regulations should pertain to the location and isolation of buildings containing inflammable or combustible materials.

Temporary Water Supply—The permanent water-supply distribution system should be planned and constructed, so as to minimize as much as possible the extent and cost of temporary water supplies for construction and fire protection purposes. Pending the installation of the permanent lines, it will be necessary to lay temporary water lines, which will usually consist of 2-in. screw joint pipe, laid directly on the surface of the ground with suitable covering at road crossings. Proper consideration must be given to the source of supply, and provision made for the constant

supervision and protection of its sanitary quality, if necessary, by the use of disinfection or filtration.

Construction Roads—The extent to which construction roads must be built will depend upon the size of the project and the character of the soil. Where possible, temporary construction roads should not be built until the streets have been rough-graded, and consideration should be given to whether economies may not be realized by utilizing the graded permanent streets and alleys for the location of construction roads.

The extensive use of modern heavy trucks has made the requirements of temporary construction roads more severe than was the case a few years ago; the trucks are operated at a much higher cost per hour than in the case of horse-drawn wagons. It is therefore possible and necessary to provide a road surface of sufficient wearing and bearing qualities to permit the efficient operation of such heavy vehicles. Cinders, local gravel or broken stone can be used for surfacing; heavy planks or corduroy are frequently suitable for such temporary roads.

Progress and Cost Reports—A' important function of the construction organization is to compile information for and prepare reports as to the progress and cost of the work. A progress chart, covering the details as to the time of starting and completion of each part of the work, is of great value in the management of construction. Unavoidable delays and conditions will undoubtedly cause modifications in the original program and its enforcement can be accomplished only by periodic reports as to the progress actually made on each part of the work. In this way, delays affecting any part of the work, with the possibilities of interference and confusion, will be detected, and steps may be taken for the rectification of conditions.

Cost accounting and cost reports will constitute one of the most difficult items of administration of construction. The cost accounting will require the formulation of a simple but effective method of obtaining the cost of labor and materials and their distribution among the various items of work. The accounting work should be placed in direct charge of an official whose experience and qualifications include both those of construction accounting and the practical direction of construction work. The ordinary accounting methods are entirely unsuitable for the purpose in hand. Where the work is being done under a cost-plus form of contract, it is abosolutely necessary that those in executive charge of the work have at hand at all times the actual cost of each part of the work, for the reason that there is no other method of determining whether or not the work is being carried out at a reasonable cost. In this manner, instances of leakage, waste, incompetence or improper methods of construction may be detected and corrected.

Record Plans and Reports—Record plans should be prepared of the development as acutally constructed. These will include the plans relating to final street locations, property lines and easements which will be necessary, for recording and describing properties and easements, and in dedicating or deeding streets or highways to the municipality. These record maps should show, in plan and profile, the definite location of the street lines, and the location of monuments and necessary information and should further show definitely established grade lines. A record map should further be prepared showing the property subdivision, block and lot records and house locations. Record plans of the street improvements, utility systems and house services and connections should be prepared which will show location, character and size, in sufficient detail so that the necessary information will be available when required.

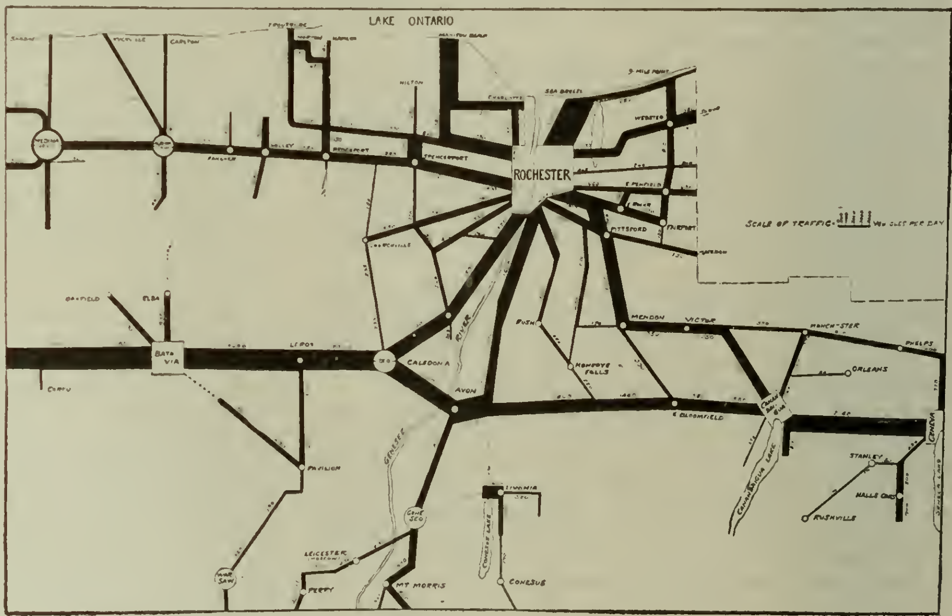
Line Widths in Photographic Chart Are Measure of Traffic Density

By Charles M. Edwards

Division Engineer, New York State Highway Commission

THE accompanying photograph is a reproduction of a chart showing graphically the traffic conditions in Division 7 of the New York State Highway Commission. The figures are based on traffic censuses taken by employees of the commission on a Saturday and Sunday in August, between the hours of 7 a.m. and 7 p.m., the results being tabulated as daily traffic.

Censuses included vehicles of every kind. The dotted lines show connecting, unimproved roads, which the traffic uses to get to the state highways. This chart will be useful in determining the types that should be used for future resurfacing and reconstruction, and also, as the state highways are extended, the changes in the amount and direction of traffic from year to year. No figures were taken in cities as the state maintains no highways within them. The main thoroughfare from Rochester to Charlotte being within the city limits will account for an apparent discrepancy in that section.



TRAFFIC DENSITIES GRAPHICALLY SHOWN BY PHOTOGRAPH

It may also be noted that a peculiar condition exists in the southeast section, where a large amount of traffic is diverted over a town improved highway, which is not shown, as the figures were taken only on highways maintained by the state. The same is also true of the conditions at the north end of Conesus Lake, where a large summer colony of Rochester and Geneseo people use the unimproved road on the west side of the lake.

Wire Cage Saves Wages of Watchman

To save the expense of a watchman for a pipe trenching machine at Springfield, Mass., the water department had a wire cage made to enclose the machine when out of use on the street. The cage cost about $400.

Report on Water-Supply Needs of Philadelphia

Consulting Engineers Advise Ultimate Abandonment of Present River Sources Preceded by Improvements and Metering

THE ultimate abandonment of the Schuylkill and Delaware rivers as sources of water supply for Philadelphia, except that the Delaware above Trenton would eventually be drawn upon as a supplementary supply, has been recommended by a Board of Consulting Engineers appointed by the mayor in July to report on extensions and improvements the water-works needed immediately, together with a plan to meet the needs of the city for the next fifty years. Taking into account the general financial condition of the city and its need for other improvements, the board recommends that the construction program for the next five or six years be limited to an outlay of $35,000,000, of which $27,000,000 would be spent for improvements and extensions to the existing works, including the distribution system, and $8,000,000 for the first steps toward the abandonment of the present sources of supply.

The new sources of supply recommended are storage reservoirs on Perkiomen, Tohickon, and Neshaminy creeks, the first two being tributaries of the Schuylkill River and the third a tributary of the Delaware River, but only the Perkiomen would be developed in the near future, while at the same time facilities for supplying water from the Schuylkill and Delaware pumping and filtration plants would be increased. The new sources would provide "semi-gravity" supplies. The program calls for the extension of the meter system "as rapidly as possible." The Board of Consulting Engineers consists of the following: J. W. Ledoux, Philadelphia, chairman; George W. Fuller, New York City; Joseph F. Hasskarl, Philadelphia; J. Waldo Smith, New York City. The report is dated Sept. 15. In general, it agrees with the opinions of C. E. Davis, chief of the Water Bureau of Philadelphia, as stated in a letter of information submitted by him to Mayor Moore on July 9, for the information of the board.

Defects in Existing System—Quality of Water

Before detailing its ideas on changes in the present water-works system the board outlined "some of the more important defects" in the existing system. The "city is seriously menaced," the report states, "by many weak points in the existing water-works where ordinary slight accidents" cause low pressures in important sections of the city, thus increasing the ordinary fire hazard. Reserve equipment is insufficient. The water-supply facilities are too largely concentrated "in a single chain" without relief connections. At the Torresdale pumping station (the pumping plant on the Delaware, supplying the Torresdale filters) there is a single inlet pipe to the station and a single outlet to the preliminary filters. There should be a new low-lift pumping plant here, with its own intake and outlet connections. At other stations the pumping capacity and intake or discharge connections are inadequate. The present "defective and leaky dam at Fairmount," on the Schuylkill, "should be replaced by a modern masonry structure as early as possible." Unless this is done, "ice gorges or floods may injure the present structure and render two pumping stations useless."

On the quality of the present water supply the report says:

The unfiltered water as drawn from the Delaware and Schuylkill rivers is now, and for many years has been, seriously polluted. The substantial pollution throws a serious burden upon the filter plants and this has been recognized by installing arrangements for preparing the water for filtration, such as sedimentation in large basins, preliminary filtration, or both; also by the use of sterilizing methods applied to the water after filtration and before its delivery to the consumers.

In general water purification practice the custom has recently been established of investigating filtration projects by ascertaining the load factor under which the filters operate and the quality of the finished supply as measured by the standards prescribed by the U. S. Public Health Service for waters to be used by the carriers in interstate traffic. The International Joint Commission having jurisdiction over the pollution of boundary waters between this country and Canada, has proposed as a limiting load factor on filters an average annual content per 100 c.c. of applied water of 500 B. Coli (intestinal group of bacteria). The U. S. Public Health Service limits the B. Coli content in drinking waters to 2 per 100 c.c. Each of these standards is thought by some to be needlessly rigid but no steps have been taken actively to modify them.

TABLE 1. AVERAGE ANNUAL CONTENT PER 100 CUBIC CENTIMETERS OF B. COLI (INTESTINAL BACTERIA GROUP)

	River Water		Applied to Final Filters	Final Effluent from Filters			Roxborough	
Year	Schuylkill	Delaware	Torresdale	Torresdale	Queen Lane	Belmont	Lower	Upper
1920*	980	730	300	1.1	5.0	4.6	4.6	4.7
1919	940	590	370	0.6	3.4	2.4	2.6	2.5
1918	880	670	340	0.7	1.8	2.6	2.0	1.4
1917	670	810	190	1.1	0.5	0.4	0.1	0.1
1916	730	810	390	0.7	0.4	0.2	0.1	0.2
1915	710	940		0.5	0.6	0.1	0.5	0.2
1914	510	750	...	0.8	1.1	0.3	0.5	0.1

* Average January to August, inclusive.

Table 1 shows a summary of the B. Coli content of the local river waters as applied to the final filters at Torresdale, and of the effluent leaving each of the filter plants, arranged as annual averages for the past few years. It appears that the load factor of the river water obtained both from the Delaware and the Schuylkill exceeds the proposed International Joint standard, but the preliminary treatment brings the water as applied to the final filters within the proposed standard.

The records show that the water sent to the consumers up to 1919 readily met the requirements of the U. S. Public Health Service. As happened with several other large water-works plants, the filters during the war reached a condition where they seriously felt the excessive strain under which they were operating and with a consequent falling off in the quality of water as shown by analyses. The State Department of Health is the body which certifies to the railroads and steamship companies, whether or not local water supplies may be served to interstate passengers. It is understood that the test applies to the quality of the water as it reaches the consumer and not as it leaves the filtration plants. The State Department of Health is now considering whether or not it will make such certification for Philadelphia water.

The filter plants are unable to carry their loads as satisfactorily as was the case before the war and they are urgently in need of revamping and enlargement as will be stated below. Notwithstanding the excellent recent record of the city with respect to its low typhoid fever death rate (see Table 2) we consider the present situation as to water treatment facilities a potential menace to the health of the community.

In appearance the city water supply of Philadelphia leaves nothing to be desired. This clear, sparkling water, however, has objectionable tastes and odors at times, par-

TABLE II. DEATH RATE FROM TYPHOID FEVER IN PHILADELPHIA PER 100,000 POPULATION

1920*	3.0	1915	6.5
1919	4.5	1914	7.5
1918	4.8	1913	15.6
1917	6.5	1912	12.6
1916	7.4	1911	14.1

*Up to September 1st.

ticularly in the case of the Schuylkill supply. These tastes are due in part to organic matter coming from polluting matters entering the stream above the intakes, but more particularly to the wastes from industrial plants, such as gas works and plants dealing with coal tar products. The control of these wastes is now being closely watched by the State and City authorities and it is believed that results will be more satisfactory in the future than in the past, although it is not reasonable to expect that the plant operators in the upper valley can at all times prevent accidental "spills" at the appliances used by them for retaining these valuable waste products which are so objectionable to the water consumers.

Relative Hardness

The total hardness of the Delaware River water averages about 50 p.p.m. which is moderately soft as compared with the water supplies furnished to other large cities along the Atlantic seaboard.

The Schuylkill River water flows over a limestone formation for some distance and has about double the hardness found in the Delaware River water. This greater hardness is not a desirable feature of the Schuylkill water, although it is a far softer water than supplied to the vast majority of the cities and towns found between the Allegheny and Rocky Mountains. It is somewhat softer than the water of the Great Lakes which averages about 120 p.p.m. and is approximately the limit below which municipal water softening plants do not strive to reduce the hardness, as at Columbus, Ohio and Grand Rapids, Michigan.

Defects at the several filter plants and their associated facilities for treating the water may be summarized as follows:

Torresdale Works—The present preliminary filters need overhauling and a renewal of the wash water and air distribution system for cleaning the sand beds. The capacity of the plant as a whole should be increased at once by building new filters of a capacity of 50,000,000 gal. daily which should later be increased to 100,000,000 gallons. These filters had best be of the rapid sand type in conformity with the recommendations made for the improvement now being installed at the Queen Lane filter plant. The coagulating basin should have a capacity of at least 10,000,000 gallons.

Queen Lane Filters—These filtration plants are now being revamped to have a capacity on an average of 140,000,000 gal. daily capable of carrying an overload of 20 to 25 per cent.

Belmont Filters—This plant requires baffles and improved inlet and outlet connections to increase the sedimentation period in the existing settling reservoirs. A new $36,000,000 rapid sand filter plant, with an independent coagulating basin, should be installed.

Roxborough Filters — Sedimentation facilities in existing reservoirs should be improved at once and later it will be necessary to install more filter units, depending upon a rearranged program for delivering water at a different pressure in the northwestern part of the city.

As bearing upon the introduction of water from new sources, the report states that whereas the entire Schuylkill supply is pumped before filtration to sufficient elevation for distribution by gravity the Torresdale filters are but slightly above the Delaware.

On the subject of metering the report says:

Meters furnish the most efficient and certain means of controlling waste and of equitably distributing the water rates. Their introduction has always been accompanied by a large reduction in the consumption, and a decided betterment in the service as to pressure and efficiency. The meter principle is growing rapidly. There are now many large cities 100 per cent metered, resulting in the deferment from five to ten years of costly improvements and extensions, and better utilization of those in existence. The advantages of complete metering are so obvious that no opposition should develop. We strongly recommend that the meter system be systematically extended to all services in the city.

Dealing with the ultimate abandonment of the present sources of supply and the inadvisability of going to the Upper Lehigh or the Susquehanna rivers, the report says:

Approved plans are now being executed that will result in increasing the draft from the Schuylkill by 25 per cent. a quantity materially in excess of the observed low flow of this river. This deficiency must be made up by storing water on one of its branches and compensating the stream flow when required. While we recommend that the Schuylkill River be abandoned as a source of water supply at the earliest possible date—largely for sentimental reasons, as with treatment it can now supply a hygienically safe water —we realize that the city's rapid growth requires many improvements other than water and that present prices make construction work very expensive, probably from two to two-and-a-half times greater than in 1914. Our recommendations, therefore, are along the line of the least capital investment consistent with needed improvements and the greatest possible utilization of present facilities.

In our judgment one storage reservoir must be constructed at once in the Perkiomen watershed to which source the city must turn if economy and early improvement in the quality of water supplied are to control. This reservoir will automatically become a part of the extended system after the abandonment of the Schuylkill River within the city limits. It will eventually, with other reservoirs, in the same and adjacent watersheds, furnish water through aqueducts leading direct to the city. Such aqueducts may be designed to deliver water at a sufficient elevation to materially reduce the pumping factor; or the available head may be applied to decrease the size and therefore first cost of the aqueducts, continuing the existing pumping lift from the river levels to the filtration plants, as may be shown expedient at the time of construction. For the present the first reservoir will give a much needed addition to the dry weather flow of the Schuylkill and improve the raw water supply.

Abandonment of Delaware Supply at Torresdale

The Delaware River water at Torresdale is at present better than the Schuylkill water, either raw or filtered. There are periods, however, when the ebb and flow of the tide tends to bring dangerous polluting matter to the intake. The establishment of inland waterways, combined with the natural growth of commerce and industry will, in all probability, result in a large growth of population along the Delaware River shores, and require ultimately the removal of the intake to a more advantageous and safe location. This can easily be accomplished without abandoning the major part of the present investment by taking the water from a point above Trenton. The water could be delivered, after sedimentation in an intermediate reservoir, to the present filters at Torresdale, as then extended and modified.

It would be a far better plan to develop progressively the Neshaminy watershed by constructing storage reservoirs which may or may not be combined with a similar development of the Tohickon watershed, as may then be shown to be the most expedient. Any deficiency in the requirements can be made up by pumping water from the Delaware River above Trenton to one of the storage reservoirs. Thus augmented, and with the Perkiomen watershed fully developed and utilized, there can be made available a supply estimated at over 700,000,000 gal. daily—sufficient to supply the ctiy for an indefinite period.

For more than fifty years the watersheds in the counties adjacent to Philadelphia have been pointed out as the ulti-

mate external source of supply. Without elaborate investigations or long consideration, it is obvious that the city cannot overlook these nearby sources and go further afield when, by reason of growth or dangerous pollution, it must extend its water-works system beyond the present local sources.

Expense grows with distance, and the watersheds of the Perkiomen, Tohickon and Neshaminy furnish a natural and ideal substitute for the present works for many reasons among which may be mentioned:

1. A utilization to the fullest extent of the city's investment in its present pumping stations, filters, reservoirs, and distribution system.

2. The capability of development by successive increments from time to time rather than a nearly complete investment at one time, as would be the case with all the more distant sources of supply.

3. Freedom from any legal interstate complications.

4. The fact that combined with, and augmented by, water from the Delaware River above Trenton, it will furnish an ample supply to the city for much more than fifty years to come.

5. The adoption of this project will insure to Philadelphia a thoroughly pure, wholesome and satisfactory supply, comparing favorably with that furnished to any large city in the country.

We respectfully urge that our recommendation of this project be approved and that the city promptly begin its execution.

Mountain Sources

Water from the distant mountains always appeals to the sentiment of the general public who think of it as crystal-clear, as they have seen it in the bubbling hillside brooks on their excursions afield—cool, refreshing and satisfying. This is seldom, if ever, so, and in the present case it is a highly idealized sentiment and far from the facts, although the mountain sources have many points of excellence, and they are admittedly superior to the supply recommended when both are considered in an untreated condition.

The Upper Lehigh and its branches and the Delaware River tributaries above the Water Gap could furnish a very soft, generally clear, and hygienically safe water which would, however, at times be turbid, have a high color or vegetable stain, and would be subject to occasional dangerous pollution. To make it as satisfactory as the water which Philadelphia is now using would require treatment to remove the color, turbidity and disease germs. *We go so far as to express the opinion that with rare exceptions no surface water should be consumed without filtration or other treatment.* [Italics ours.—Editor.]

The cost of a water supply of a given quantity is roughly proportionate to the distance between source and point of use, other things being equal. Therefore, for economical and business reasons, a city should seek successively, as it outgrows its supply, the available source nearest at hand and reduce to a minimum the abandonment of its existing useful plant. Cities rarely discard on a wholesale basis their existing water-supply facilities, but from time to time reach out and make additions to their supplies.

Works for a supply from a mountain source would require as part of the initial construction, a full size aqueduct capable of delivering the ultimate desired capacity of 500,000,000 gal. per day. Water from a mountain source could be delivered at an elevation sufficient to make pumping unnecessary except for the highest parts of the city. Its introduction would involve, however, radical readjustment, and perhaps entire replacement, of the filtration plants, and extensive changes in the distribution system.

Instead of progressive development being possible, as is the case with the supply herein recommended, all the mountain sources that can be considered as physically available would require enormous initial outlay, with the accompanying large interest charges throughout the period when only a portion of the capacity of the works could be utilized. We believe that all mountain sources should be dismissed from active present consideration, and not taken up until the city's growth approaches the limit of the nearby sources, at which time they may offer the best and most feasible addition.

In view of the conditions stated, detailed investigations of distant sources seemed unnecessary at this time. We have, however, made careful examination of information in previous reports on the water supply, and particularly the very comprehensive data compiled by the Chief of the Bureau of Water, and have prepared comparative estimates of cost several proposed projects.

The main data on which the board bases its recommendations for a future daily supply of 500,000,000 gal., with ability to supply 600,000,000 gal. daily for limited periods, are: With a present population of about 1,825,000 the average daily consumption in 1919 was 311,000,000 gal., or an average of 170 gal. per capital, which was exceeded by 23, 20 and 12 per cent, respectively, during the maximum day, week and month in the past two years. The estimated population fifty years hence is 3,250,000. With all services metered by that time it is assumed that the average daily per capita consumption would be about 150 gal., and the daily total about 500,000,000 gal. The estimated cost per million gallons daily of the recommended semi-gravity project (storage on the Perkiomen, Tohickon and Neshaminy, supplemented by pumping from the Delaware above Trenton) is $270,000, compared with $511,000 for the Susquehanna and $649,000 for the Upper Lehigh possibilities.

The program recommended by the board to cover the next five or six years involves a total outlay of $35,000,000, as already stated, divided as follows:

First impounding reservior on Perkiomen Creek with necessary development of program for stored water supply	$[illegible]
Improvements in and extensions to the Delaware River supply works	$[illegible]
Improvements in and extensions to the Schuylkill River supply works	$[illegible]
Extension of distribution mains and distributing reservoir for the northeast portion of the city	$[illegible]
Extensions and betterments to existing distributing reservoirs and main pipe lines	$[illegible]
General improvements essential for safe maintenance of the plant	$[illegible]

Intercrystalline Fractures and Season Cracking of Soft Steel

Examination of a number of serious cases of service fracture of soft steel at the National Physical Laboratory of England has showed, according to W. Rosenhain and D. Hanson in a paper read before the Iron and Steel Institute, Sept. 21, 1920 ("Intercrystalline Fracture in Mild Steel") that, while the fracture is generally through the ferrite crystals, in a small number of cases the fracture goes between the crystals. All such cases were detail fractures, and most of them occurred in steam boilers. Some evidence was found to indicate that corrosion is a factor in bringing about such fracture, just as it does in the notorious season cracking of cold-worked bronzes and brasses. One of the four cases reported occurred in cold-drawn steel tubing, and in this case the product of corrosive action in the crack could be seen under the microscope. While the authors of the paper suggest that initial stress is a factor in the cracking, as it is in season cracking of brass, they do not find a satisfactory source of such initial stress in boiler shells except in the operation of riveting under excessive pressure. However, heat appears to be a factor in the cracking, for the authors say that they have not yet observed an intercrystalline fracture in soft steel exposed to stress at ordinary temperature only.

Rapid Transit Plan for New York Proposes 830 Miles of New Track

Report by D. L. Turner, Chief Engineer, Outlines Comprehensive Development for Next 25 Years at Cost of $350,000,000—Twenty-One Subaqueous Tunnels and Three Moving Platforms Recommended

TWENTY-ONE two-track subaqueous tunnels, 830 single-track miles of new line, three crosstown moving platforms and two-story subways of eight and of six tracks are outstanding features of the $350,000,000 comprehensive plan for rapid transit development in New York City during the next 25 years proposed in a report which Daniel L. Turner, chief engineer of the Transit Construction Commission, submitted recently to Commissioner John H. Delaney. Emphasizing the point that it has averaged 10 years from the inception of previous general transit projects to the date of their operation, Mr. Turner recommends that the new building program be started at once in order that all of the facilities proposed may be available by the year 1945. Twenty-five years hence it is estimated that five billion passengers per year must be accommodated.

The accompanying map indicates the extent of the project covered by the report, new routes being indicated by dotted lines while existing facilities are shown by solid lines. In addition to extensions to many routes of the present system the comprehensive plan contemplates for the near future two new trunk lines for the east and west sides of Manhattan, including an Amsterdam Ave.-Eighth Ave. route and a Madison Ave. route. The moving platform lines are designed to provide transfer facilities across town between all north and south trunk lines and their locations are through 14th St., 42d St., and 57th St., extending in each case from the Hudson River to the East River.

If the recommendations of the report are carried out the Borough of Richmond, located on Staten Island in New York Harbor, would for the first time, be provided with rapid transit facilities, connections to the Brooklyn lines being supplied by tunnels under The Narrows.

The construction of the new rapid transit lines, Mr. Turner points out, should precede the population and form the basis of the city plan. Upon these two cardinal principles, he believes, the future of the city depends. Extracts from the report follow:

Traffic Growth Enormous

In the past the traffic on the street railway lines in New York City has nearly doubled every ten years. In 1913, the year the Dual Contracts were signed, the rapid transit lines in Manhattan and Brooklyn (subway and elevated lines together) carried 810,000,000 passengers. In 1920 the rapid transit lines, including the old and new lines, will carry about 1,333,000,000 passengers for the year. This means that the rapid transit traffic per year has already increased 523,000,000 passengers, although the Dual System is not yet completely in operation. The present year's rapid transit traffic—1,333,000,000 passengers—is nearly one-half of the total traffic capacity of the Dual System. The Interborough trunk lines in Manhattan are saturated now in the rush hours one way. In about another ten years the whole Dual System will have become saturated with traffic.

The first Interborough subway, just before service on the two new east and west side lines was inaugurated, carried a maximum of 418,000,000 passengers per year. The old and new Interborough subways, although the new lines will have been in operation only about two years, will carry this year about 577,000,000 passengers—an increase of 38 per cent in about two years.

The New York Municipal Railway lines in 1918, at about the same time the east and west side Interborough service was begun, carried about 258,000,000 rapid transit passengers per year. This year they will approximate 378,000,000 passengers—an increase of about 46 per cent in two years.

In 1910 it was estimated that the total traffic on all lines for 1920 (surface, subway and elevated lines) would amount to about 2,600,000,000 passengers. For the year ending June 30, 1920, the traffic amounted to about 2,400,000,000 passengers—practically substantiating the estimate of ten years ago. The total traffic to be provided for in 1945, 25 years hence, is estimated to amount to somewhere around 5,000,000,000 passengers. The population of New York then will be somewhere around 9,500,000 people.

New Lines Should Precede Population

The foregoing figures are sufficient to indicate the enormity of the traffic growth for which municipal transportation must be provided if the development and the prosperity of the city are not to be held back. In order to keep pace with the enormous traffic growth the city must build more transit facilities—then more again—and still more again—and must keep on doing this continually.

The Dual System was planned primarily to best serve the whole community. New lines were laid down through the congested areas. But instead of confining all the new lines to old lines of travel, or to the already congested sections, lines also were laid down in wholly undeveloped portions of the city. It was expected that this principle in planning rapid transit lines, in conjunction with the new zoning law limiting the height of buildings in congested sections, would work together so as to distribute the population rather than to further concentrate it. In other words, as far as practicable, the idea followed in planning the system was that the transit facilities should precede the population—not follow the population.

Convenient Service Basis of Transit Plan

When a city has developed to a point where its outer limits exceed 4 or 5 miles from the center, the congestion in traffic which has developed and the time which is consumed in traveling become such factors that travel on the surface is no longer sufficient, and faster means of transit must be provided between home and business—or between the outlying sections and the center. At this time rapid transit lines must be developed. The first rapid transit lines may be two-track lines—similar to the Manhattan and Brooklyn elevated lines, for example. On such lines, including all stops, passengers can travel at about 15 or 16 miles per hour, so that a 10 or 12-mile radius city can be served properly. As the outer limits of the city become more and more distant from the center, the transit speed must be increased. In response to this requirement the express-local transit service has been developed, similar to the subway lines in Manhattan and Brooklyn. On these express-local lines passengers can travel through the outlying sections on the local trains, making all stops, at the rate of about 16 miles per hour, and through the center on express trains at about 25 miles per hour. The average speed from the outer limits to the center increases with the increase in the length of the express tracks. A line with express tracks running to the end of it could properly serve an 18-mile radius city. In New York, with an existing proportion of express tracks on the subway lines

NEW ROUTES PROPOSED IN COMPREHENSIVE RAPID TRANSIT PLAN FOR NEW YORK CITY

the average speed from the circumference to the center of the city is about 18 miles per hour, thereby, on the hour standard, furnishing satisfactory service 12 miles out. The combination express-local service will thus bring passengers into the center fast enough to permit them to complete their trip between home and work within the desired hour.

Surface transit must be replaced by elevated, open-cut or subway transit. In other words, surface line service must give way to rapid transit service. This evolution in city transit in New York—particularly in Manhattan—is necessary not only because of the tremendous traffic increases which must be accommodated but also because this is one way in which additional street capacity for vehicles can be obtained. It may be assumed that convenient rapid transit service will be provided if a prospective passenger is not required to walk much more than half a mile to reach a rapid transit line routing towards the business center, which is the objective point for most of the traffic. Most people can walk a half mile in ten minutes. On this basis of planning the rapid transit lines will be about a mile apart in the residential districts, but as they approach the center they will route closer together, to the extent of traversing every street in extreme cases. For crosstown service in the outlying sections rapid transit lines two miles apart will conveniently serve the community. At the center the crosstown lines must be closer together. They must be close enough to provide sufficient transfer capacity, as capacity and not convenience is the controlling factor in such location. When its transit program conforms to this standard of convenient service New York City will have been provided with a complete rapid transit system, and in effect its surface car system will have been replaced by a rapid transit system, as must be the case to relieve surface congestion.

In the development of the plan every collecting and distributing branch traversing The Bronx, Queens, Brooklyn and Richmond is routed into and through the center in Manhattan—assumed to include that portion below 59th Street. In other words, all transit lines, wherever they may originate in the outlying boroughs, enter and traverse the center, so as to afford the same degree of accessibility to this 8 sq. miles from all of the 315 sq. miles constituting the whole city. The circumstances demand this. But it would be better if other centers could be created and thus avoid focusing the active life of the entire community in one area.

In the case of the lines serving Richmond—Six two-track collecting and distributing lines—three of the lines reach the center in lower Manhattan by way of Brooklyn. The first Richmond lines should not only provide transit for Richmond, but also should traverse and serve Brooklyn.

The other three, those for later development, reach the center by way of New Jersey.

As far as it has been practicable to do so every trunk line traversing the center in Manhattan is connected at both extremities with collecting and distributing branches in such a way as to develop a two-way traffic, thereby utilizing such trunk lines for the movement of fully loaded trains in both directions during each rush hour, in this way making use of the street system through the center to its maximum capacity for rapid transit service. Even under such conditions, however, practically every north and south avenue through the center of Manhattan will be utilized by rapid transit lines.

Two-Story Subways—In some cases it is proposed to utilize the north and south avenues for rapid transit purposes to a greater extent than ever before contemplated. It is necessary to do this because there are not enough up and down avenues available for trunk lines. From the City Hall to 125th St., including Broadway, there are only eleven through avenues. Two avenues, Sixth and Seventh, are cut off by Central Park, with no population to serve and with lakes and reservoirs to build under. Above 125th St. there are still fewer through avenues. The eleven through avenues connect and serve about 150 effective crosstown streets to 125th St. Expressed in another way, Manhattan from the Battery to Spuyten Duyvil has approximately 100 miles of north and south thoroughfares to serve approximately 325 miles of crosstown streets—or the ratio of crosstown to longitudinal streets is over 3 to 1.

These conditions explain the inordinate congestion which exists along all north and south travel lines. Consequently, since the avenues are too few in number, it is proposed to multiply their use underground. In the case of Eighth Ave., a two-story eight-track subway is proposed. In the case of another, Madison Ave., a two-story six-track subway is proposed. All of the tracks in these two-story subways will probably not be constructed at the same time. Some new lines will have to be provided soon on the west side and some on the east side of Manhattan. Probably two-story lines will have to be started in Eighth Ave. and in Madison Ave. at about the same time, but with only two tracks in each story, provision being made in locating the line in the street and in constructing it so that the remaining tracks can be added later on.

An effort has been made to bring the trunk lines throughout the center as near the median line of Manhattan as possible. In this manner the majority of the rapid transit lines through the center south of 59th St. is contained within the section between North Ave. on the west side and Lexington Ave. on the east side. The trunk lines are routed north and south in as straight lines as practicable, which will at the same time permit them to be brough closest to the median line.

Moving Platforms—Loops within the center are objectionable because they segregate traffic to such an extent as to create a menacing congestion of all kinds—pedestrian, vehicular and transit congestion. The best way of providing convenient crosstown connections between all lines is by means of a number of crosstown lines routing practically from river to river. Surface lines may be utilized at first if proper transfer arrangements are effected. But where the traffic is dense, in order to relieve the street for other uses and to accelerate transit movements, the railway traffic should be placed underground. It is believed that the most desirable way of furnishing such crosstown connections is by means of underground moving platform lines.

21 *Two-Track Tunnel Crossings*—At the present time there are 34 single-track river crossings connecting Manhattan with The Bronx, Queens and Brooklyn. The proposed plan contemplates adding 42 single-track river crossings. All of these crossings will be by means of tunnels. This means, therefore, that the comprehensive program includes 21 additional two-track tunnel lines under the waters surrounding Manhattan and connecting Manhattan with The Bronx, Queens, Brooklyn and Richmond.

830 *New Single-Track Miles*—The proposed new routes have not been studied in detail. It is therefore impossible to say how much of the mileage will be underground mileage and how much of it elevated mileage. The total new mileage, including the new lines, extensions and moving platforms, and including the third tracks, amounts to about 830 single-track miles of additional rapid transit facilities. The Dual System has 616 miles of single track. The proposed new facilities therefore would considerably more than double the Dual System mileage. The third tracks do not traverse the center and therefore do not add materially to capacity, but they permit of decreasing the time of travel between the outlying limits and the center. Twelve extensions to the existing lines are proposed.

31 *Additional Subway Tracks Through Center*—The Interborough east and west side trunk lines contain four tracks each, or eight tracks altogether. At the present time only six of these eight tracks carry loaded trains through the center during the rush hours. Relatively empty trains travel over the other two tracks. In other words, only two pairs of these tracks develop a two-way traffic; the other two pairs develop only a one-way traffic. It is proposed at some future time to connect up the two one-way traffic pairs to Brooklyn, thereby transforming them into two-way traffic pairs, and in this manner obtain an additional two-track capacity through the center during the rush hours. Similarly it is proposed to extend the pair of tracks of the New York Municipal four-track trunk line which now terminates at 59th St. into upper Manhattan so as to secure another full capacity movement through the center, which with the two Interborough full capacity movements will add three new full capacity movements altogether.

At the present time traversing the center north and south there are 7 trunk lines, consisting of 20 tracks (excluding third tracks). There are proposed 6 new trunk lines, consisting of 28 tracks, thus making a total of 13 trunk lines, consisting of 48 tracks, running north and south in Manhattan through the center. The three new full capacity movements, with the 28 new tracks which are proposed under the comprehensive plan, will furnish 31 additional full capacity tracks through the center, all connected with collecting and distributing branches running out into and through the outlying sections of all of the boroughs.

New Trunk Line Tracks

Although it is not possible to look ahead to the end, it is practicable to see forward to the near future. For the year 1920 the total traffic on all transportation lines—surface, subway and elevated—will amount to about 2,400,000,000 passengers. If 25 years from now 5,000,000,000 passengers must be accomodated, and most of them on rapid transit lines, it means that enough facilities must be added to serve 2,600,000,000 passengers. Eight new trunk line tracks through the center with collecting and distributing branches running out from their extremities would be sufficient to do this. Supplementing the new trunk lines, three crosstown moving platforms should be constructed to supply proper distributing facilities throughout the center. Also, two of the existing one-way traffic lines should be extended north or south, as the case may be, in order that their full trunk line capacity through the center may be utilized.

The following extensions and new routes are recommended for early construction to meet the next 25 years' requirements.

Extensions—The first new work that will have to be carried out will probably be certain extensions or additions to the existing lines, as follows:

Extension of the Corona branch of the Steinway Tunnel line from its present terminus to Main St., Flushing.

Extension of the Steinway Tunnel line, from its proposed terminus at Seventh Ave. and 41st St. west through 41st St., to a connection with the proposed Eighth Ave.-Amsterdam Ave. trunk line, as already described.

Two-track extension of the New York Municipal Railway Corporation Broadway-Fourth Ave. Trunk line, from 59th St. and Seventh Ave. up Central Park West and Eighth or Seventh Ave. to the Harlem River.

Extension from the New York Municipal Railway Corporation Broadway-Fourth Ave. subway, at Broadway and City Hall Park, via Ann St. and the East River to Brooklyn, and thence via Brooklyn Bridge terminal property, Washington St., Livingston St., De Kalb Ave. and Fort Green Place to a connection with the Fulton St. elevated line at or near Ashland Place. This connection has already been under consideration.

Two-track tunnel under the Narrows connecting the southern extremity of the Broadway-Fourth Ave. line of the New York Municipal Railway Corporation with the Borough of Richmond, providing the first rapid transit facilities for this borough.

Continuation of the Nostrand Ave. subway of the Interborough Co. south into and through Coney Island.

Crosstown line through Queens and Brooklyn connecting the Astoria branch in Queens with the Brighton Beach line in Brooklyn, thereby providing a crosstown line between Queens and South Brooklyn, and being a part of the proposed Brooklyn waterfront crosstown line previously described.

Extension of the two tracks of the Interborough Seventh Ave.-Brooadway line now terminating at the Battery, from a point at Greenwich and Liberty Sts., via Liberty St., Maiden Lane and the East River to Brooklyn, and thence via Hicks St., Union St., Seventh Ave. and Gravesend Ave. to a connection with the Culver line.

Also some minor extensions to the elevated lines where such lines are not now routed to the city limits.

New Trunk Lines—In addition to the foregoing extensions the following new trunk lines will probably have to be constructed in the near future:

Serving the west side of Manhattan, four tracks of the eight-track Eighth Ave.-Amsterdam Ave. trunk line, extending from 155th St. in upper Manhattan to 23d St. in lower Manhattan, with a collecting and distributing branch from its northern extremity extending north through upper Manhattan and into The Bronx, and provision for an easterly branch, which later can be constructed east across the Bronx via 161st St., Longwood Ave. and Randall Ave. to Throgg's Neck, and with a branch from its southern extremity extending east through 23d St. to the East River, which subsequently can be carried across to Brooklyn, and with another branch extending south down Hudson and Washington Sts. to somewhere near the Battery, which subsequently can be extended to Brooklyn.

Serving the east side of Manhattan, four tracks of the six-track Madison Ave. trunk line, extending from the Harlem River to 23d St., with no collecting and distributing branch at the northern extremity, but with a two-track collecting and distributing branch extending from the southern extremity down Fifth Ave. and through lower Manhattan to some point near Park Place, the other two of the four tracks terminating at 23d St. and Madison Ave.

Moving Platforms—In order to provide sufficient transfer facilities across town between all of the north and south trunk lines to permit of the traffic reaching the center having easy access to any point within the center, three moving platform subways should be included in the program, namely, through 14th St., 42d St., and 57th St., practically from river to river, connecting all the up and down rapid transit lines.

The extensions, new trunk lines and moving platforms projected above will probably meet all of the rapid transit requirements for the next 25 years. The building program should be laid down in such a manner as to enable the beginning of construction of these lines as soon as possible, and so as to equally distribute their construction over this 25-year period in order that all of the facilities outlined may be available at the expiration of this period.

It is impracticable to estimate the construction cost of this 25-year program because of the long period over which the construction would extend. At pre-war prices, however, it is estimated that the construction program outlined would cost somewhere in the neighborhood of $175,000,000. At present prices it is estimated this cost would amount to $350,000,000. It is hardly likely that present costs will be greatly exceeded, so that the cost of carrying out this program will probably be somewhere between these two figures. These figures do not include interest during construction or engineering and superintendence.

Feeding Garbage to Hogs at Halifax, England

A profit of £400 ($2,000) from garbage-fed hogs at Halifax, England, during the past year is reported by the Street Cleansing Committee of that city. Feeding was started in a small way during the war but, according to the London *Surveyor*, "grew until 125 animals were in stock, pigs for killing being sold to local butchers." School children are paid "sixpence a stone" (12c. per 14 lb.) for garbage brought from their own and neighbors' homes. By this means over 20 tons (2,240 lb.) have been received, for which £82 ($400) has been paid.

Conveyors Speed Delivery of Sacked Coffee to Ships

Installation at Port of Santos, Brazil, Has Capacity, Per Unit, of About 3,000 Sacks Per Hour

By S. T. Henry
Vice-President, Allied Machinery Co. of America, Formerly Associate Editor, *Engineering Record*

For several years an extensive system of conveyor belts has been used successfully in the Port of Santos, Brazil, for transporting sacked coffee from warehouses 280 to 360 ft. from the dock to the decks of steamers alongside the latter. The installation is divided into several units. Each unit has a capacity to deliver 2,000 to 2,500 sacks, each containing about 200 lb. of coffee, per hour from warehouse to steamer.

Santos is the principal shipping port for Brazilian coffee. The amount of coffee that passes through this port has been from 5,000,000 to 7,500,000 sacks per year for the last five years. Shipments are made at various rates depending on market conditions, steamer space available and other factors.

FIG. 1. TYPICAL DOUBLE WAREHOUSE AT SANTOS

The coffee is delivered to the port by steam railroad. Some of the shipments from the interior go from the railroad cars directly into the holds of the steamers. A large percentage of the shipments, however, are stored in warehouses along the docks awaiting the arrival of steamers or for various other reasons.

The warehouses are long, low buildings in rows parallel to the docks. The street to the left of the warehouse in Fig. 1 is about 140 ft. in width. On the left side of this street and close to the docks is a row of merchandise warehouses, Fig. 2, each about 100 ft. wide. Between the merchandise warehouses along the docks and the steamers is a space about 40 ft. wide, on which are laid railway tracks, and tracks for traveling cranes and bridges.

Less than half of the coffee stored in the warehouses is delivered by the conveyor belt installation from the warehouses directly to the deck of the steamers in which shipment is made. The warehouses that are equipped with conveyors each have a conveyor on the longitudinal center line between the two sections that make up a double warehouse. At the transverse center line of the building each longitudinal conveyor delivers to a cross-conveyor that extends under the street shown in Fig. 1. This conveyor under the street delivers to an inclined conveyor between the ends of the warehouses along the docks. The inclined conveyor extends from the conveyors under the street up to horizontal conveyor along the water side of the dock warehouse. Platforms on brackets which carry the conveyors along

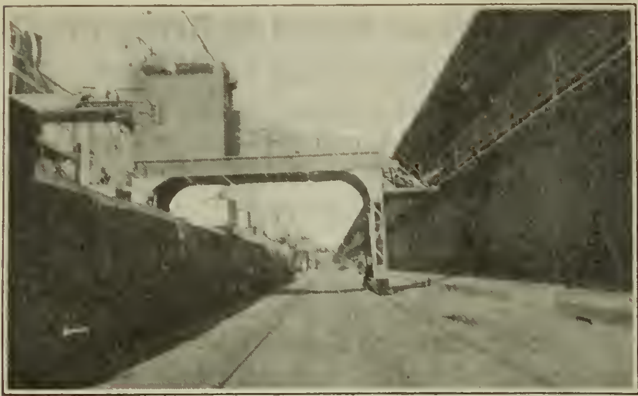


FIG. 2. RELATION BETWEEN CONVEYORS ALONG DOCKS AND TRAVELING BRIDGE

the water side of the dock warehouses also are shown in Fig. 2.

The conveyors on traveling bridges receive the sacks from the conveyors along the water side of the dock warehouses. The arrangement of these traveling bridges is shown in Figs. 2, 3 and 4.

The conveyors in the warehouses are in concrete-lined trenches about 6 ft. wide and 6 ft. deep. They are covered with removable planks which are set in shoulders on the top of the trench sidewalls, so that the covering they make is continuous and flush with the floor of the warehouse. The conveyors in the trenches are supported by fixed steel frames. All of the conveyors are 24 in. in width and are motor driven.

FIG. 3. DELIVERY OF SACKS BY CONVEYOR DIRECT TO DECK OF STEAMER

The conveyors under the street are in concrete-lined tunnels. They are also on fixed steel frames. There are four of these cross-conveyors in tunnels and four inclined conveyors connecting with those along the water side of the dock warehouses.

The total length of the conveyors on the brackets along the dock warehouses is approximately 1,800 ft. These horizontal conveyors are arranged to drive in one direction, but they are sectionalized so that each inclined conveyor delivers to either of two sections running in opposite directions.

Four of conveyor bridges (Fig. 3) are installed. All of them are of the same design. Each is arranged with a leaf which can be raised (Fig. 4) to clear the steamers, as shown in one of the photographs. The bridges deliver sacks to the deck of the ship, as shown in Fig. 3. From the deck of the ship the sacks are lowered into the hold on chutes by hand.

This installation of conveyors was made prior to the war. It has been in continuous operation since then. A careful inspection indicates that the maintenance has been low and that the upkeep is not serious. Canvas belts have been used in recent years because rubber belting could not be secured. The foreman in charge believes that rubber belting is much better for this service.

The only opportunity for improvement on the system appears to be in the handling of sacks in the warehouses. At present, men carry the sacks an average of 40 ft. to the conveyors in the trenches on the longitudinal center line of the warehouses. Portable conveyors on flat-wheel casters would eliminate all this carrying.

FIG. 4. CONVEYOR BRIDGE WITH LEAF RAISED

FIG. 5. SACKS ARE SOMETIMES LOADED BY HAND

All of the coffee not handled by the conveyors is carried on to the steamers by men, as shown in Fig. 5.

In studying the capacity of the installation, a unit was considered as the conveyors in one warehouse, the corresponding conveyor under the street, the inclined conveyor to which the street conveyor delivered, the corresponding two sections of the conveyor along the water side of the dock warehouses, and one traveling conveyor bridge. An observation of 27 min. showed, by careful counting, that one of these units was delivering at the rate of about 1,800 sacks of coffee per hour. That is, the unit could deliver that number of sacks from the warehouse to the ship in that time.

The foreman in charge claimed that the capacity of a unit is easily 2,500 sacks per hour, and that they have handled as high as 3,000 sacks per hour per unit. The capacity obtained apparently depends on the rate at which sacks are loaded on the conveyor in the warehouses and on the skill of the men who straighten the sacks at the points where one section of the conveyor delivers to the next section. It appeared that a unit could handle about 2,800 to 3,000 sacks per hour, if the men needed to align the sacks at the junctions would work with reasonable efficiency.

Engineering Courses for Ex-Service Men

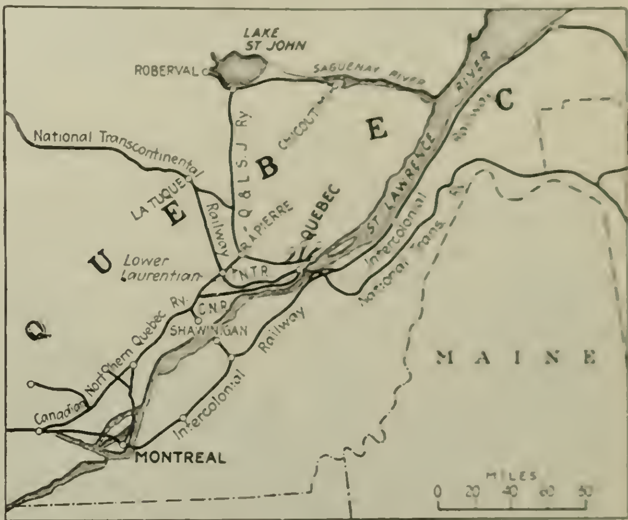
A recent bulletin issued by the national service department of Engineering Council announces that the Federal Board for Vocational Education has arranged with engineering Schools in all parts of the country to give engineering instruction to 2,387 ex-service men, all branches of engineering being represented. As colleges and universities start courses for the current school year additional arrangements are being made.

Location Betterments on Canadian National Railways

By Henry K. Wicksteed
Chief Locating Engineer, Canadian National Railways

PRESENT CONSTRUCTION and studies for location betterments on the Canadian National Railways may best be understood by a brief review of early railroad building on the Canadian Northern. The principal component of the lines composing the Canadian National System is that of the Canadian Northern. This was financed, designed, and built, as everyone knows, by the firm of Mackenzie & Mann, both members of which were not only very able business men and financiers, but had had a long previous experience in contracting on the Canadian Pacific, and an absolute confidence in the resources of Canada and its future. They knew personally a great many of the older engineers and others who had been identified with the construction of the older road, and they gathered about them a number of these men who knew the topography of Canada as no one else could know it, and the weak points of the older roads as well as the strong. Under these circumstances it is not surprising that the Canadian Northern from Montreal and Toronto to Vancouver, has the reputation of being the best long distance line on the continent in proportion to cost, and the best on this continent from an economic point of view means the best in the world. Some day justice will be done to the extraordinary talent and vision of these two men. Public opinion is even now swinging round in that direction. The successful man has always a great crowd of detractors, but as successful man remarked to me a few days ago, it is easier to make and keep a reputation than to do things. These men attempted the impossible and got away with it. Two farmers' sons built 10,000 miles in less than 20 years.

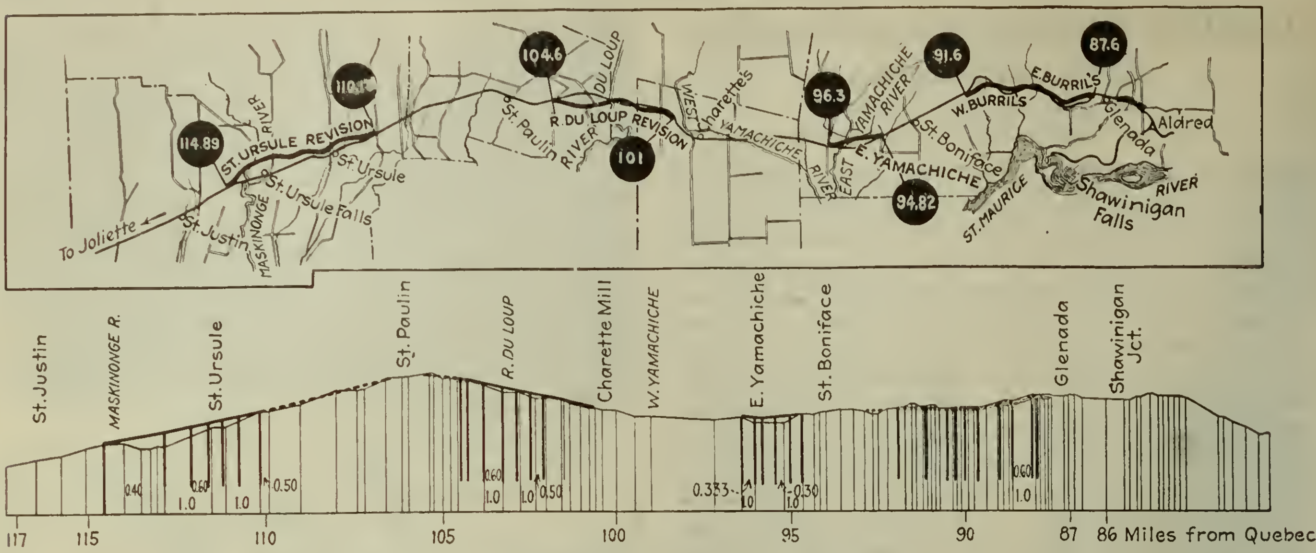
Part of this system in the East was composed of acquired lines which were linked together and sometimes acted merely as feeders to the parent system; sometimes formed part of the main line itself. They had nearly all been finished years before, and in location features were not on a par with the somewhat higher standards demanded at the present day. One such road was the Bay of Quinte which was used with modifications for some 25 miles between Toronto and Ottawa. Grades of 1.5 per cent were reduced to 0.5 per cent, while the other construction was going on, and finished simultaneously, the stations being left in their original positions, and the existing business of the line being left undisturbed. A still more important link in the main chain between Montreal and Quebec was the Great Northern of Canada, completed about 1900, and itself composed of older roads coupled together. It extended originally from Hawkesbury on the Grand Trunk, 60 miles east of Ottawa, to Rivière à Pierre on the Quebec & Lake St. John, and was intended as an overflow route for the somewhat heavy flow of grain then going east from the Georgian Bay at Parry Sound to Quebec. One hundred miles of this route, from Quebec to the St. Maurice, was made up of two colonization roads, the Lower Laurentian and the Quebec & Lake St. John, and had a number of grades of 2 per cent, and curvature as sharp as 10 deg., in combination. The newer portion had been built to a 1 per cent standard. The most objectionable part of this combination was eliminated by building a new line from the St. Maurice 80 miles to Quebec, which reduced the distance some 17 miles, and the ruling gradient from 2 per cent uncompensated to 0.60 per cent compensated. This provided for nearly one half the distance between Quebec and Montreal and two-fifths of that from Quebec to Hawkesbury. Nine miles of the remainder was taken up by a sharp drop into the valley of the St. Maurice, and an equally sharp rise on the opposite side, and of the remainder all but 30 miles was on the great Montreal plain, and where the grades were at all objectionable, they were all so short as to be easily reducible by ordinary steam shovel work.



QUEBEC NATIONAL RAILWAY SYSTEM

The St. Maurice depression, involving as it did the moving of a station and raising of a bridge over the river, has been left alone for the present, and is being worked as a special short division, but this 30 miles involving some long 1 per cent grades became one of the first studies of the Canadian National staff. Surveys showed that these could be reduced to 0.60 per cent by the construction of some 1[illegible] miles of new line, and 4 deg. curves substituted for the 8 deg. standard now obtaining, and that the capitalized value of the change would amount to some $5,000,000 or more, while the cost was estimated at $1,500,000, but this cost was largely made up by that of four steel viaducts over as many rivers. The existing bridges, which had been standing some 20 years, were none too heavy in the first place, and quite unequal to modern loads, and rebuilding them in the new sites was somewhat cheaper than in the old. The amount chargeable to grade revisions therefore, was less than $500,000 and it needed little argument to convince the directorate that the expenditure was a good investment. Work on these changes has actually been commenced.

Meantime the traffic on the Quebec & Lake St. John, a little separate system of 280 miles built as a colonization road, had grown very rapidly, owing to the development of the wood pulp and paper industry in the Saguenay basin, and its 1.5 per cent grades (and on the Quebec end 2 per cent), had become very expensive to maintain and operate. Most of this traffic goes to and beyond Montreal, and leaves the Q. & L. St. J. at R. a Pierre, running over the 40 miles of the Lower



BETTERMENTS UNDER CONSTRUCTION ON ST. LAWRENCE SUBDIVISION

Laurentian above mentioned with 2 per cent grades, and into the main line at the St. Maurice. The National Transcontinental, another member of the National System, crosses this midway between R. a Pierre and the St. Maurice, and this too is carrying more traffic to and from Montreal over this little one-horse colonization branch. Studies now being made for the reduction of these 2 per cent grades to the same 0.60 per cent standard are well advanced and very encouraging, but obviously in a reduction from 2 per cent to 0.60 per cent with considerable changes in elevation, it can not be expected that much of the old line will remain. It is possible, however, to retain all the stations and traffic points intact. Otherwise there would be a very serious rebellion among the good people of the province of Quebec.

Last in importance perhaps, and furthest away from the great trade centres, but among the most interesting of all, are the studies on the Quebec & Lake St. John itself. One hundred and twenty-five miles north of Quebec is the city of Chicoutimi. Many Canadians have never heard of it, and probably the great majority of Americans. Yet it is a seaport nearer to Europe than any in the United States. Within 50 miles of it are a million horsepower of water power or more, most of which is running to waste. Within 150 miles are some of the greatest spruce forests of the world, and at its doors, and extending more than 50 miles, are 1,000 square miles of good agricultural land. In this city, and on this land, are 50,000 to 60,000 industrious and thrifty French Canadians. From Canada, the United States, and both England and France, capital has come freely in the past, and is still coming for investment in pulp grinding and paper making. To the westward, and tributary to this city are mineral areas which have caused at least one flurry of excitement. Quebec has perhaps the sanest population, and the most progressive and business-like government of any province in Canada. This combination is a hard one to beat, and many people are realizing it. One chance acquaintance on the train in midwinter had come all the way from Kansas City merely to look into the chances for profitable investment.

Under these circumstances, it is only natural that the traffic on the Quebec & Lake St. John should increase, and that it should look forward to economic development and improvement in grades and curvature, and possibly, in the more remote future, to electrification. At every few miles along its line are rivers with minor waterpowers which can be developed easily and cheaply. Few of them perhaps are large enough to justify a transmission line to distant localities, but quite large enough in the aggregate to keep a railway going, and probably so evenly distributed that a high tension line and converters would be unnecessary. This matter of electrification of Quebec lines will soon be well worth studying, but the question of grade reduction and increasing at moderate expenditure the train load by 50 per cent and sometimes over 100 per cent, remains relatively just as important. Electrification will reduce or nearly eliminate the coal bill. Grade reduction will reduce both coal and wages in proportion to tonnage. Both expenditures will probably soon be worth while. The accompanying plans and profiles show some of the most interesting of the problems under construction and study.

Sewage Sludge Utilization at Glasgow

More extensive utilization of sewage sludge from the chemical precipitation works of Glasgow, Scotland, is proposed, according to the London *Surveyor*. All the sludge from the works at Dalmuir and Shieldhall was sent to sea last year but the larger part of that produced at the Dalmarnock works was pressed and sold to famers. The Dalmarnock sludge yielded a revenue of about £2,000 ($9,730) last year. By pressing all the sludge at Dalmarnock this year it is expected that the revenue will be increased by £1,200. Changes under way at the Shieldhall works will save the city £7,000 a year as compared with the cost of sludge disposal at sea. If similar changes were made at the Dalmuir plant a further saving of £10,000 would be made. One reason why these changes have been delayed, the *Surveyor* says, is that heretofore "an economical price could not be obtained for the manure, but now" the city "could get readily 4s. (about $1) per ton instead of the market price of 1s. per ton which ruled five years ago.

Notes from Foreign Fields

MAKING THE MOST OF LIMITED NATURAL RESOURCES IN HOLLAND

By E. J. Mehren
Editor, *Engineering News-Record*

HOLLAND is of much interest from the engineering standpoint. We know it as a picturesque country, a land of windmills, of wooden-shoe children, of rosy-cheeked girls, of scrupulous cleanliness, and of ever-present canals, but we do not, as a rule, appreciate that its engineering achievements are of a very high order. Nor do we realize from what meager resources the Dutch people have built for themselves an important place in the affairs and commerce of the world. Their land has an area of only 12,558 sq.mi., approximately the size of Massachusetts and Connecticut combined.

CANALS IN AMSTERDAM

About 25 per cent of it was once covered with water. About 13 per cent more is so low that it would be covered by every high tide, were it not for the dikes. On these unfavorable lands the Dutch people, with infinite patience, untiring energy and much engineering skill, have built up an agricultural industry rivaling that of any similar area in the world. For centuries Holland has been rising from the sea, until now, having reclaimed all land whose location would naturally lead to its reclamation, she has begun to turn back the sea on a grand scale. She has taken in hand the oft-discussed project of reclaiming the Zuider Zee.

But if Holland must contend with unfavorable land conditions, she has an advantage in location on which her thrifty and shrewd people have not failed to improve. Situated at the corner of the Continent she is a natural avenue of commerce for a rich and populous hinterland, while within her territorial confines a mighty river—one of the world's greatest commercial waterways, the Rhine—empties into the sea. To her come the Rhine argosies. She transships their cargoes and in turn sends them back laden with the products of Dutch colonies and of every country of the globe.

These two facts—the unfavorable natural condition of her land, and her fortunate commercial location—are the controlling elements in the engineering of the Netherlands. Her drainage practice—with the accompanying arts of diking and pumping—lead the world, while she is properly a Mecca for those who are seeking data on the design and operation of ports and harbors.

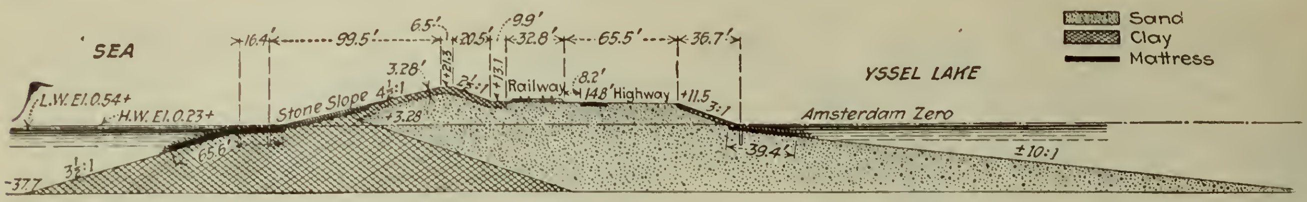
These do not, of course, exhaust the list of interesting engineering developments in Holland, but they are the ones that will get the most attention from the visiting engineer.

Drainage—Land drainage, of course, is not an unknown art even with us, but it is carried out in Holland under far more difficult conditions than in the United States. True, there is much land at about their Amsterdam zero—average high water level at Amsterdam—which is relatively easy to handle, but that which was formerly covered by lakes or the sea lies from 3 to 5 m. below average high water level. Hence the wind mills. In the Haarlem Meer polder ("polder" is the name given to a reclaimed area), for example, the land is at an elevation of –4.25 m. (–14 ft.). The water levels in the polders are kept from 50 to 75 cm. below the ground surface, so that the maximum pumping lift at high water would be about 5.75 m. (about 19 ft.).

The drainage is effected by systems of canals, with principal branches about 1 km. apart. From these laterals run off, about 75 m. apart. Where necessary, tile drains are laid between these laterals.

Pumping was done formerly entirely by windmill, but steam and electrically driven pumps were introduced many years ago and are gradually supplanting their more picturesque but less economical predecessor. The windmill, however, is not by any means fully superseded. In fact, at one polder I visited, the Schermer, the pumping is still entirely done by wind power and there are no less than 55 mills at work on the unwatering of this 4,445-hectare (11,000-acre) polder. The reclamation of this area, by the way, dates back to the year 1635.

The windmill design has been little changed in centuries. A typical mill that I inspected in the Province of North Holland had a sail area on each of its four vanes of about 67 sq.ft. The pump itself was a wooden spiral, with an outside diameter of 2 m. (6½ ft.) and a pitch of about 2 ft., set on an incline of probably 30 deg. The shaft attached to the vanes, and the vertical shaft transmitting the power to the pump were of timber, as were the pinions at top and bottom of the vertical shaft. At the Schermer polder the pumping



CROSS-SECTION AT MAXIMUM DEPTH, ZUIDER ZEE DIKE

was done in three lifts (by three sets of mills), each lift being of 1½ m., the polder water level being, at most, 4½ m. below the Amsterdam zero.

The high cost of windmill pumping is due to the cost of attendance. Each mill has its own operator, who makes his home, with his family, in the mill tower. In the steam and electric pumping plants, obviously, the cost of attendance per 1,000 cu.m. of water pumped is but a small fraction of that of the windmills.

As previously noted, steam and electric power are now much used for pumping. The pumps would form an interesting study for those interested in the history of pump development. There are scoop wheels of various types, centrifugal pumps, and screw pumps, the last of the type designed by A. B. Wood, of New Orleans, and first installed in the drainage pumping plants of that city. Electric pumping capacity is provided on the basis of removing 10 cu.m. of water per minute for each 100 hectares in the polder, figuring that the pumps will operate 18 hr. per day. This is the normal basis. If there is much water area in the polder, the capacity need not be so large, on account of the reservoiring effect of the water areas. Because of the reliability of steam power, steam pumping plants are generally figured on the basis of operating 24 hr. per day.

Manual Control

Most of the plants are manually controlled, but there are some automatically controlled electric pumping stations. The equipment has not a heavy load factor, operating only 1,000 to 1,200 hr. per year.

The dikes are built of sand or loam, with a clay protection ranging from 50 to 75 cm. thick. One dike I saw on the Zuider Zee had a height of 4.5 m., a top width of 1.5 m., a sea slope of 2 on 1, and a back slope of 3 on 1. The sea slope, in addition to the 75-cm. clay covering, had the following protection—two courses of hand-placed brick, a course of broken brick to act as bedding, and then basalt blocks 40 to 60 cm. high and 8 to 12 cm. through, placed on end and brick or stone chinked. These basalt blocks, by the way, are much used in Holland for slope protection and the facing of sea walls. They are of the typical columnar basalt, having the cross-section of irregular polygons, and are imported from Germany.

Zuider Zee Work—Much interest naturally is taken in the reclamation of the Zuider Zee. The project has been under active discussion for seventy years and in July of this year work was actually taken in hand. The most striking feature is that the entire area back of the great dike is not to be reclaimed, but is to include a large lake as well as the new polders. The total area affected will be 360,000 hectares (889,000 acres), of

1. AREAS TO BE RECLAIMED FROM THE ZUIDER ZEE

which 215,000 hectares (531,000 acres) will be reclaimed and the remainder 145,000 hectares (358,000 acres) will remain as lake. The great dike will have a length of 30 km. (18 miles) divided by the Island of Wieringen (see map herewith) into 2.5 and 27.5 km. lengths. The average depth of the Zee on the line of the dike is 4.14 m. (12.57 ft.) below the Amsterdam zero and 3.6 m. (11.8 ft.) below ordinary low water level. The greatest depth below the Amsterdam zero on the line of the dike is 11.5 m. (37.7 ft.). A cross-section of the proposed dike at the maximum depth is shown herewith. It is on this section—between Wieringen and the Province of North Holland—that work is now under way.

BASALT-BLOCK FACING FOR SEA WALL

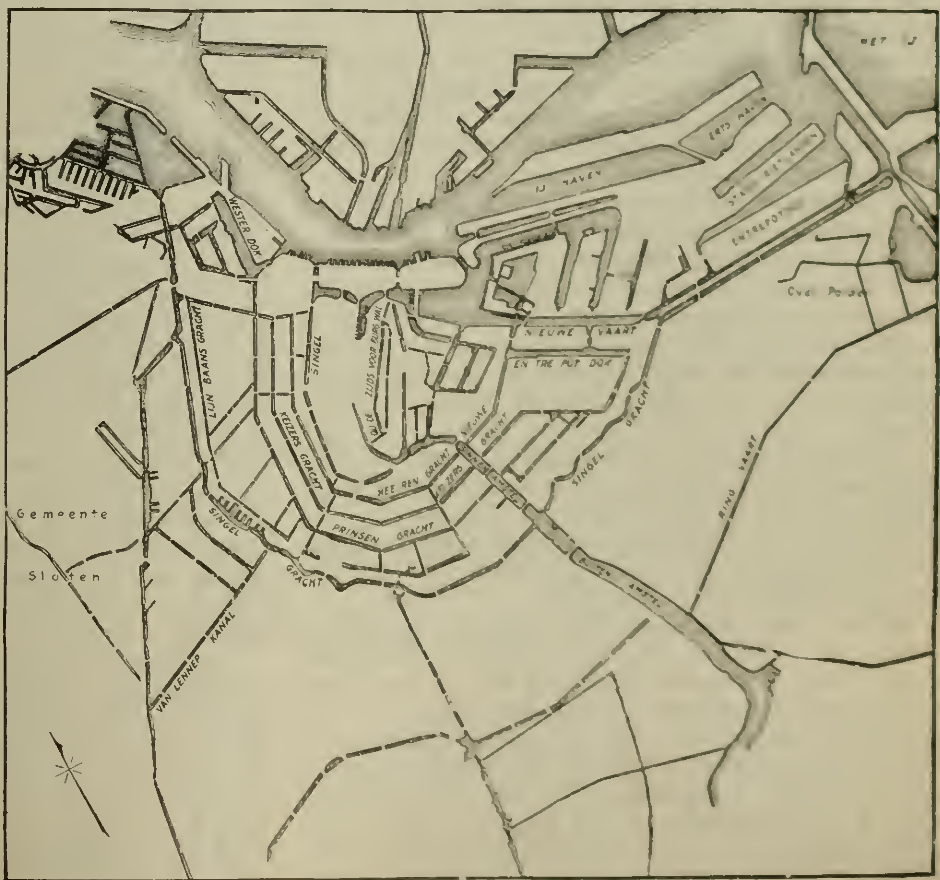
SEA WALL AT SCHEVENINGEN WITH BASALT-BLOCK STONE

The maximum elevation of the great dike is 6.5 m., while the highest water level, at storm tide, is 3 m., both above the Amsterdam zero.

In the area to be drained the sea bed is at an elevation of 3 to 4 m. below the Amsterdam zero, and since the shrinkage of the soil when unwatered is about 1 m., the dry land will be from 4 to 5 m. below ordinary high water.

The decision to allow approximately 40 per cent of the area back of the great dike to remain covered with water was reached only after long study. The areas bordering on the Zuider Zee are deficient in supplies of fresh water. During midsummer it is sometimes found necessary, as a last resort to save crops, to admit brackish or sea water to the polders. This is detrimental to the land and has been followed by diseases of stock. Since the Yssel Lake (as the new lake will be called) will receive the discharge of the Yssel River, one of the mouths of the Rhine, and several small rivers that now flow into the Zuider Zee, it will in time be changed into a fresh-water lake. Then, in times of drought, irrigation water can be admitted from it to the polders, while the communities in the neighboring provinces will be able to draw their water supplies from it. The Yssel takes about one-ninth part of the total flow of the River Rhine and has a maximum discharge of 2,000 cu.m. per second. It is proposed that the level of Yssel Lake shall ordinarily be kept at —0.40 m. (referred to the Amsterdam zero) and that its highest level shall not be more than +1.00 m. Since ordinary low water at Wieringen, where the discharge sluices into the sea will be located, is —0.54 m. and the ordinary high water level +0.23 m., it will be seen that the level of the lake can be maintained entirely by gravity discharge into salt water. Storm tide can prevent discharge by sluicing for a maximum period of only three or four days.

It is obvious that it would have been possible to inclose the areas to be reclaimed without constructing the great dike, but this would have made it necessary to build the bounding dikes of a section to resist storm tides from the North Sea. Their additional cost would have offset to some extent the saving caused by eliminating the great dike. Moreover, the great advantages of having a body of fresh water would have been lost. The keeping of storm tides away from the polder dikes has the great additional advantage of lessening the danger of breaching, and this is an important feature because of the great destruction of human life and property values sure to result from the breaking of a



CANAL SYSTEM OF AMSTERDAM—THE NORTHERN VENICE

dike. In the past Holland has had some bitter experiences with dike breakages and the insurance afforded by the great dike is not a negligable item in the considerations. Finally, the lower and more constant level of Yssel Lake will cheapen the cost of pumping water from the polders.

The map shows the location of the sluices—east of the Island of Wieringen. The plans call for twenty-five sluices, each 12 m. wide, so that there will be a sluicing length of 300 m., or 984 ft. The bottom of the sluices will be at an elevation of —4.40.

Pre-war estimates of the cost of the work were 40,000,000 guldens ($16,000,000) for the great dike, and 230,000,000 guldens ($92,000,000) for the whole project. The cost per hectare would have been approximately 1,100 guldens ($440), or about $180 per acre. Costs now are between two and three times what they were before the war, but before the work has progressed far prices will probably be lower.

The work now under way, on the 2½-km. length of dike between the Province of North Holland and the Island of Wieringen, consists in depositing in the deepest channel clay obtained by ladder dredge in nearby areas of the Zuider Zee. It is hauled to site in bottom-dump barges. Fortunately there are large areas of clay available, overlaid by about 1 m. of sand.

Conditions are not so favorable, however, as to the supply of willows for mattress work and stone for the paving of the slopes. Willows grow naturally on some of the low islands in the Zuider Zee, but the natural growth is insufficient for the needs of the work. For that reason 500 hectares have been planted to willows adjacent to the Zee, and an additional area of 500 hectares is to be set out as rapidly as possible. It takes about three years for willows to mature so that they can be used for mattress purposes.

Stone for paving is to be basalt, and arrangements have been made with the German quarries for the necessary supplies. In fact, the speed with which the dike work can be prosecuted will probably be controlled by the ability to get basalt.

Obviously, as the closure of the great dike is approached a very difficult problem will be encountered in handling the large tidal flow. Erosion of the sandy sea bottom will be prevented, according to plans, by covering the bottom with mattresses weighted with rock.

It is expected that the construction of the sea dike will take about ten years, and that the completion of the entire project will require between thirty and forty years.

The magnitude of the project itself would naturally command interest in any country, no matter how large. When, however, it adds to the area of a nation 6½ per cent, one can well imagine the transcendent importance which it has not only for the engineers but for the entire population of the country.

Canals and Harbors—The canal is almost as intimately associated with Dutch scenery as is the windmill. There are no less than 3,600 km. of canals, and 1,000 km. of navigable rivers. By comparison, the standard-gage railways have a length of 3,400 km. and the meter-gage lines, 2,500 km. The canal system had its beginnings centuries ago. The reclamation of lake and sea areas necessitated the leaving of canals, and their subsequent enlargement and improvement. These formed an obvious means of transportation, and as population increased played an important part in the country's economic life. Even today, with an adequate railway system, the water-borne traffic is extensive. The canals have a minimum depth of 3 m.

The existence of the canals naturally stimulated extensive development of canals in the cities and towns. They tap every quarter of the cities and afford means of delivering cargo by water. Amsterdam in particular is well supplied with canals and may be called a northern Venice. A plan of the city, herewith, shows the extent of the canal system.

The ports of Amsterdam and Rotterdam are especially well developed. Amsterdam's business consists principally in the transference of freight between oceangoing vessels and either railway or barge. For that reason the port design follows that of most of the other large European cities; that is, the vessels tie up at piers, which are amply provided with cranes and other transshipment equipment. The piers are planned on a very broad basis. In view of the inadequacy of pier design in the United States, as exemplified by the Staten Island piers, it was interesting to hear the manager of the port remark that a width of 100 m. was not sufficient. The width determined as the minimum in Amsterdam is 150 m. (492 ft.), and this width will be used in the coming extension of the port on the west side of the city.

Rotterdam is chiefly a port of transshipment between ocean-going vessels and the barges navigating the Rhine. For that reason basins are provided at which the ocean-going vessels tie up at buoys and pile clusters. Transshipment devices for handling grain, coal, and miscellaneous cargo have been developed to an elaborate extent.

Amsterdam is connected with the North Sea by the North Sea Canal, which is about 24 km. long, the greater part being the canalization of the Ij (*pronounced eye*), a former arm of the Zuider Zee, which was closed off by a dam just east of Amsterdam, when the canal was built. At the same time the remaining parts of this arm of the sea were reclaimed and form what is known as the Ij polders. The canal has a width on bottom of 50 m., is 9.8 m. deep, with side slopes of 3 to 1. It is now being deepened to 15 m. and is to be widened to 100 m. on the bottom.

The maximum tidal range is 3 m. and to control the levels in the canal locks are located at both the North Sea and the Zuider Zee ends. The largest lock at the North Sea end is now 12 m. wide and 225 m. long, with a depth of 10 m. of water over the sills.

Work has just been started on an immense lock, which, with the widening and deepening of the canal itself, is expected to provide for the largest oceangoing shipping for many years to come. The lock will have the enormous dimensions of 50 m. width and 400 m. clear length, with 15 m. of water on the sills. The lift, however, will be only 3 m.

This tremendous lock will be built in the wet by the caisson method, similar to that used at Pearl Harbor. This will be done because a number of the important Dutch cities, including Amsterdam, depend for their water supply on the water accumulations in the dunes, in which this lock will have to be built. If the site were to be cofferdammed and pumped there would be danger of seriously affecting this underground reservoir. The work has only now been taken in hand, but should

develop much of interest to the engineers interested in canal and lock work all over the world.

The engineers in charge of the canal and the lock are well known in the United States, both of them having been in America to study our canal practice. HEER G. S. VAN DEN BROEK is in charge of the canal, and JHR. C. E. W. VAN PAHHUYS in charge of the lock.

Roads—Despite the fact that traffic is light, the highway system of Holland cannot be said to be in good condition. This, however, is not a reflection upon the Dutch engineers, in view of the very bad soil conditions with which they must deal. The land lies low and the water in general is near the surface. In addition, many of the roads are on a soft peaty foundation.

As in most of the European countries, there is a national highway system. It consists of about 2,000 km. of road, paved with brick in the western portion of the country, gravel in the east, and macadam in the south. By far the greater length is paved in brick, the individual units being 6 cm. wide, 22 cm. long, and 11 cm. high, laid on sand. There are some stone roads, built of imported block, but, on account of the soil conditions, they have not given good service. Such of the macadam roads as I saw—and the mileage of them is relatively short on the national system—were in good condition. I did not get into the country where gravel was used. In general, the government roads are 5 m. wide. The secondary highway system is under the control of the provinces and the tertiary system under the control of the communities and the polders.

One unusual feature is that the highway engineer must provide a path for the bicyclist. The ratio of bicycles to population is probably higher in Holland than in any other country in the world. There are no less than 1,200,000 bicycles in the population of 7,000,000. On the other hand, there are only 6,000 passenger automobiles and 2,000 motor trucks.

There is agitation in favor of an extension of the government highway net and of its improvement by bettering and widening the surfaces. A 7½-m. carriageway is being strongly urged, with adequate provisions, in addition, for both footway and bicycle paths. Widening is in progress in a number of places.

Industrial Conditions—In general industrial conditions in Holland are good. Like all other European countries, Holland felt the pressure of the war, prices being now three times as much as they were in 1914. Labor has, on the whole, had increases proportionate to the increase in the cost of living, but the middle class, as elsewhere, has been pinched. The efficiency of the workers is somewhat better than in other countries of Europe, the opinion being that production per man is 70 to 80 per cent of pre-war production. On Oct. 1 the 8-hr. day goes into effect, by law, in certain trades, and the intention is to extend its application year by year.

I was interested to learn that there is a cleavage in labor along religious lines. The Christian unions (both Catholic and Protestant) apparently have been much more reasonable than the Socialist and Communist unions. They have, for example, no objection to working more than 8 hr. a day and have not objected to piece work. The other unions, on the other hand, have wanted an 8-hr. day. The Socialist unions work piece work though their leaders are opposed to the system while the Communist unions are strongly opposed to piece work.

Engineering Interest—When planning my trip I was in grave doubt whether I should include Holland in the itinerary. Its engineering works were less known to me than those of any other country that I had considered visiting. Did emergency require it, therefore, I had planned merely to pass through Holland without stopping. However, I am glad that I spent time there. Not only did I find the engineering works of great interest, but a hospitality and an understanding of Americans and American conditions that were second to none that I met in Europe. I found the Dutch engineers close students of American practice, and admirers of the way American engineers and contractors take hold of their engineering enterprises.

In the hope that my own experience in visiting Holland will be duplicated, I would most earnestly urge upon engineers who plan visiting Europe to include Holland in their itineraries.

The Hague, Aug. 4.

Macadam Roads Given Skin Coat of Tar Good After Nine Years

IN RECONSTRUCTING macadam or gravel roads the South Park Commissioners of Chicago have developed and perfected a method of applying a skin coat of hot pitch, which after nine years under heavy traffic conditions is still in very good condition, according to Harry S. Richards, superintendent of maintenance, South Park. While these roads have been described before, the long period of their service is warrant for a recounting of the methods used in their construction.

The old macadam was loosened with a spike wheeled road roller and then scarified and harrowed. This process tends to bring the larger pieces of metal to the surface. The road is then brought to the desired grade and compacted by the use of a 10-ton roller.

On this surface was spread a layer of crushed stone between 1½ and 2 in. in diameter, which was thoroughly compacted by means of the roller mentioned above. After the voids were completely filled with limestone screenings the road was sprinkled and rolled in a manner exactly similar to that followed in constructing the ordinary macadam type.

Before the surface treatment is applied, it has been found to be the best practice to throw the surface open to traffic for a week or ten days. At the end of this period it is traversed with a horse-drawn revolving broom which prepares the surface for the reception of the skin-coat treatment, which consisted of hot pitch applied under pressure at the rate of ¼ to ⅓ gallon per square yard, and at a temperature of not less than 250 deg. Before this pitch has cooled it is covered with ¼ to ⅜-in. chips of limestone, or gravel of equal size. The final touch is given by thorough compaction with a roller weighing about five tons.

Safety and Sanitation Not a Park Purpose

The New York State Court of Appeals has decided that the leasing of the Arsenal Building, in Central Park, New York City, to the Safety Institute of America for use as a safety and sanitation museum, would be a diversion of a portion of the park from its legitimate use for park purposes.

Letters to the Editor

Against the Federation

Sir—In the hope of somewhat clarifying the situation in regard to the proposed federation of engineering societies in the minds of members of the national technical societies, especially those like myself who are members of both the American Society of Civil Engineers and the American Association of Engineers, the following observations are offered:

The aims of the proposed federation have been advanced fully and need not be repeated here. The engineer is a professional man and as such demands the maintenance of the highest possible technical standards. For this purpose the founder societies have come into being and have functioned. If engineering is to be an advanced profession the scientific basis must be constantly expanding and advanced ground must be continually broken. This work is largely in the hands of the founder societies—stimulating research work and bringing to attention the most progressive achievements of engineering. Such work, it has long been considered, is best done by separate societies devoted to the different branches of the profession. Engineers have, however, another great field of interest; namely, that involving their responsibilities as citizens; service to the engineer in the way of increasing his prestige, support of their fellow engineers in all matters affecting public or professional interests, employment service, etc., including the protection of the public and the profession by their influence on legislation. It seems to be the well-meaning object of those advocating the federation to set up machinery to accomplish this.

That the American Association of Engineers as an organization favors any agency aiming to accomplish these results is shown by the fact that it has offered its hearty co-operation to the promoters of the federation. The letter of its secretary, C. E. Drayer, to R. L. Humphrey appearing on p. 62 of *Engineering News-Record* of Sept. 23, 1920, makes this fact clear. I can see no reason for any member of the American Association of Engineers who is not also a member of a founder society opposing the federation. However, when one comes to study the matter as a member of both American Association of Engineers and a founder society or even as a member of a founder society who is informed as to the organization, aims and accomplishments of the American Association of Engineers, we have a horse of another color. The founder societies are organized and functioning now in their chosen and broad fields and no doubt can and will rise to greater heights of accomplishment. The American Association of Engineers is a national organization, organized for non-technical work, to assist the engineers to perform their many civic obligations, to watch and direct legislation affecting our particular field, raise the prestige of the profession in public esteem, obtain proper recognition of engineering employees by employers and co-operation between them, welfare work including employment service, etc. A study of its records will disclose that this work is being advanced successfully and in a manner consistent with highest ethics, having adopted a code of ethics for engineers probably unequalled, having taken a determined stand against unionism in the profession, and having given service to the young men which is stemming the wave of unionism threatening the good name of our profession. This organization has now, I believe, about 21,000 members. It aims to be practically all-inclusive; it is soundly organized, functioning freely, democratic, effective and of high tone. Therefore, why embark on a new adventure hazardous on account of its absolutely unsound plan or organization, expensive in any case (with its sound and effective organization the American Association of Engineers is finding it difficult to give the best service at $10 entrance fee and $10 dues); and last but most important: Why introduce an element into our founder societies which will absorb effort and interest which should be devoted to technical development, threatening the consuming of much time and courting the probability of many serious dissensions?

Members of founder societies: The high prestige of your society so dear to you is at stake. Your pocketbook is in danger of a raid.

Members of the American Association of Engineers who are members of a founder society: You are now supporting two organizations which should and I believe will cover the full needs of the profession as far as can be served by organization and you are now being asked to support a movement which at best, it seems to me, represents simply a duplication of the work of the American Association of Engineers. ROBERT H. JACOBS.

New York City, Oct. 9.

Oppose Am. Soc. C. E. as Federation Member

Sir—The American Society of Civil Engineers is now facing what is probably the gravest question that has ever come before it. It must decide whether it is to retain its position as one of the foremost engineering societies in the world or whether it is to surrender its prestige and influence into the hands of a new and untried organization of no professional standards and of vague purposes, in the management of which the Am. Soc. C. E. would have an insignificant and inequitable voice.

We cannot afford to dally with this proposal. The risk is too great. Once the Am. Soc. C. E. has surrendered its name and prestige they are gone. No one can foretell by whom or in what causes they may be exploited, or to what policies the society may be committed; for no one seems to know what are to be the objects, the methods, and the scope of the new organization.

It is urged that we should join the Federation because others are doing so. That is never a convincing argument, and in this case it is little short of absurd. No other body of engineers in the United States has so much to lose by joining the Federation as has the Am. Soc. C. E. It is easy to understand why the Federation should want the Am. Soc. C. E., but that is not an argument that should carry weight with the member who is thinking of what is best for the society and for the profession of which it is now the leading exponent. It is easy to understand why the promoters of the Federation should wish to absorb the Am. Soc. C. E. together with all the prestige and influence it has built up through the 68 years of its leadership; but this will but constitute additional reason for caution on the part of those who value that prestige and who are scrupulous as to the ends toward which that leadership may be directed.

We urge that in considering the Federation question the members of the Am. Soc. C. E. retain a firm grasp on these basic facts and principles. We urge a serious reading and consideration of the arguments against the Am. Soc. C. E. joining the Federation as prepared by Past-President Pegram, and Directors Alvord and Tuttle (see *Engineering News-Record*, Sept. 30, and sent to the membership together with the ballot. These arguments are just and sound. They will appeal to the member who understands and appreciates what the Am. Soc. C. E. is and stands for and who approaches the present problem animated only by a desire to do what is best for the society and the profession.

The standing of the Am. Soc. C. E. in the eyes of the world is the most valuable profesisonal asset that it brings to its membership. Let us not pawn this asset for the vague and questionable possibilities that may lie in the new Federation.

If you have already voted and wish to change your vote you may send in a new ballot and ask for the return of the first one.

ONWARD BATES, past president, Am. Soc. C. E.
J. WALDO SMITH, past vice-pres., Am. Soc. C. E.
ALEXANDER C. HUMPHREYS, past director, Am. Soc. C. E.
JOHN G. VAN HORNE, past director, Am. Soc. C. E.
CHARLES F. LOWETH, past vice-pres., Am. Soc. C. E.
DABNEY H. MAURY, member, Am. Soc. C. E.
CHARLES L. STROBEL, past vice-pres., Am. Soc. C. E.

NEWS OF THE WEEK

New York, October 14, 1920

Large Bond Issues Asked for New Jersey Highway Bridge Work

Eighteen million dollars for highway bridge reconstruction are asked of the New Jersey legislature by the new state highway commission. Of the total, $4,000,000 is required for immediate renewal of bridges now unsafe, and $2,000,000 for repairs and temporary reconstruction of 200 out of the 600 bridges now on the state's highway system, while ultimately $12,000,000 more will be needed for bridge replacement. The money is to be raised by bond issues authorized by a referendum vote to be ordered by the next legislature.

Development of a state highway system now including sixteen lines of road, or "routes," has been proceeding for two years, but a number of important bridges on these routes are in such condition that immediate replacement is needed. Charles A. Mead, department engineer of bridges, has reported that seven of the most important bridges are in such condition that they must be renewed at once, and that repairs costing over $300,000 will have to be done to keep them open for traffic until the new bridges are completed. For these large structures and for urgent repairs on about 200 smaller bridges a total of $6,000,000 is required within the next three years.

"It is our view that this work cannot be ignored if traffic is to be maintained on the highways," says the commission. "The sum of $18,000,000 will have to be provided eventually to build highway bridges adequate to meet the demands of the present traffic and to form fitting links in the state highway system. These estimates are based upon present-day costs."

Included in the seven large projects that are reported to be urgent, rebuilding of the Amboy bridge over the Raritan River will require $2,700,000; this bridge is now restricted to loads of 5 t., but the new one of 20 t. capacity is contemplated. Reconstruction of the Matawan Creek bridge ordered by the War Department, will cost $225,000, Cooper's bridge over the Navesink River and the Manasquan bridge $400,000 and $470,000, the Shark River bridge $260,000, and the Pine Brook bridge over the upper Passaic River $130,000.

The commission says, "Unless the rivers and smaller bodies of water are spanned with suitable structures, the good which we hope the citizens of the state who use the roads may derive from them will be lessened. The bridges are an integral part of the highway construction.

American Society C. E. Amendments to Constitution Defeated

In Letter Ballot of Record Size Proposed Changes in Administrative Machinery Fail To Secure Necessary Two-Thirds Majority Vote

Proposed changes in the constitution of the American Society of Civil Engineers, involving, (1) an enlargement of the scope of the organization to include co-operation in economic and civic affairs; (2) establishment of Local Sections and assignment of all members thereto; (3) reduction in the number of directors from District 1 (New York City); and (4) a new basis for the nomination and election of officers, including an annual conference of Local Section representatives, were defeated in the referendum vote in which 4,521 ballots were canvassed Oct. 6 at the meeting of the society in New York City. The remaining three of the seven proposed constitutional amendments, providing for an increase in annual dues, a change in the election of honorary members and a prohibition against the candidacy for office of a member of the nominating committee were carried. The result is, in effect, a repudiation of the measures advocated by the Joint Conference Committee.

A record vote on the seven questions was polled. In all 4,781 ballots were received; of these 260 were invalid, leaving the net ballots counted 4,521. In every case the majority of the votes cast was in favor of the proposed amendments but a change in the constitution of the society can be made effective only by a two-thirds affirmative vote, so that amendments A, B, F and G, although favored by the majority, were defeated by margins of 224 ballots, for amendment A; 416 ballots, for amendment B; 307 ballots for amendment F; and 448 ballots for amendment G.

A study of the vote by districts shows, in the case of the proposal to enlarge the scope of the Society (amendment A) a heavy negative vote from New York, there being 509 "No" against 318 "Yes." In the eastern Pennsylvania region the reverse was true, the "Yes" vote being 309 against 115 "Noes." Amendment A was also favored by substantial majorities in western Pennsylvania, Illinois, Michigan, Wisconsin, Minnesota, Texas and the Pacific-Coast States. New England was very evenly divided. The full details of the vote by districts is given in the accompanying table.

As explained in this journal last week (p. 719) amendment A proposed the co-operation of the Society in civic and economic affairs. Amendment B covered the establishment of Local Sections. Amendment C increased the an-

RESULTS OF LETTER-BALLOT, AM. SOC. C. E. AMENDMENTS

District* No.	Ballots Counted Upon Amendment. "A" Yes	"A" No	"B" Yes	"B" No	"C" Yes	"C" No	"D" Yes	"D" No	"E" Yes	"E" No	"F" Yes	"F" No	"G" Yes	"G" No
1—Foreign	36	29	22	43	43	21	48	15	53	11	29	33	26	37
1—Resident	318	509	278	549	578	224	556	240	592	207	278	544	262	555
2	158	176	140	192	234	86	262	57	279	41	150	184	135	196
3	120	126	109	137	139	102	171	69	179	63	121	125	111	132
4	309	115	303	123	338	80	361	54	379	39	305	117	300	120
5	190	112	182	120	222	77	238	62	245	54	190	111	170	128
6	294	123	280	138	322	88	334	76	360	49	287	129	271	141
7	270	57	258	69	260	64	262	56	263	56	[illegible]	56	256	67
8	254	144	243	153	275	110	302	84	324	64	236	158	224	169
9	147	107	129	125	171	79	195	53	208	41	147	104	131	118
10	154	80	145	89	158	71	184	48	198	35	148	83	141	91
11	224	53	206	71	210	62	230	43	253	22	218	57	206	66
12	156	27	153	31	143	41	152	26	165	15	155	28	150	31
13	146	65	136	75	131	80	151	55	172	35	143	68	132	78
Total	2,776	1,723	2,584	1,915	3,224	1,185	3,446	938	3,670	732	2,675	1,797	2,515	1,929
Required to carry	3,000		3,000		2,940		2,923		2,935		2,982		2,963	
Carried by	......		...		284		523		735					
Lost by	224		416								307		448	
Total vote	4,499		4,499		4,409		4,384		4,402		4,472		4,444	
Percentage "Yes"	62		57		73		79		83		60		57	

* *Dist.* 1, N. Y. City and foreign; *Dist.* 2, New England States; *Dist.* 3, N. Y. State and Quebec; *Dist.* 4, eastern Penn., Md., N. J., Del.; *Dist.* 5, D. C., Va., N. and S. C., Ga., Fla.; *Dist.* 6, Western Penn., W. Va., Ohio; *Dist.* 7, Ontario, Mich., Wis., Minn., Manitoba, Ia.; *Dist.* 8, Ill., Ind., Ky., Tenn.; *Dist.* 9, Ala., Miss., La., Ark., Mo.; *Dist.* 10, Okla., Kan., Col., Utah, Neb., Wyo., N. and S. D., Mont., Saskatchewan and Alberta; *Dist.* 11, Tex., Mex., Ariz., S. Cal.; *Dist.* 12, B. C., Idaho, Wash., Ore., Alaska; *Dist.* 13, Northern Cal., Nev.

nual dues. Amendment D provided for changes in electing honorary members. Amendment E prevented nominating committee members from running for office. Amendment F reduced the number of directors from the New York District. Amendment G involved changes in the administration of the Society's affairs.

All Factors in Building Industry Plan Harmony Congress

Seven elements in the building construction field are to hold a congress in June, 1921, or sooner, to discuss the problems of the field from every angle with a view to obtaining better co-ordination and giving better service to the public. A preliminary meeting of six of the interests involved—architects, contractors, sub-contractors, labor, engineers and material men—met Sept. 27 in Chicago and appointed a steering committee of six to study the situation and make plans for the congress. The seventh interest yet to be interested in the movement is the financial, to be represented by the Investment Bankers' Association. The committee appointed is as follows: R. D. Kohn, representing the American Institute of Architects; General R. C. Marshall, Associated General Contractors of America; Morris Knowles, Engineering Council; Wharton Clay, the material men; Louis K. Comstock, the sub-contractors; Thomas R. Preece, Building Trades Department of American Federation of Labor.

Each interest pledged itself to contribute $300 to a fund for incidental expenses. This meeting, attended by 32 men, followed a preliminary meeting in Atlantic City called by the American Institute of Architects at the same time as a meeting of the National Board for Jurisdictional Awards in the Building Industry. The members of the Board of Awards are selected by the American Institute of Architects, Engineering Council, the Associated General Contractors of America, the National Building Trades Employers' Association and the Building Trade Department of the American Federation of Labor.

Increased Assessment for Miami Conservancy Flood Protection

An additional levy of 14 per cent of the total estimated flood benefits of the Miami Conservancy District has been made by the directors of the district, in addition to the original levy of 36 per cent made in September, 1917. The amount of $10,793,000 to be raised by this additional levy is made necessary by the increased cost of the work over that corresponding to the prices prevailing when the estimates were prepared. The board of directors states, however, that the increase in cost of the work does not compare at all unfavorably with the increased cost of similar enterprises.

State Highway Officials Support Federal-Aid Bill

Plans are being prepared by the American Association of State Highway Officials to support actively the Chamberlain bill, which proposes appropriations of $400,000,000 for the continuance of Federal aid in the construction of rural post roads. One-fourth of the appropriation is to be available during the fiscal year ended June 30, 1922. The remainder is to become available in equal proportions during the following three fiscal years.

In extending the Federal aid, the Chamberlain bill proposes to make provision for the public land states. The bill provides "that in each state in which the percentage of total land area to which the title of the United States is unqualified, exceeds ten per cent of the total area of all lands in the state, the Secretary of Agriculture may reduce the ratio of co-operation required, but not to below one-half that which the total of the patented land and national forest land bears to the total area of all lands in the state." A separate fund is provided for national forest roads and trails.

Another provision of the Chamberlain bill is that preference is to be given "such project as will expedite the completion of an adequate national highway system, connecting at the state boundary."

League to Further Irrigation Needs Formed in Northwest

At an irrigation congress held recently in Seattle and attended by more than seven hundred delegates from northwestern states, there was formed the Northwestern Reclamation League which is to further the irrigation needs of that territory. The league will undertake a nation-wide campaign of education to arouse public sentiment on the need for Federal legislation that will promote reclamation of arid lands in the West; it will make a systematic effort to show the manufacturers of the East how the reclamation of arid lands in the West will open new markets to them, and the United States Chamber of Commerce is to be asked to appoint a committee to do educational work on this general subject through its affiliated state and local chambers. Officers of the new league are: president, James A. Johnson, farmer and banker, Shelby, Montana; secretary, James A. Ford, managing secretary Spokane Chamber of Commerce.

Philadelphia Section, Am. Soc. C. E., for Federation

At a meeting held Oct. 4 the Philadelphia Section of the American Society of Civil Engineers passed a resolution introduced by Richard L. Humphrey, endorsing the Federated American Engineering Societies and advocating the entry of the Am. Soc. C. E. into the new organization.

Engineer Heads Roadmasters' Society

The engineering side of railway maintenance-of-way work was made prominent at the recent annual meeting of the Roadmasters and Maintenance-of-Way Association, held in St. Louis. Weight of rail in economic relation to traffic was the subject of a report by J. B. Baker, engineer of maintenance of way, Pennsylvania system. In the discussion of a paper on maintenance of rail joints by R. H. Howard, chief engineer of maintenance of way, Wabash R.R., several members referred to the modern practice of oiling splices and bolts to prevent rust and to facilitate removal. Repair of frogs and switches by welding by the oxyacetylene process was approved in the report of a committee headed by M. Lipman, division engineer of the Pennsylvania system, but it was pointed out that only competent men should be allowed to operate the apparatus. So far the process has not been successful with manganese steel parts. The committee did not recommend it for frogs and switches in high speed tracks and Mr. Muff, A., T. & S. F. Ry., finds it economical to send the parts to the shop for welding rather than to do the work in the track. Cutting bolt holes in rails with torches has been discontinued on the Missouri Pacific Ry., as rails have fractured at holes made in this way. On the Pennsylvania system electric welding has been found less satisfactory than the oxacetylene process.

Methods of increasing the efficiency of track forces were discussed in a paper by F. G. Jonah, chief engineer of the St. Louis-San Francisco Ry. (see *Engineering News-Record*, Sept. 30, 1920, p. 662); H. J. Pfeifer, chief engineer of the Terminal R.R. Association of St. Louis, pointed out that with the present high rates of wages it is important for roadmasters to see that their men give a proper equivalent in labor. As to the use of motor section cars, it was stated that the Elgin, Joliet & Eastern Ry. is using cars large enough to carry 25 men. Training foremen in special extra gangs and the establishment of a general roadmaster on each division were ideas advocated in a report by Wm. Shea, C., M. & St. P. Ry.

The future of the tie supply was discussed in a paper by H. Von Schrenk, consulting engineer, who advocated wider use of preservative methods and more care in getting full life out of ties in the track. A report on road crossings, by J. B. Martin, New York Central Lines, dealt mainly with bituminous macadam (see *Engineering News-Record*, Oct. 9, 1919, p. 696), and discussion showed that this construction is in use on several roads, including the Chicago & Northwestern Ry. and the Lehigh Valley R.R. It appears that as a rule no plank or guard rail is used, the flangeway being formed in the paving. A report on the equation of track values, by L. C. Ayers, assist-

ant superintendent, Norfolk & Western R.R., gave various items of work as equivalent to the maintenance of one mile of main track.

The officers elected for 1920-21 include the following: president, W. P. W. Wiltsee, assistant engineer, Norfolk & Western R.R., Roanoke, Va.; secretary, J. P. McAndrews, roadmaster, Chicago & Northwestern Ry., Sterling, Ill. The next meeting will be held at Chicago in 1921.

The following subjects have been selected by the Roadmasters and Maintenance-of-Way Association for presentation at the annual convention in 1921: Records and accounts of a roadmaster's office, F. J. Meyer, assistant engineer, New York, Ontario & Western R.R.; classification of second hand rail, Wm. Shea, general roadmaster, Chicago Milwaukee & St. Paul Ry.; economical methods of laying and renewing ties, G. S. Brooks, general roadmaster, Terminal Railroad Association of St. Louis; construction and maintenance of railway track crossings, D. O'Hearn, roadmaster, Elgin, Joliet & Eastern R.R.; stimulating rivalry between section forces, G. W. Koontz, roadmaster, Delaware & Hudson R.R.

Convention Discusses Smoke

The advantages of smoke prevention and the objectionable effects of smoke were presented in various aspects at the recent Chicago convention of the Smoke Prevention Association. Education was considered to cover 90 per cent of smoke reduction, which means that any move to reduce smoke must begin with the higher officials. To eliminate the widespread nuisance from domestic smoke, Dr. E. V. Hill, of the Chicago smoke department, suggested that the city should purchase the gas plants, install byproduct ovens and utilize the coke for domestic fuel. He suggested also the use of central heating plants, each serving an entire block or several blocks. Mr. Kreisinger, U. S. Bureau of Mines, thought the coal having less than 10 per cent ash might be used in byproduct plants, but that coal of higher ash content should be used in mechanical stokers or pulverized coal furnaces. Pulverized lignite has been burned successfully. A great part of the proceedings related to furnace design and accessories. Locomotive equipment and firing methods were also discussed. The president is J. M. Lonergan, New York; secretary, F. A. Chambers, Chicago. The 1921 meeting will be held at St. Louis.

Bridge Patent Suit Settled

Claims for infringement of patents in several bascule bridges over the Chicago River, brought against the city of Chicago by the Strauss Bascule Bridge Co., have resulted in an agreement by the city to pay $348,500. Two court decisions had been rendered in favor of the company and the city decided to settle rather than continue the case.

International Road Congress Officers Are French Engineers

Both the new president and secretary-general of the Permanent International Association of Road Congresses, elected at the meeting held in Paris, June 21, are engineers in the Ponts et Chaussées in the (Department of Bridges and Roads) Ministry of Public Works, France, and both have distinguished

ALBERT MAHIEU, PRESIDENT, PERMANENT INTERNATIONAL ASSOCIATION OF ROAD CONGRESSES

civil and military professional records. Albert Mahieu, former colonel of engineers, the new president of the association, is also counsellor of state, inspector-general of bridges and roads and secretary-general of the Ministry of Public Works. Paul le Gavrian, former lieutenant-colonel of engineers, is secretary-general of the association and chief engineer, Direction of Roads, Ministry of Public Works, France.

M. Mahieu was graduated from the Ecole Polytechnique in 1884. After graduation as engineer of bridges and roads he was active in highway and railroad construction in central France and at Paris. During this period he made especial studies of road construction and maintenance and became one of the best known of the French road engineers.

In 1908 he was charged by the Minister of Public Works with the organization of the first international road congress, whose secretary-general he became upon its permanent organization. As a member of the executive committee he assisted materially in planning and presiding over succeeding congresses held at Brussels in 1910 and London in 1913. When war was declared M. Mahieu was commissioned a colonel of engineers and was placed at the head of the service of military roads of all the French armies, a position he held through the war. After the war he again became active in work for the association and when, at the June, 1920, meeting, Mr. de Preaudeau, because of ill health, resigned as president, M. Mahieu was the unanimous choice as his successor.

M. le Gavrian, the association's new secretary-general, is a graduate of the Ecole Polytechnique and of the Ecole des Ponts et Chaussées, Paris. Shortly after his graduation from the latter institution he assisted in the design and erection of the large structures built for the Paris Exposition, and also the public boulevards, among them Avenue Alexandre III, and water, gas and sewer installations.

In 1901 M. le Gavrian was given, at Versailles, one of the most important highway road posts in France. Effects of automobile traffic had just then begun to be felt and he began intensive study of road construction and maintenance with the new factors taken into account. He was among the first engineers to introduce into France systematic use of tar for highway construction and maintenance. He experimented in various road products such as tar, pitch, petroleum oils, bitumen and asphalt, and finally established French technique in construction of aggregate mixture surfaces. Upon the organization of the first congress M. le Gavrian arranged the technical details.

At the outbreak of war M. le Gavrian was commissioned lieutenant-colonel of engineers and charged with directing the road service of the French Sixth army. In this capacity he took part in the battles of the Somme, Aisne, Chemin des Dames, the second battle of the Marne and Chateau Thierry. In 1918 he was attached to the French Mission at G.H.Q., A.E.F., in which position he co-operated with the American First and Second armies in the repair and maintenance of the roads in the Toul, St. Mihiel and Verdun sectors. After the armistice he was attached to Marshal Foch's staff and made responsible road officer with the French army of occupation.

Demobilized in April, 1919, M. le Gavrian resumed his work as chief

PAUL LE GAVRIAN, THE ASSOCIATION'S NEW SECRETARY-GENERAL

engineer, Direction of Roads, Ministry of Public Works. Early this year he was named professor at the Ecole Nationale des Ponts et Chaussees.

James A. McCrea, Engineer, Vice-President of the P. R. R.

Col. James A. McCrea, previously engineer, maintenance-of-way, Pennsylvania R.R., Lines East, who during the war served as deputy director general of transportation, has been selected to succeed the late Richard L. O'Donnel as vice-president of the Pennsylvania Railroad system, in charge of the Central Region, with headquarters at Pittsburgh. Under the reorganization of the Pennsylvania R.R., dividing it into four grand divisions, over each of which is appointed an operating vice-president, the Central Region embraces portions of what were formerly both the Western and Eastern Lines including the entire Pittsburgh district, one of the greatest railroad traffic producing territories in the world, extending from Altoona in the East to Columbus, Ohio and the Lake ports.

COL. JAMES A. McCREA

For the past two years Colonel McCrea has been vice-president of the Bankers' Trust Co., New York City, and previous to the war was general manager of the Long Island R.R. He was graduated from Sheffield Scientific School of Yale University in 1895 and entered the chief engineer's office of the Pennsylvania Lines West of Pittsburgh as a draftsman, later engaging in field work. Within two years he was appointed assistant engineer and in 1889 became engineer, maintenance-of-way of the Pennsylvania R.R., Lines East.

After his appointment as engineer, maintenance-of-way, Lines East, Colonel McCrea returned to the Western Lines in 1901 as superintendent of the Cincinnati Division, where he remained for five years. He was then transferred to the Long Island R.R. as general superintendent and became general manager in 1911. Upon his return from France in March, 1919, he left railroad service to become vice-president of the Bankers' Trust Co.

During the war Colonel McCrea rendered noteworthy service as general manager and later deputy director general of transportation of the American Expeditionary Forces, in recognition of which he was awarded the Distinguished Service Medal of the United States and was made an officer of the French Legion of Honor. Colonel McCrea is son of the late James McCrea who was the chief executive of the Pennsylvania R.R. from 1907-1913 and who for twenty years was vice-president of the company at Pittsburgh.

Road Machinery Company Cited for Unfair Competition

The Federal Trade Commission has cited the Eastern Road Machinery Co., Boston, Mass., in a complaint of unfair competition in the sale of road building machinery. Forty days are allowed the respondent in which to file an answer, after which time the case will be set for trial on its merits.

The company is required to answer an accusation that it has given to public officails and to employees of its customers sums of money and gratuities as inducements to influence them to recommend the purchase of the respondent's road making machinery.

A. A. E. Presents to I. C. C. New Definition of Engineers

At a hearing Oct. 1 granted the American Association of Engineers by the Interstate Commerce Commission a new definition was presented under which professional engineers in railroad service, classified as subordinate officials, are included. The term "engineers of mechanics" as defined after the I. C. C. hearing March 15 now includes civil engineers. It is recommended that there shall be included in the group within the term "subordinate officials" the following:

TECHNICAL ENGINEERS — This class shall include all professional engineers, assistant engineers, engineer assistants, instrumentmen, rodmen, chainmen, designers, draftsmen, computers, tracers, chemists, architects, engineer supervisors, engineer inspectors, and all other employees engaged in office or field work in any department and performing engineering work. None of the foregoing who have authority to employ, discipline, or dismiss subordinates shall be included.

The Commission has taken the matter under advisement and will probably make a decision within the next two weeks. George W. Hand, assistant to the president, Chicago and Northwestern Ry. Co. and chairman of the national railroad council of A. A. E., presented the substitute definition. He was accompanied by J. B. Jenkins, valuation engineer, Baltimore & Ohio R.R. Co., C. C. Burritt, office engineer, Southern Railroad, and R. C. Bailey, district secretary, A. A. E.

N. Y. Section, Am. Soc. C. E., Will Discuss Freight Distribution

The New York Section of The American Society of Civil Engineers will hold a meeting at the Engineering Societies Building, 29 West 39th St., New York City, on the evening of Oct. 20. The subject for discussion will be the local distribution of freight and food products. All members of the society are invited to attend.

Water Master Plan Introduced in California

Irrigationists supplied by water from Kings River in California organized early this year and after agreeing upon the individual rights and priorities involved asked the State Water Commission to place one of its engineers in charge of apportioning the water to the various canals. The Commission complied with this request and after the season's experience with the water master plan, tried out this year for the first time in California, found it to be such a success that in an announcement relating to the plan, the Commission says: "Neither the people nor the state will endure the waste."

As long ago as 1917 a bill was introduced in the State Legislature giving the Commission authority to place water masters upon all the large streams of the state, but the plan was then little understood and met with so much opposition that it was abandoned. In the absence of any joint plan the superintendent of each irrigation canal has been responsible to the water users under his canal for seeing that their full share of water was secured. This method is fairly satisfactory in time of abundant water but in time of drought the result has been found to be endless dispute and friction, expenditures for litigation and for checking rival claimants as well as extensive waste of water. Hence the low water of the past three years in California has been a factor in getting the water master plan into operation.

The Kings River system, one of the most important of the state, supplies water for 625,000 acres. This area is served by about 20 large and 25 small canals, many of which must be supplied in accordance with rights that vary with the seasons or total flow. The water master is expected to make equitable distribution in conformity with all the varying conditions. In addition to the constant variations in the river itself, occurring not only from day to day but from morning to night, the apportionment has to be adjusted for all such factors as sudden hot spells that melt the snow, thunder showers, accidents to canals or headgates, dangers of overflow, etc. Under these varying conditions it is part of his duty, in the words of the State Water Commission, "to keep reasonably satisfied the several thousand irrigators normally suspicious of each other."

Break Ground for Hudson Vehicle Tubes

The ceremony of breaking ground for the vehicular tunnel under the Hudson River between the states of New York and New Jersey took place Oct. 12 at the site of one of the ventilating shafts near Canal and Washington Sts., New York City.

Engineer Officers Commissioned

As a result of the recent examinations, the following appointments as commissioned officers in the Corps of Engineers of the Army have been announced:

To be Majors: Peter M. Anderson, Washington, D. C.; Harry F. Cameron, Washington, D. C.; Samuel F. Crecelius, Richmond, Ky.; Malcolm Elliott, Florence, Ala.; Elihu H. Ropes, Washington, D. C.

To be Captains: James D. Andrews, Jr., Camp Zachary Taylor, Ky.; Samuel L. Damon, Camp Travis, Tex.; James M. Farin, Chicago; George A. Geib, Gilbert, Me.; Lewis C. Gordon, Fort Scott; Robert C. Hunter, Wollaston, Mass.; William S. Kilmer, Washington, D. C.; Harry D. W. Riley, Zone Supply Office, Washington, D. C.; Harry O. Tunis, Baltimore; Elliot Vandevanter, Hanover, Md.; Harry D. Vaughan, Camp Taylor, Ky.

To be First Lieutenants: O. G. Hoaas, Wichita, Kan.; Albertis Montgomery, Camp Travis, Texas.

Engineering Societies

The New York Section, American Water Works Association will hold its October meeting at Hotel McAlpin, New York City, Oct. 20. There will be an opening luncheon followed by an illustrated talk by George C. Whipple on "Eight Months in Europe with the League of Red Cross Societies."

The Iowa Section, American Water Works Association will hold its sixth annual convention Nov. 5 and 6 at Iowa City. Since the section now includes Wisconsin, Missouri, Nebraska and South Dakota, the name will probably be changed at this meeting.

The Louisiana Engineering Society, at its meeting of Oct. 11, listened to a paper on "Present Status of the Sewerage, Water and Drainage System of New Orleans," by George E. Earl, general superintendent, Sewerage and Water Board.

The Engineering Society of Buffalo, at its meeting of Oct. 5, was addressed by J. R. Bibbins of the Arnold Co., Chicago, on "Technical and General Problems Involved in City Building," illustrated by lantern slides. Capt. George H. Norton, city engineer, spoke on Buffalo's municipal engineering problems, and Harry J. March, engineering executive, Buffalo City Planning Commission, showed, with a series of lantern slides, the growth of Buffalo up to the present and the application of the engineering principles necessary to adequately provide for the greater Buffalo of the future.

The Detroit Engineering Society announces the following program: Oct. 15, "Relationship of Foreign Labor to Its Employers," by Frank J. Raymond, of the Inter-racial Council; Nov. 5, "Conditions in Europe from a Political, Social and Engineering Standpoint," by E. J. Mehren, editor of *Engineering News-Record;* Nov. 19, "New Water Filtration Plant for Detroit," by Major T. A. Leisen, engineer for the Board of Water Commissioners.

The Illinois Section, Am. Soc. C. E. was addressed Sept. 28 by President Arthur P. Davis on the constitutional amendments pending before the society. The section will meet Oct. 14, at the rooms of the Western Society of Engineers, to discuss the proposed entrance into the Federated American Engineering Societies.

The San Francisco Engineering Council at its September meeting adopted a new constitution which reduces the membership of the council to three representatives of each individual section or society and increases the number of societies represented to include the following: San Francisco Sections of the American Society of Civil Engineers, American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Institute Mining Engineers, American Chemical Society, Pacific Association of Consulting Engineers, and the American Association of Engineers. Further plans for the California Engineering Council were discussed, and it was also decided to urge upon the San Francisco Chamber of Commerce action in the matter of interesting the Federal Government in dredging a deeper channel across the bar at the entrance to San Francisco Bay.

The Southern California Section, Am. Soc. C. E. held a meeting at Los Angeles, Sept. 22, at which J. C. Allison addressed the members and guests on "A Final Solution of the Irrigation and Flood Control Problem of the Lower Colorado River." Mr. George G. Anderson discussed the details of the efforts of the society's Committee on Development and the events leading up to the submission to the membership of the proposed amendments to the constitution. He pointed out the urgent necessity of a full and representative vote on these amendments and urged all to vote.

The Engineers' Club of Philadelphia announces the following October meetings: Oct. 8, American Institute of Electrical Engineers—afternoon session "Technical Session on Economics of Power Plants," with addresses on "Economic Study of Secondary Distribution" by P. O. Reyneau and H. P. Seelye, and "Electrical Demand Measurements" by P. A. Borden; evening session, "Session in Commemoration of the Discoveries of Arago, Ampere, Davy and Oersted." Principal speakers, Prof. Elihu Thompson and Prof. M. I. Pupin. Oct. [illegible] American Society of Marine Draftsmen. Oct. 12, Tuesday luncheon address, "Bureau of Standards and Its Engineering Contacts" by Dr. George K. Burgess. Oct. 13, American Association of Engineers. Oct. 14, American Society of Heating and Ventilating Engineers: "Résumé of the Work of the Research Bureau" by Dr. John R. Allen. Oct. 15, Illuminating Engineering Society. Oct. 16, Smoker, "A Trip Across the Andes and Through Chile" by Senor Richard Barrous, Special Commercial Commissioner to the United States for Chile. Oct. 19, Tuesday luncheon address, "The Inspiring Outlook for American Engineering" by Morris L. Cooke. Oct. 19, Regular meeting of Engineers' Club, "The Development of the Technique of Changing from the 2-Shift to the 3-Shift Day in a Continuous Process Industry" by Robert B. Wolf, consulting engineer. Oct. 20, Society of Automotive Engineers, "The Future of Highway Transportation as It Affects the Automotive Engineer" by C. M. McCreery. Oct. 21, American Chemical Society. Oct. 22, American Society for Steel Treating. Oct. 26, Tuesday luncheon address. Oct. 26, American Society of Mechanical Engineers, "Bearings" by Albert Kingsbury. Oct. 27, Society of Municipal Engineers, address by Hon J. Hampton Moore, Mayor of Philadelphia. Oct. 28, American Welding Society.

Personal Notes

R. H. COULSON has been appointed district engineer of the Western District, New York Central Lines, with headquarters at Buffalo, succeeding the late N. F. Thompson.

W. O. WASHINGTON, recently engineer of Caldwell County, Tex., has been appointed highway engineer for Cameron County, which is planning a system of concrete roads. His headquarters are at Brownsville, Tex.

C. S. SHAUGHNESSY, formerly engineering examiner in the New York City Civil Service Commission, has been appointed chief examiner of the Civil Service Commission of Philadelphia. He is the first engineer appointed to such an office.

JACKSON R. CRISSEY has resigned as city engineer of Johnstown, Pa., to enter the field of construction. Mr. Crissey entered the employ of the city fourteen years ago as a field engineer and was city engineer for seven years.

FRANK BACHMANN, chief chemist Industrial Waste Board, Connecticut State Department of Health, and recently in charge of the sewage experi

mental plant at New Britain, has severed his connections with that board to join the staff of the Sanitary Engineering Department of the Dorr Co.

MONROE L. PATZIG consulting engineer, Des Moines, has been appointed plant inspector for asphaltic paving materials now being used in Rock Island, Ill.

T. W. NORCROSS has been appointed chief engineer of the Forest Service, U. S. Department of Agriculture, succeeding O. C. Merrill, who recently resigned to become executive secretary of the Federal Power Commission.

S. J. HUNGERFORD, of Toronto, has been appointed vice-president of the Canadian National Railways. He has been in railway work from youth, starting as a machinist's apprentice with the C. P. R.

M. H. MACLEOD, of Toronto, has been appointed vice-president in charge of construction of the Canadian National Railways. Mr. MacLeod was formerly chief engineer at Winnipeg for the Canadian Northern Ry.

ARTHUR S. MILINOWSKI and JOHN F. DRUAR have become associated under the firm name of Druar & Milinowski, consulting engineers, St. Paul, Minn. The firm will conduct a general engineering practice, specializing in municipal improvements and public utilities. Mr. Milinowski was formerly assistant engineer on barge canal construction in the department of the New York State Engineer, at Rochester, N. Y. Mr. Druar has been engaged in similar work at St. Paul for the past twelve years.

R. E. MCDONNELL, of Burns & McDonnell Engineering Co., consulting engineers, Kansas City, Mo., was elected president of the Southwest Water Works Association at the ninth annual meeting in New Orleans, Sept. 24.

WALTER PAGE, president Page & Co., Ltd., contractors, Toronto, has been elected president of the Ontario Paving Brick Co., Ltd., Toronto.

OBITUARY

JAMES H. SHERMAN, president Sherman Engineering Co., of Kansas City, Mo., died on Oct. 2. He was 36 years old. During the 18 years of his engineering work he spent four years with the Pere Marquette and New York Central railroads; seven years with the Truscon Steel Co. as designer and assistant district manager; one year with the American Rolling Mill Co. as manager of its metal lath department; four years with the Lehrack Construction Co., Kansas City, and the Burrell Engineering & Construction Co., Chicago, as chief engineer; and the last two years of his life as president of the Sherman Engineering Co., which he organized for the purpose of specializing in the design of grain elevators and flour mill buildings.

JOHN D. ISAACS, JR., chief engineer, S. J. Junkins & Co., Ltd., was killed Oct. 1 by the accidental discharge of a shotgun while hunting duck at Lake Manitoba, Canada. Mr. Isaacs was the son of John D. Isaacs, consulting engineer of the Southern Pacific Co. at New York. He was born in Oakland, Cal., in 1882 and was educated at the University of California. During this period he took a leave of absence of one year to become engineer of construction of the Yosemite Valley Ry. After leaving college he entered the service of the Harriman System in the engineering department. He had charge of the location and construction of the line from Chehalis to Aberdeen, Wash., and later was engaged in track elevation and building construction work for the Oregon-Washington Railroad & Navigation Co. in Spokane, where he initiated original methods for moving large concrete abutments in connection with track elevation work. For the last few years Mr. Isaacs had been associated with the Junkins company and had had charge of extensive wharf and dock work carried out by that company for the Canadian Pacific R.R. at Vancouver. He also had charge of hydro-electric surveys and development work in the Canadian Northwest, some of which were notable for having been carried out during the winter season, when it had been thought impossible to accomplish such work at this time of year. At the time of his death he was in charge of work for the Junkins company, lining the Connought tunnel, formerly known as the Roger's Pass tunnel of the Canadian Pacific line.

Thrust Boring Machine

A new machine to appear in England is a hydraulic thrust boring machine, designed for use in boring horizontal holes up to 12 in. in diameter for pipe and cable installations. The new machine which eliminates both trench excavation and spoil disposal, inasmuch as boring is done by earth compression, receives the following description in a recent issue of *Engineering Review:*

Invented by Captain A. R. Mangnall and Captain Irving, this machine is claimed to revolutionize present practice for pipe and cable laying in that type of ground suitable for operation of the machine. The earth must be consolidated and possess clay in some percentage, and of a hardness not exceeding the stiffest blue clay. As this covers most of the cases where normal excavation can be carried out, the application of this machine is calculated to be widespread.

The ability of the machine will be realized when in half an hour, and departing only a trifling amount from the predetermined course, a hole 150 ft. long and 4 in. in diameter is made horizontally below the ground without disturbing the surface.

Small pits 150 ft. apart or other convenient distances are made in the ground, and, in turn, linked together by thrust-borings of the required size. Holes up to 12 in. in diameter can be made, and even larger sizes under certain conditions. Thrust-borings are made of any suitable depth required, and, as trench excavation is dispensed with, all surface reinstatement costs are eliminated.

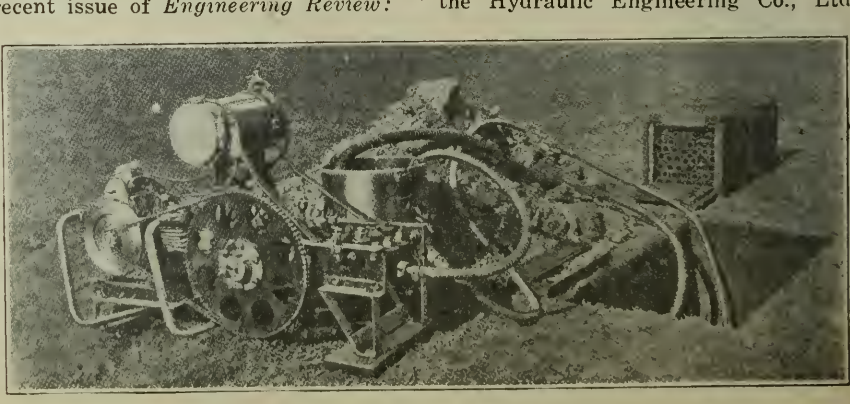
In thrust-boring the earth is compressed and displaced around the thrust-boring tool, there being no cutting action, and consequently no "spoil," to be disposed of. By virtue of this "compression" around the thrust-bore, the internal skin is hardening sufficiently to permit the feeding along its surface of heavy cables or pipes, without causing any material scouring of the bore.

The apparatus is portable, all the gear weighing only 13 cwt. for cable laying, while for the larger holes in pipe laying a heavier plant is required, but the weight depends largely on conditions.

The machine consists of an hydraulic cylinder carried on trunnions in a light steel carriage, and capable of being turned from a horizontal to a vertical position. Inside the cylinder is a piston with short guiding fingers. This "gun," complete in its carriage, is dropped onto its base framework in the pit, the rear end having suitable abutment members to take the load. The "gun" is connected by flexible pressure pipes to a small gasoline driven pump set. The water is in continual circulation through the system during the whole of the operation, only a small reservoir tank being required. The operation is begun by turning the "gun" into a vertical position and dropping the "pilot"—the "business end" of the thrust bar—into it.

The "gun" is turned down, and, after being aligned on its position at the next pit by suitable elevating and training gear, the pressure is admitted behind the piston and the pilot is thrust forward into the ground. The admission and exhaust valves are operated by one single lever. The gun is again raised, and the first extension piece pressed into it, the water being exhausted in this operation. The gun being again lowered, the pilot is thrust forward by the extension piece. This operation is repeated until the "pilot" breaks through into the next pit and the boring is completed. The whole cycle of raising the gun, inserting an extension piece, lowering the gun, making the coupling and thrusting the piece home, occupies less than one minute. The extension pieces are then withdrawn from the completed bore, and, on being uncoupled one by one, are placed in the case ready for boring at the next pit. Allowing for time in extracting these tubes, cleaning and moving the entire gear from pit to pit, at least two thrust borings can be made in an 8-hr. day, the thrust-boring screw consisting of three men.

The machine is manufactured by the Hydraulic Engineering Co., Ltd.,



THRUST-BORING SET INCLUDING EXTENSION JOINTS

A Consolidation of Engineering News and Engineering Record

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British Miners' Strike

THE BRITISH MINERS, contrary to expectations, have gone on strike. Two postponements, at the request of the Government, raised high the hope that there would be a peaceful settlement. Now 1,000,000 men have laid down their tools, and England faces the greatest peace-time crisis in her history. If continued but a few days (this is written on Monday afternoon) factories must shut down and transportation will probably be seriously curtailed. As to the outcome of this trouble, there seems to be no doubt whatever in well-informed British quarters. The Government has confidence that the Nation approves its course of not making the concessions demanded by the men. It believes that the inconvenience will be tolerated, and that the preparations it has made will prevent, for as long a time as the strike can last, hardship due to failure of the food supply. With its habitual calmness the people have watched the struggle coming on and the actual conflict is entered, according to the Manchester *Guardian*, with surprisingly little heat on both sides. This temper is an admirable one and gives hope that the men themselves, recognizing the calm attitude of the public, with its evident desire to be fair, will listen to the counsel of their leaders and return to work before the crisis produces the acute suffering that is inevitable with its long continuance. This much is certain—the British public will not allow the strike to be the instrument for nationalizing the mines, the original object of the union's leaders.

Earth Shrinkage Research

NEED for further experiments in determination of the final change in volume of earth from excavation to embankment was shown in the article by E. E. R. Tratman in *Engineering News-Record* of June 24, 1920. Since that time the subject has been under discussion in various published communications, and an article presenting the results of a study from measurement records, made by a sub-committee of the railroad presidents' conference committee on valuation, was published in the issue of Aug. 26, 1920. Definite progress in earth-shrinkage research is shown in the recent "density" tests conducted by the valuation department of the Chicago, Burlington & Quincy R.R., as reported elsewhere in this issue. Here, a relation appears to have been established between the amount of shrinkage and the depth of excavation below the surface. In this connection it is interesting to note the recent experience of an Eastern road. It allowed 10 per cent for shrinkage in building a yard embankment with material taken from deep excavation. But after a prolonged wait the material had not shrunk 10 per cent and it was necessary to remove some of it in order to bring the embankment down to grade. Further research is important not only for valuation but also for location and construction purposes.

Sand Fills for Factory Sites

HYDRAULIC FILLS of pure lake sand have been specified in recent operations of reclaiming low lands for factory sites on the shores of Lake Michigan. The artificial plateau which lifts the enormous Field Museum building at Chicago some 30 ft. above the lake shore represents the beginning of this practice but more truly characteristic examples are furnished by the fill at Waukegan, Ill., described on another page, and a simultaneous and almost equally as large an operation at Muskegon, Mich. Prevalence of sand beaches and inshore dune lands affords the opportunity for choosing sand and makes the choice economical, but the practice is also based on other considerations. The sand fill is clean and sanitary and its surface drainage is as nearly perfect as can be. A more important advantage is that the moment the sand is hydraulically deposited it attains its final settlement and solidity. Foundation construction can proceed at once, without fear of internal readjustments of the supporting earth. Moreover, as indicated by the operation described, some rather remarkable hydraulic-dredging records are being made in handling these large volumes of sand.

Cost-Plus for Public Works

FOLLOWING the rejection of bids opened April 27, 1920, for the construction of the Wanaque earth dam of the North Jersey District Water Supply Commission the contract is being readvertised with important changes. Originally there was provision for a readjustment of prices, during the progress of the work, based on a rise or decline in the cost of labor (see *Engineering News-Record*, April 8, p. 734). Even this stipulation, decidedly radical for this class of contract, did not have the desired effect of securing either a sufficiently large number of bidders or prices low enough, in the judgment of the Commission's engineering advisers, to justify an award. The particular feature of the new contract, for which bids close Oct. 28, is the inclusion of two forms of proposal, the first involving a type of cost-plus-percentage fee and the second a straight unit price. While the cost-plus feature was widely used in war contracts and has always been more or less common in private work, its adoption now for a public works project is worthy of note. Under the cost-plus form for the Wanaque dam the work is divided into various items, and prices have been determined and made public by the commission's engineer for which it is estimated that unit quantities of the respective items can be constructed or furnished. Upon the estimated cost of the work, as thus obtained, the contractor bids his percentage compensation fee. There is also a sliding scale feature of the payment clause whereby the contractor's percentage, if the actual cost exceeds the estimated or "base" price, is reduced; or increased, on the other hand, if he succeeds in doing the work at a lower figure than that set by the engineer. The cost

of the work now to be placed under contract, exclusive of the percentage fee on the chief items, is $1,384,150. The low bid on the previous occasion of opening bids, reduced to terms of the present project (which has been reduced in size from that originally advertised) was about $1,790,000. The latter figure, of course, included contractor's profit. The occasion of opening bids next week on the revised contract, therefore, will be interesting from the point of view of determining whether the new cost-plus feature will result in more bidders and lower prices.

What Will the American Society of Civil Engineers Do With Its Proceedings?

WITH the August number the American Society of Civil Engineers made important changes in its *Proceedings* and invited views on proposals even more far reaching. These changes and proposals needed immediate consideration, but it was idle to expect it while the constitutional amendments were under discussion. Now the time is more propitious.

The changes already made were put into effect without consulting the members, and the publication committee has authority to proceed with the others when it sees fit. It is apparent, therefore, that the committee considers them purely administrative in character. In this view, evidently, the board of direction concurred, for it is not conceivable that the board would endorse anything, without consulting the membership, that it considered ran counter to the essential service of the society.

The changes and proposals, however, are such a marked departure from past practice that an examination of them in the light of the society's purpose is called for. In fact, such an inquiry is demanded by the uncertainty displayed by the publication committee itself. Possessed with the full authority of the board to make additional changes, it hesitates to use its authority until it has heard from the members. It apparently doubts its own conclusions, even after it has convinced the board of their soundness and secured for them the board's approval.

The society's object is "the advancement of engineering knowledge and practice, and the maintenance of a high professional standard among its members" While there have been suggestions as to new methods of accomplishing this purpose, and even of broadening it by emphasizing the society's civic duty, there has never been a desire to divert the society from its original and constitutionally expressed object. The attainment of that object has been sought, principally, by discrimination in admitting members, by the presentation and discussion of technical papers, and by committee work.

Keeping the object in mind, we direct our attention to the new measures.

All of them are put forward as part of a program of economy, in response to a resolution of the board directing the committee to report a plan whereby savings may be made in the publications. As a matter of fact, some of the changes and proposals actually call for greater expenditures. The committee's suggestions, therefore, fall into two classes—those that make for economy and those that make for expansion.

The "economy" features include the reduction of margins and the omission of papers, of discussions, and of the new-book and current-engineering-literature sections. Merely a synopsis of the papers is to be printed in *Proceedings*. The papers in full, the discussions and the two sections are to be sent only to those who request them, but each member is to receive the *Transactions*, made up as heretofore—with the papers and discussions in full.

Of these changes the most important, obviously, is the omission of papers and discussions, and this, as well as the other changes and proposals, the committee has handled as a matter of mere administration. But is it a mere detail when viewed in the light of the society's object, "the advancement of engineering knowledge and practice"?

To advance an art is no small task, and in its accomplishment every step needs to be taken to overcome natural human indifference. Instead of helping to secure for the society's papers maximum attention by making them easy of access, the committee's plan places a hurdle in the way. We cannot believe that the papers will get so good attention under the new plan as under the old, nor that the discussions will be followed so assiduously. If that view be correct, the new scheme hits directly at the society's progress along one of its chosen lines.

From this standpoint, too, the proposal of the acting secretary that the papers and discussions be printed as formerly and that the *Proceedings* be collected from members to be bound merits consideration. It has obvious difficulties. The task of collection would be tremendous, and the collation of the discussion on a given paper immediately following the paper itself would be well-nigh impossible. Modifications can be suggested. Each member, for example, might be allowed to look after his own binding, albeit he would get less from the society for his dues by the value of a paper binding of *Transactions*. Further, the issuance of all discussion in a single pamphlet to be bound with the *Proceedings* already in the members' hands would at least result in putting all of the discussion on a given paper in one place, though not following the paper itself.

Before dismissing the "economy" measures, it is not out of place to ask why, if economy was in mind, the committee did not apply its pruning knife to the department carried for some time in the *Proceedings*, entitled "Items of Interest." It is formless, without policy or plan, and ran, in the August number, to twenty pages. Evidently the committee fails to distinguish between the function of "advancing" engineering knowledge and "disseminating" engineering knowledge. "Items of Interest" disseminate, but do little or nothing toward "advancing" engineering knowledge. Some of the items are necessary matters of news, but very many of them have no place in any scheme that fits into the object as expressed by the society's constitution.

We come now to the second element of the plan—that of expansion. This element, too, is the more important, even though the announcement, while asking questions on certain of its features, did not segregate it and thus direct toward it the attention it deserves.

The proposal, reduced to a sentence, involves the abandonment of the publication of a "proceedings" and the substitution therefor of a magazine. "Announcements" are to give way to journalistically treated sections, entitled "Society Affairs" and "Activities of Local Sections." A correspondence department is to be inaugurated in which will be discussed not merely

society matters and "general developments in engineering," but also "topics of passing importance to the profession." The only papers to be printed are "short, timely papers of wide general interest." The introduction of editorial comment, of a section on engineering research, and of employment notices is being considered, while the publication committee has authority to increase the page size to 9 x 12 in.—the standard magazine size—and to insert advertising. These proposals, combined with the "Items of Interest," previously referred to, complete the project of making a magazine for the members of the society.

Obviously, some of these things are desirable. The flatness of *Proceedings* in the past has been deplorable. There is need for the journalistic treatment proposed for society affairs and the activities of local sections, but obviously the relief of this flatness does not necessitate editorial comment—nor correspondence on "topics of passing importance to the profession"—nor an increase in page size—nor the taking of advertising. All of these things are part of the scheme of making a magazine. The argument that has brought the committee to this conclusion probably runs something like this:

We must secure revenue. Revenue can be secured from advertising. Advertising can be secured most easily for a paper that is read. To be read a paper must be interesting. To be interesting it must be varied and not too heavy. Therefore to get revenue we will make a magazine that is varied and not too heavy.

The chain of reasoning might go unchallenged in a purposeless organization, but with a body established for definite purposes—pursued with devotion for sixty-eight years—the argument must be examined in connection with those purposes.

The blunt question is whether the publication of a magazine fits in with the object of "advancing engineering knowledge and practice," or is an alien activity. Certainly, a "proceedings" on the old order, with some obvious improvements in presentation, did serve that object. The form of magazine now planned by the publication committee, however, is directed chiefly at the "dissemination" of engineering knowledge, rather than its advancement through the focusing of serious engineering thought on the technical problems confronting the profession. The committee's drift is apparent not merely from the character of the "Items of Interest" now published in the *Proceedings*, but also from its invitation to the members to submit letters on "topics of passing importance to the profession," and its conclusion to print in the *Proceedings* only "short, timely papers of wide general interest."

The incompatability of magazine publishing with the conduct of a society appears at many points. Take, for example, the matter of editorial comment. Whose opinion shall be expressed? We have in the past been treated to sharp conflicts even on technical matters which, it would appear on the surface, could be settled by a clear presentation of "facts." For the best accomplishment of the society's object a judicial habit of mind and a calm course are desirable—something that will not be encouraged if the society decides to take editorial positions, with the certainty of ensuing controversy.

The incompatability appears also in the matter of advertising. Is there not a fine distinction conferred by aloofness from commercial considerations, a distinction inseparable from high professional standing? We believe that there is, and the fact that other societies do not believe so does not prove the case against us. The American Society of Civil Engineers stands second to none in prestige. The character and appearance of its *Proceedings*, the discrimination it has exercised in the admission of members, the carefulness of its public expressions, the quality of its committee work, have stamped it with a distinct and enviable personality. Will the society retain that personality when advertising salesmen are peddling the society's wares? What will be the society's standing if the publication committee's query, "Shall an intensive campaign for advertising be inaugurated," be answered in the affirmative?

It should not be necessary to discuss the disturbing effect of the commerical attitude further. Engineers have always recognized a very distinct cleavage between professional and commercial thinking. The two are incompatible. You cannot serve two masters. When advertising revenue becomes big, larger than the dues, let us say, to which phase of the work will the executives of the society give the greater attention?

Yet another thought is warranted on this important subject—or rather on this *critical* subject because it involves the entire future attitude of the society. So far has this matter of publishing been carried by certain societies that the expression "publication society" has been coined. It is for the members of the American Society of Civil Engineers to decide now whether theirs is to be a technical organization devoted to "the advancement of engineering knowledge and practice," or a publication society. To help the thinking in this direction the extreme case of the National Geographic Society is cited. Any one may become a "member" of this body by subscribing \$2.50 a year for a magazine. It is distinctly devoted to the "dissemination" of geographical knowledge, but is not distinguished for work in the "advancement" of geographical knowledge. It is regarded generally as a publishing organization, not as a scientific society.

Evidently, then, there are in the publication changes of the American Society of Civil Engineers two distinct movements. The one seeks to cut the garment according to the cloth. The other already begins to expand plans for the garment in the hope that more cloth will be available—even if the additional cloth is to be bought with commercial revenue. Both movements seem to have proceeded without adequate consideration of their relation to the society's object.

The main issue is this: Shall the society through an inadequately considered publication plan depart from its principal object?

Expressed as matters of detail the issues are these:

Shall the society get its full papers and discussions in *Proceedings* or only in *Transactions?*

Shall the funds be used to publish a magazine?

Shall the society raise additional revenue by commercial means?

These are important questions. If the membership does not react sharply and strongly it may be sure that before long it will find the proposals of the publication committee in full effect. The committee has authority to proceed with the changes without consulting the membership but preferred to invite the storm, if there were to be one, rather than wait for it.

The choice is in the hands of the members. What do they want?

Cellular Flat Slabs Lighten Concrete Building

Foundations of Boston Structure Vary With Changes in Ground, but Saving in All Footings Results From Reduction in Floor Weights of Special Slab Design

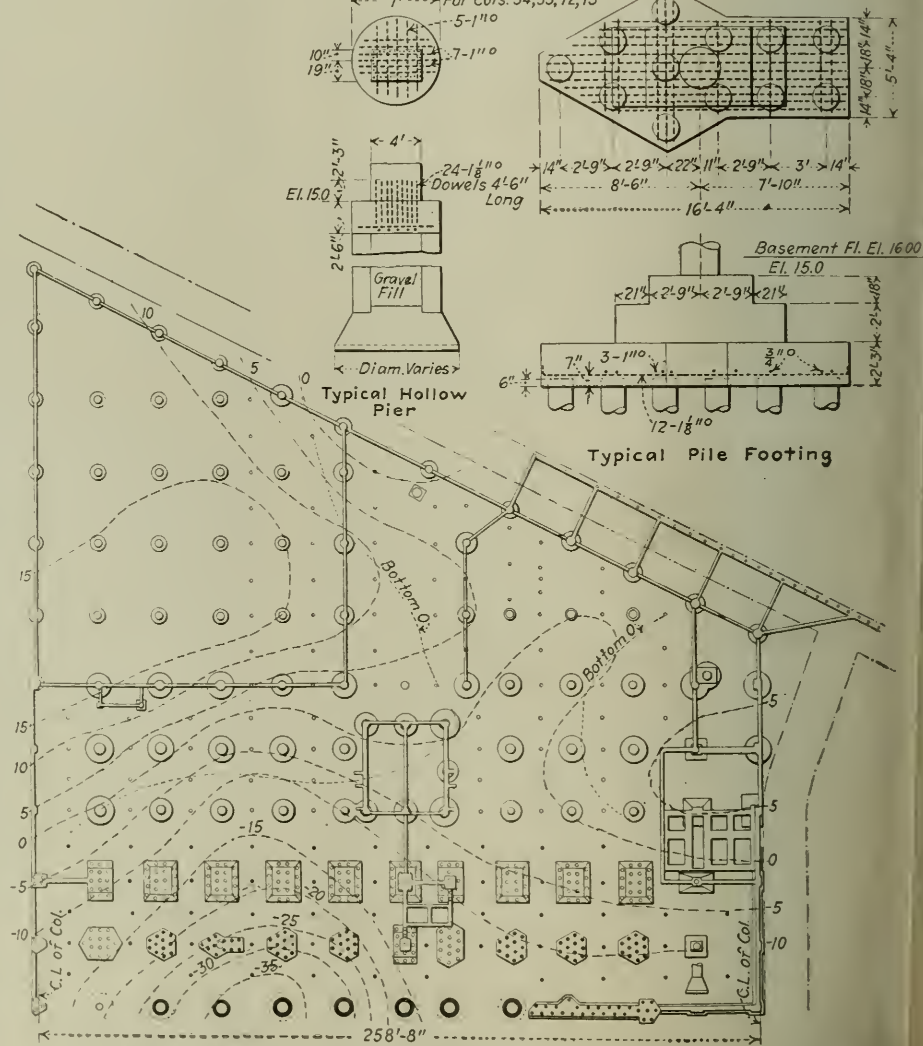
By Oren S. Hussey
Engineer, Nashua, N. H.

REINFORCED-CONCRETE flat-slab floors, in which the main slab is made up of two-way beams, were used in the new Noyes-Buick automobile building on Commonwealth Ave., in Boston. The construction saved weight in the framework itself but also materially reduced the loads on the foundations which had to be specially built on account of rather unsatisfactory soil conditions. The surface was of soft peat with underlying hardpan at irregular depths of from 8 to 30 ft. below the river level. The reduction from using the two-way slab was figured to be about 30 per cent.

The building covers about 52,000 sq.ft. of ground area. The front section of the building is five floors high with basement and covers about 25,000 sq.ft. of surface, while the balance of the ground area is covered by a rear section consisting of one floor and a basement which is used for shop purposes. The first floor of both sections was nearly all of the two-way cellular flat-slab type of construction. The other floors and roof in the front or five-story section, except where column heads were objectionable for architectural reasons, were also of this type of construction, while the shop roof at the second story level in the rear, carried by steel trusses, was of a ribbed one-way type of construction.

The foundations used for the structure were of several types. The piers in the left rear corner were on clean, hard, fine clay sand from the basement level down, but this condition varied suddenly and often elsewhere to a maximum of 40 ft. in depth. Except for the corner mentioned above and the three rows of columns next to Commonwealth Ave., all piers were of the type largely introduced and executed by Lt. Col. Charles R. Gow and generally known as "Gow" piers. They consist of a circular concrete shaft with a spread footing or bell at the bottom and were most useful and economical at depths of from 10 to 30 ft. in wet ground where the soil immediately above the bearing stratum is peat or other material capable of being undercut to form a bell.

Open excavations were made within sheet steel telescopic cylinders ranging from 36 to 72 in. in diameter, the size being selected which, by reductions of 2 in. for each 5-ft. section inserted, would give the required minimum diameter at the bottom. The cylinders were excavated by hand, the bells chambered out and immediately filled with concrete, the shaft cylinders being then filled and pulled one by one. This construction gave a pier which was oversized at the top but one which required no bracing when excavated, or forms when concreted, leaving a balance in econom[y]. To meet the conditions which were found to ex[ist] under the three front rows of piers on the Commonwealth Ave. side of the structure, it was decided to u[se] the cast-in-place Simplex piles, 16 in. in diamet[er], driven by the New England Foundation Co. These pi[les] were designed to carry from 25 to 30 tons each with penetration of from 10 to 12 ft. into sand and gra[vel]



FOUNDATION LAYOUT OF NOYES-BUICK BUILDING SHOWING HARD BOTTOM CONTOURS AND VARIED FOOTING

FORMS FOR SUPPORTING FLAT-SLAB PANS

PUTTING FLOOR PANS IN PLACE

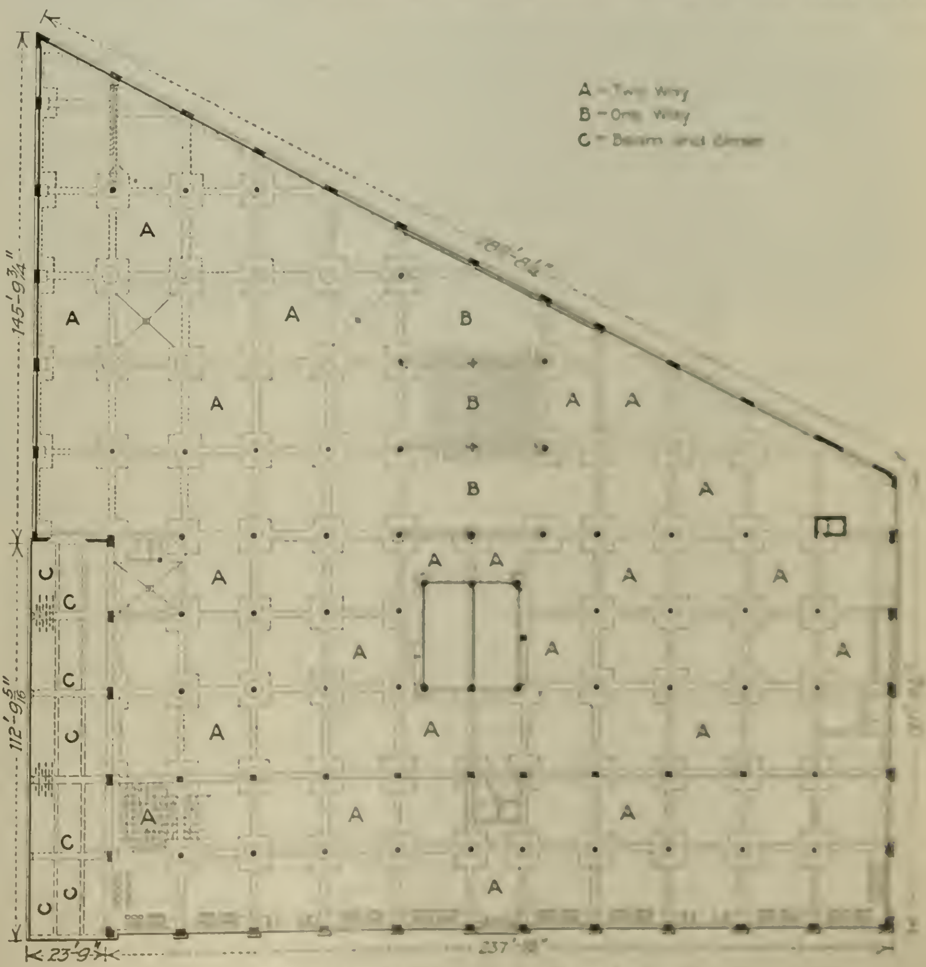
subsoil. They were driven with a 3,600-lb. drop hammer and showed a penetration of from 1 to 3 in. from the last eight blows, a constant drop of 10 ft. being maintained with the hammer, and a penetration into bottom of from 8 to 16 ft. Pile No. 11, having a penetration of 1½ in. in the last eight blows and approximately 10 ft. into bottom, was given a load test. The test showed a permanent settlement of 0.03 ft. under a three-day application of 55 tons; a load of 60 tons increased the permanent settlement to 0.053 ft. This was considered a satisfactory test for the designed load of 27 tons.

In the front row of piles and in parts of the second row, it was found impracticable to drive the ¾-in. heavy Mannesmann steel tubes, forming the temporary pile casings, through the thirty or more feet of gravel filling, or, when this was accomplished, the added resistance of the hard bottom prevented further penetration. Persistent attempts ruined tubes and machinery used for driving and recourse was had to open end caissons for the street front foundations.

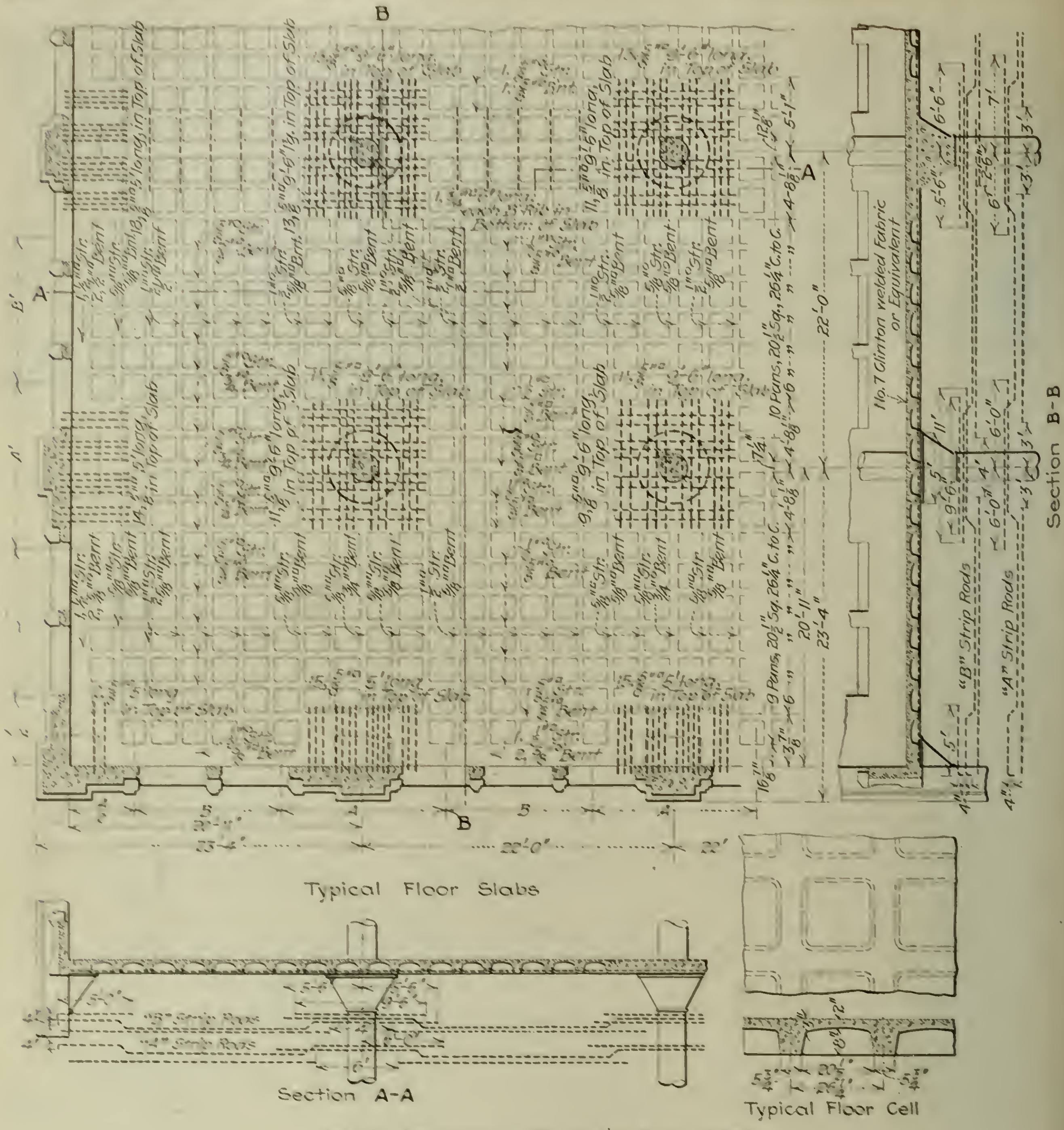
Because of the shallow depths of the underlying peat, two feet or less, which prevented chambering for bells, the contractor provided caissons of 8-in. shells cast in place with an outside diameter nearly or quite equal to the bell diameter and carrying a short steel cutting edge at the bottom. These were excavated by hand as in the case of the other piers, the bell and core being poured full when the bottom was reached. The majority of these piers were sunk by gravity but an occasional pier required jacking down, the surrounding earth being used for load.

In the center of each basement bay, a concrete pile or a dug pier was sunk to support the basement floor loads, the underlying earth being equal to the requirements.

The major part of the typical floor, as shown in one of the drawings, is of the cellular flat-slab type, that is a girderless reinforced-concrete floor system in which there is the usual column, capital and column head but in which the slab proper instead of being of uniform thickness is of criss-crossed reinforced-beams made by dome forms which are removed, leaving the honey-comb or waffle-like ceiling shown in one of the views. The



TYPICAL FLOOR LAYOUT OF BUILDING



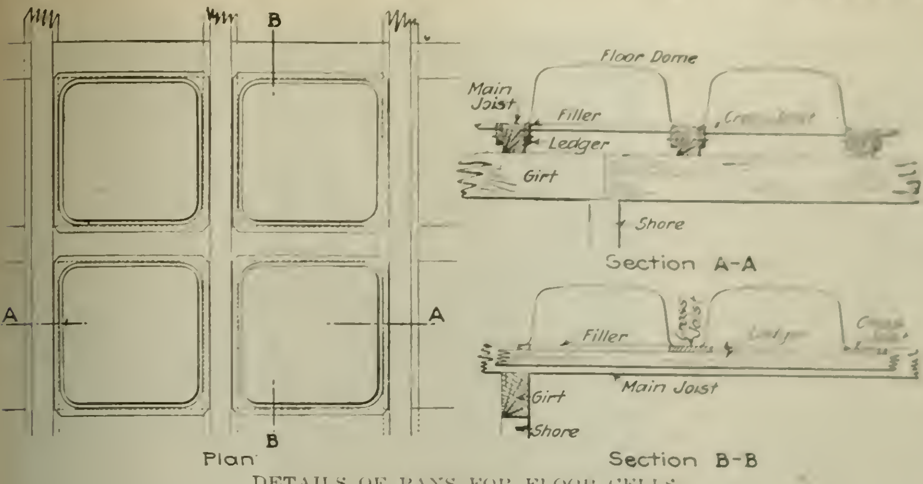
DETAILS OF TYPICAL CELLULAR FLAT SLABS

panels varied in area but a typical interior panel was 22 ft. square, with a 5-ft. capital and a column head 9 ft. 4 in. square. Domes 20½ in. square left beams 5¾ in. wide at bottom on 26¼-in. centers both ways. Reinforcement as shown in the typical panel drawing consisted of rods in the bottom of beams in both directions, bent up over the supports and supplemented by extra bars criss-crossed in the upper part of the column head.

One of the drawings herewith gives the moments as figured for a typical interior panel under the provisions of the Boston building code as given in the caption to the cut. Under this code the building was designed to carry 150 lb. per square foot less a reduction for slab areas exceeding 300 sq.ft. of 25 per cent, or a net live-load of 112½ lb. per square foot. The depth of the floors was uniformly 10 in. without dropheads regardless of the change in span from 22 to 25 ft. Of this total depth, 2 in. was taken up by the top slab, the balance being the depth of the rib and fillets on either side of the rib. The building law permitted concrete fire protection below the steel of ¾ in. for flat slabs and 1½ in. for the beams or ribs; the value of *d* therefore was 7.88 in., this value being taken as the mean of the depths in each direction.

In order to secure the cellular steel forms for the slab, steel domes, manufactured by the Truscon Steel Co., Youngstown, Ohio, were purchased under a guarantee against patent infringements. These domes, shown in an accompanying view, were about 20 in. square with flanges of 1 in. additional on each side, 8 in. in depth and made from No. 16 gage metal, hot pressed.

The weight of the floor, 9½ in. thick, under ordinary



DETAILS OF PANS FOR FLOOR CELLS

conditions, would have been approximately 115 lb. per square foot outside of the area of the plinths; the actual weight of the floor, as constructed with cellular flat slab, steel domes, manufactured by the Truscon Steel purposes of computation was taken at 80 lb. per square foot, including the plinths. It will therefore be seen that, with the form of construction adopted in this building, the saving in weight was somewhat over 30 per cent; the saving in load on the columns was about 15 per cent and slightly more on the foundations. As the depth of the steel, i.e. the value of *d*, was substantially the same in either design, the saving in this was directly proportional to the total loads, or about 15 per cent.

It can be seen that the wisdom of adopting the design used in the construction of this building would depend largely upon the matter of forms and the cost of the same—the saving in other directions being obvious. In designing the forms, the purpose was not only to effect economy in construction but also to permit of the ready removal of the steel domes without disturbing the posts supporting the fresh concrete. It had been found that the domes could be removed at the end of two or three days, after the concrete had been poured to good advantage and used over again in other parts of the work, thus reducing the number of domes required for any particular work. To permit of this ready removal of the domes, 4 x 4-in. joists, planed on top with 2 x $\frac{7}{8}$-in. ledgers nailed on the sides and $\frac{7}{8}$-in. below the top of the joists, were used. These compound beams were formed and then laid parallel, 26$\frac{1}{2}$ in. apart with 8 x $\frac{7}{8}$-in. cross pieces laid also on 26-in. centers. This arrangement, by the use of double-headed nails, permitted the ledgers to be moved and the domes dropped without disturbing the joists or posts. In order to more easily drop the domes in case of their sticking in the concrete, a lever was used which engaged small holes in the side walls of the domes; no difficulty was experienced in removing the domes except in some instances when they had been left in place too long.

The domes were used over repeatedly in the construction of this building and when finished with, were apparently in as good condition as when new. It was necessary, however, that they be well greased before being placed in position and care was taken to see that this was done. The accompanying cuts show the construction of the compound beams and the methods used in placing them in position to hold the domes.

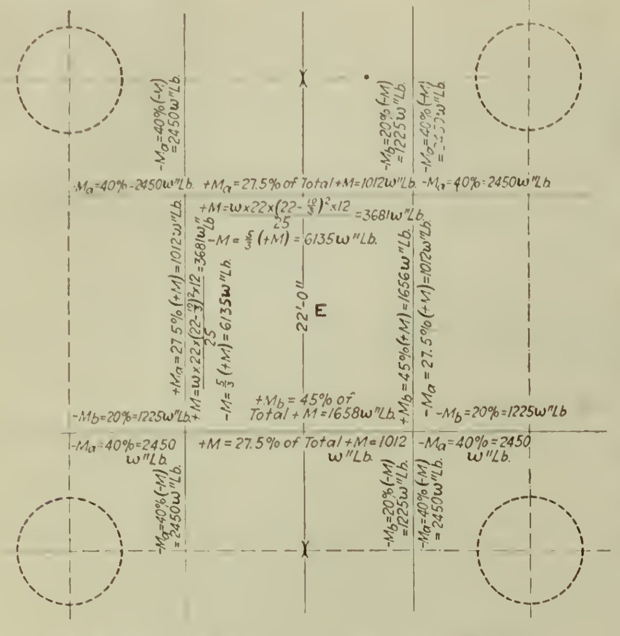
The contractor reported that the cost of forms, constructed as described above, was substantially identical with the cost of ordinary flat-slab forms but observation of the work indicated that there should be a material saving made because of the repeated use of and the great facility with which the forms were erected after the first time.

FLOOR PANS AND REINFORCEMENT BEFORE PLACING CONCRETE

The determining factor of this design, as worked out by the Joint Committee methods, appears to be the negative compression in the rib at the "mid section" and there is also, in some cases, danger of excessive shear near the plinth in the column sections. Either one or the other difficulty may be overcome, however, by providing tapered ribs which would require special forms. The tapered ribs were not used in the Noyes-Buick building as they were not considered necessary in that particular case.

Pans New in Flat-Slab Work

Square pans have been used in concrete design for a good many years, but, so far as is known, they have not been used in flat-slab computations until recently. It would appear that their use in such computations is entirely legitimate and consistent with the Joint Committee conclusions except possibly in the matter of reducing the allowance made by that committee for the tensile strength of the positive moment concrete. The Boston Building Department solved this possible difficulty by allowing 18,000 lb. per square inch on the steel in all sections except where the tensile steel was in the



MOMENTS ON MIDDLE FLAT SLAB PANEL

Formulas used are from Boston Building Law.
Total moments for entire width of bays

Interior bays: $+M = \dfrac{wLl^2}{25}$

$-M = \dfrac{wLl^2}{15}$

Wall bays: $+M = \dfrac{wLl_1^2}{20}$

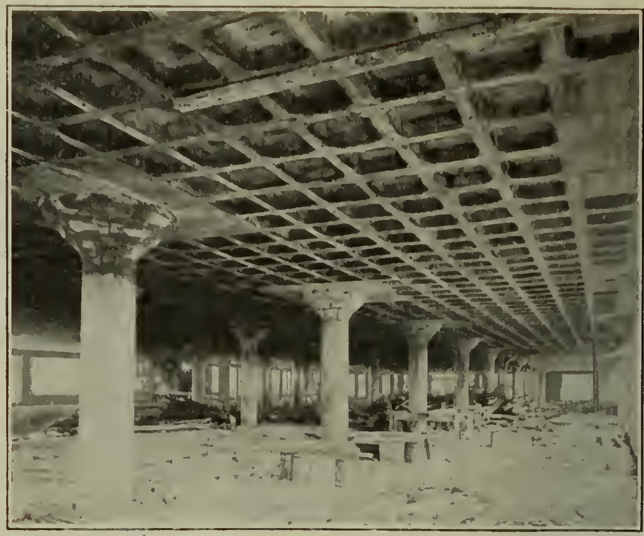
at wall $-M = \dfrac{wLl_1^2}{30}$

at interior cols. $-M = \dfrac{wLl_1^2}{12.5}$

in which:
- w = total weight of floor per sq.ft.
- L = width of panel at right angles to strip considered.
- l = length of strip center to center of columns—$\frac{2}{3}$ dia. of interior column capital.
- l_1 = length of strip from face of wall column —$\frac{1}{3}$ dia. of interior column capital

lower side of the rib; in such cases, the allowance was reduced to 16,000 lb. per square inch.

In 1917, Nils F. Ambursen proposed the use of the cellular steel pans or domes in connection with a patent "Uni-Form System" of steel forms and with W. L. Church, consulting engineer for the Blaw-Knox Co., worked out an elaborate series of computations to permit of preliminary convenient and economical designing. On June 17, 1919, a patent, No. 1,307,031, was issued to Edwin Albright—now assigned to the Des Lauries Column Mould Co.—for the combination of dome and flat-slab construction. There has been some controversy over this patent but as responsible manufacturers of domes are willing to guarantee the user against infringement suits, there should be no hesitancy shown by engineers in using this valuable method of floor design. Whatever the facts as to invention and patent rights are, much credit is due Mr. Allbright for his good work in perfecting the practical details of this type of construction and for erecting some typical buildings.



COMPLETED CELLULAR FLAT SLAB FLOOR FROM BELOW

The general contractor for the Noyes-Buick building was the F. T. Ley Co., of Springfield, Mass., the architect, A. H. Bowditch, of Boston, Mass., and the engineer responsible for structural design, Henry F. Bryant, of Brookline, Mass.

Activated-Sludge Process at Sydney, Australia

Six activated-sludge tanks have been built to displace septic tanks for the treatment of the sewage of Syndey, Australia, according to the annual report of the Metropolitan Board of Water Cupply and Sewage for 1919-20 (J. M. Smail, chief engineer.) Three of the six tanks were in operation at the end of the year and were treating an average of 900,000 Imp. gal. a day. "The most recent conclusion" as to operation, says the *Journal* of the Institution of Municipal and County Engineers (London) in a synopsis of the Sydney report, is "that the tanks could be operated at a 12-hr. cycle, allowing two fills a day." This rate could be exceeded with the dilute sewage of wet weather. The 12-hr. cycle includes filling and aerating 7 hr.; settling, 2 hr.; decanting, 1 hr.; sludge aeration, 2 hr. The sludge is kept at about 20 per cent of the capacity of the tanks.

On methods of sludge disposal the *Journal's* abstract says:

For the first five months of the year, before decanting the excess sludge from a tank, settlement was allowed to go for four hours, and the amount then sent to sea was at the rate of 75 cu.yd. per 1,000,000 (Imp.) gal. of sewage. For the remainder of the year the excess sludge was run into a spare tank, kept aërated, and when a certain amount had accumulated, settled for s me hours. The supernatant liquid was conducted over the sand beds on which a corn crop was growing, much to the benefit of the same. On account of the shortened time of settlement in the treatment tank, 1,000,000 (Imp.) gal. of sewage produced 135 yd. of sludge, but by settling it again in another tank as described, the amount sent to sea finally was only 43 yd. per million—a saving of over 42 per cent on the earlier figures, and a considerable saving from a monetary point of view in puntage charges.

Experiments were made to de-water the sludge by means of a centrifuge. It was found that practical results could be obtained and that about four-fifths of the original water could be removed. Further experiments are being conducted to de-water by treatment in an artificial filter bed of coarse gravel.

Federal Highway Council Plans Intensive Subgrade Study

A THOROUGH study of highway subgrades with a view to the elimination of road failure due to poor foundations by increases in metal thicknesses, and by strengthening the bearing power of soils through mechanical or chemical treatment, is outlined in the report of the Committee on Subgrade and its Relation to Road Surfacing and Traffic, recently submitted at the meeting of the Federal Highway Council at Akron, Ohio.

Realizing that, owing to the increase in commercial motor vehicle traffic, wheel concentrations on the road surface combined with lack of supporting value of the underlying subgrade, have resulted in structural failures of every type of road constructed up to the present time, the committee believes that neither time nor expense should be spared in making generally available all possible information upon the bearing value of soils. It believes that the problems of eliminating road failures due to poor foundation are possible of solution in one of three ways:

1. By making the road surface thick enough so that the pressure from heavy traffic will be sufficiently distributed to the underlying subgrade, or so that the surface because of its inertia may absorb a considerable amount of the shock of traffic.
2. By designing the slabs to have sufficient strength to bridge over the soft subgrade.
3. By improving drainage systems to exclude moisture in sufficient amounts from soils which are rendered of low bearing value by the presence of moisture.

Problems Outlined for Study

In order to make an adequate subgrade study, the committee has outlined a number of problems which it intends to solve through the co-operation of various sub-committees. These problems are:

(1) Obtain samples of subgrade material at points where failures have occurred; also samples from the same road of like construction and like traffic where failures have not occurred. Data accompanying the samples should contain information as to the topography, type of drainage, character of construction, and all other information having relation to the condition of the road; make a physical examination, bearing value tests, and such other investigations as may be suggested with data furnished; (2) development of field tests for bearing power of soils; (3) making studies of drainage, using experimental sections of roads; (4) a study of chemical methods of subgrade treatment for increasing bearing value or preventing absorption; (5) a study of mechanical methods of subgrade treatment; (6) a study of freezing and thawing on the volume and on the supporting properties of soil; (7) a study of the effect of moisture on the volume changes in soil; (8) a study of the transmission of pressure to the subgrade; (9) a study to ascertain the practical classification of subgrade materials; (10) any special problems that arise.

In order to expedite the work of the various committees handling these problems, a tentative outline of procedure has been drawn up which will serve as a guide to the sub-committees and enable them to decide in the shortest possible time upon the method of procedure to be followed by them in their studies. The various sub-committees are expected to report upon proposed procedure to the special advisory committee not later than Nov. 15, and after this date the subcommittees should be able to pursue actively their various investigations. The committee believes that most soils have adequate bearing value when they have a sufficiently low percentage of moisture; and that it is not impossible that some soils will be susceptible of treatment, either mechanically or chemically, which will render them of a higher bearing value than they have in their natural condition.

Importance of Work Recognized

The committee recognizes the importance of the work and the necessity for obtaining results in the shortest time. Its report reads that "an investigation of methods for obtaining high-class construction should very properly be considered as a part of any program of construction and it should be emphasized that of the funds appropriated for road construction there should be set aside an adequate portion for pursuing the needed investigation to make for wise expenditure of these funds." The subgrade committee of the Federal Highway Council has as its chairman General Coleman Du Pont and as its vice-chairman, C. M. Upham, state highway engineer of Delaware.

Direct-Process Native Furnace Iron Like Metal in Delhi Pillar

NATIVE Indian direct-process furnaces are still making wrought iron from ore and producing a material which is exactly the same as the iron of the world-famous Delhi pillar. It has been known for some considerable time that this pillar is welded up of a large number of small pieces of wrought iron, each representing a single heat of a small hand-blown direct-process furnace. Andrew McWilliam describes in detail the operation of such a furnace in a paper just read before the Iron and Steel Institute ("Indian Iron Making at Mirjati, Chota Nagpur").

The furnace described was operating within five miles of a large modern steelworks, and was producing iron used for all sorts of native tools and other articles, including plows, sickles, axes, knives, and the like. The furnace worked on hematite found locally, and charcoal made in the adjoining jungle. The furnace is reported as being 15 in. in interior diameter at the bottom, 4½ in. at the top, and 3 ft. 10 in. high. The charge was raked in bit by bit at the top as the burden goes down during the process of the combustion and reduction. Two foot-power bellows supplied the blast. The full time required to run a heat was 5½ hr. The product was a spongy mass of iron which when forged out into bars weighed 14 lb. 8 oz. Analysis of the product showed carbon 0.06, silicon 0.22, sulphur 0.03, phosphorus 0.20 per cent, and a trace of manganese. Analyses of iron from the Delhi pillar by Hadfield are reported as showing carbon 0.08, silicon 0.05, sulphur 0.01, phosphorus 0.11 per cent, but the amounts of all these alloying elements in the native-made iron vary considerably, and the two products quoted are to be regarded as identical, according to McWilliams.

Density Tests of Earth Shrinkage in Railway Fills

Samples Taken by Special Device Indicate Swell and Shrinkage According to Depth in Original Excavation

DENSITY tests of earth samples made recently by the valuation department of the Chicago, Burlington and Quincy R.R. resulted in the conclusion that shrinkage in embankment from original excavation bears a definite relation to the depth of excavation and showed the relation of depth to weight of earth and apparent "shrinkage" from subsidence of subgrade. The density method consists in comparing the weight of the net metallic content of equal samples of unmolested earth from an embankment and from the natural bed adjacent to the excavation which supplied material for the embankment. This net metallic content is taken as the weight of the sample after drying, the moisture content being eliminated by the heat. Difference in weight is taken as the measurement of change in volume.

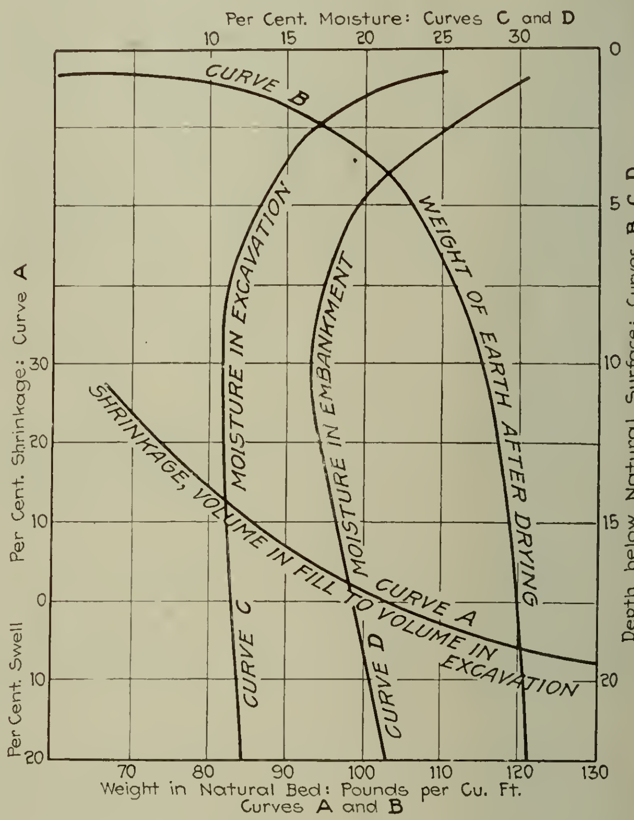
At the point where a sample was to be taken, a pit was dug to the level of the top of the sample and then continued around the marked area of sample for a depth of about 18 in., leaving a pedestal of undisturbed material. For cutting the sample, a steel cylinder 10 in. long and 10⅝ in. in inside diameter was used, having one end beveled to a cutting edge and the other end threaded for a screw cap. By means of a driving cap this cylinder was forced down into the undisturbed pedestal until the core projected above the top. The projecting earth was cut off level with the top of the cylinder and the cover was screwed on. The lower part of the pedestal was broken off with a shovel, the cylinder being then inverted and protruding earth sawed off level with the cutting edge. The sample thus taken was emptied into a closely woven sack and sent to the railway company's laboratory, where it was broken up and dried at 170 deg. F. until by successive weighings no further loss in weight was obtained. In all, 89 samples were taken of clay, loam and gumbo in glacial drift formation in Iowa, Illinois and Missouri.

It soon became apparent that the shrinkage bore some relation to the weight of the earth in its natural bed. This condition is illustrated by curve *A* in the accompanying diagram. It was discovered also that the dry weight of material in its natural bed bore a relation to depth below the natural surface, as shown by curve *B*. Further, the records indicate a greater moisture content in samples from embankment than in those from excavation, as indicated by curves *C* and *D*. This moisture content was taken as the condition when the sample was received at the laboratory.

These studies indicate, says the report, that earth the metallic content of which in the natural bed weighs less than 103 lb. per cubic foot shrinks when placed in embankment subjected to traffic, but when this weight exceeds 103 lb. the material retains a more or less permanent swell. As shrinkage bears a relation to weight and weight bears a relation to depth below the surface, the shrinkage of a fill has some relation to the depth at which the material occurred in the excavation.

Upon this evidence is based the conclusion that earth obtained in excavation down to 4 ft. below the surface will shrink when placed in embankment, but that material taken at greater depths will swell. The former condition is the more important, according to the report, since ordinarily from 60 to 100 per cent of a railway embankment is of material obtained within the 4 ft. depth. Practically all side borrow falls in this class and the top 4 ft. of a railway cut contains a relatively large yardage on account of the trapezoidal section of the cut.

Traffic as a factor in shrinkage, due to load and vibration, is indicated by samples of similar material taken from embankments subjected to different conditions:



TESTS OF EARTH SHRINKAGE SHOW RELATION TO DEPTH IN ORIGINAL EXCAVATION

> No. 1. Embankment 17 years old, built for future double tracking but having no track laid. Shrinkage, 6.7 per cent.
>
> No. 2. Embankment 49 years old but abandoned after 32 years of traffic with light equipment. Shrinkage, 12.9 per cent.
>
> No. 3. Embankment 17 years old and subjected to traffic of the heaviest equipment during the entire period. Shrinkage, 13.6 per cent.

For the purposes of these tests the problem was to determine what percentage should be added to embankment (for the valuation inventory) to produce the yardage which would have to be moved to make the embankment. Therefore, there was developed an "additive factor" or percentage, which is somewhat different from the term "shrinkage." For all embankments in Iowa an average additive factor for net shrinkage of 11.55 per cent was indicated by the tests. The report points out, however, that the sides of an embankment, including the quantities in the outside 3-ft. slab or beyond slope lines drawn from the toes of the ballast, are clear of the influence of loading and are subject to a frost action which neutralizes shrinkage. Eliminating these areas, the additive factor for shrinkage would be reduced by 20 per cent, or to a net figure of 9.24 per cent.

An unmeasured subsidence of the earth under all embankments is indicated, says the report, by the established characteristic of extremely high shrinkage of surface soil, which characteristic is supported by common knowledge of the high porosity and void content of surface soil. It is considered obvious that if this earth will shrink when placed in embankments it will be compressed in its natural bed by the load of the embankment and the effect of traffic, producing an apparent "shrinkage" from subsidence of subgrade. It is concluded that under grading conditions in Iowa this will add 3 per cent to the apparent shrinkage of the embankment.

Construction Allowance

Loss of material by wastage in transportation from cut to fill and by wind and rain erosion during construction and prior to operation is difficult to estimate, but the report states that such loss will readily be admitted by all engineers experienced in or familiar with railway construction. It suggests that possibly this may be covered by adding "some small percentage based upon opinions of many competent minds," but does not offer any figures for this allowance. On the basis of 9.24 per cent for shrinkage and 3 per cent for subsidence, the total additive factor for shrinkage for Iowa embankment is taken as 12.24 per cent, without considering subsidence separately.

These density tests were made under the direction of H. S. Marshall, valuation engineer of the Chicago, Burlington & Quincy R.R. His report is given as an appendix to the report on swell of rock and shrinkage of earth by a sub-committee of the Railway Presidents' Conference Committee, published in *Engineering News-Record*, Aug. 26, 1920, p. 418.

Tar Macadam Roads Show Lowest Total Annual Cost

A TAR macadam road constructed of an 8-in. broken stone foundation, a surfacing of crushed rock 2 in. thick laid in two 1-in. courses and impregnated with 1 gal. of tar per square yard, shows the least expenditure—interest on original cost and maintenance—per mile per year in a comparison of six types of surfacing made by J. A. Johnston, district engineer, District 1, Division of Highways, Massachusetts Department of Public Works. Other types included in the comparison are waterbound macadam, asphalt mix, asphalt penetration, concrete and gravel. The roads compared were chosen because of the availability of their maintenance data, because they were typical examples of their types, and because all, save concrete, are built of the same foundation thickness and foundation material.

The tar macadam, which has been patented by Mr. Johnston, is distinguished from a number of other bituminous types by the fact that the 2-in. surface was laid not in one but in two courses. The foundation is built in the same manner as that for numerous bituminous types. Upon the foundation is placed broken stone not less than 1½ in. in longest dimension. The stone is so spread that after thorough rolling the resultant surface will be 2 in below the finished surface of the road. Depressions formed under rolling are filled with 1½-in. stone and rolling is continued until an unyielding surface is obtained. On the surface so prepared is spread a layer of broken stone ranging in size from ¾ in. to 1½ in. This layer completely covers the base, though with the thinnest possi-

SUMMARY OF AVERAGE COSTS PER YEAR

	Water Bd. Mac. Mile	Water Bd. Mac. Sq.Yd.	Asphalt Mix Mile	Asphalt Mix Sq.Yd.	Asphalt Pen. Mile	Asphalt Pen. Sq.Yd.	Concrete Mile	Concrete Sq.Yd.	Gravel (Oiled) Mile	Gravel (Oiled) Sq.Yd.	Tar Macadam Johnston Process Mile	Tar Macadam Johnston Process Sq.Yd.
Expenditure	519.24	0.047	143.44	0.013	101.09	0.009	35.59	0.003	341.34	0.031	93.05	0.[illegible]
Interest	435.56	0.040	644.69	0.059	492.18	0.045	581.63	0.053	244.64	0.022	340.53	0.[illegible]31
Total	[illegible]54.80	0.087	788.13	0.072	593.27	0.054	617.22	0.056	585.98	0.053	433.58	0.039

DETAILED COST FIGURES ON FOURTEEN HIGHWAYS COVERING SIX TYPES

	Type and Location													
	Water-bound Macadam Oiled	Asphalt Mix			Asphalt Penetration			Concrete			Gravel (Oiled)	Tar Macadam Johnston Process		
Cost	Great Barrington	West Springfield	Chicopee	South Hadley	Northampton Br.	Lee (So.)	Northampton River Road	Hancock	North Adams	Wilbraham	Sheffield	Oxford	Lee	Dudley
1913 Cost	.....	.....	**$15,363**	.....	.....	.....	**$10,890**	.....	.....	.....		**$7,645**	**$9,988**	
1914 Cost	.....	.....	.....	.....	$14,762	.....	.....	.....	.....	.....	$6,116			
Int. at 4%	.....	.....	615	.....	.....	.....	436	.....	.....	.....	..	30[illegible]	400	
Expenditure	.....	.....	.....	.....	.....	.....	43	.....	.....	.....		3[illegible]8	63	
1915 Cost	.....	**$17,798**	.....	**$15,191**	.....	**$11,264**	.....	.....	.....	.....	..			
Int. at 4%	.....	.....	615	.....	590	.....	436	.....	.....	.....	245	306	400	
Expenditure	.....	506	1	.....	10	.....	30		...	.	234	86	140	
1916 Cost	**$10,889**	.....	.....	.....	.....	.....	.....	**$16,441**	**$15,851**	**$11,330**				**$11,909**
Int. at 4%	.....	712	615	608	590	451	436			..	245	306	400	
Expenditure	.....	546	43	17	12	39	1	.....		.	231	167	.	
1917 Cost	.....	.....	.....	.....	.....	.....	.....	.....	.....					
Int. at 4%	436	712	615	608	590	451	436	658	634	453	245	306	400	31[illegible]
Expenditure	452	.....	627	30	293	49	54	33	13	32	417	115	10	3[illegible]
1918 Cost	.....	.....	.....	.....	.....	.....	.....	.....						
Int. at 4%	436	712	615	608	590	451	436	658	634	453	245	306	400	31[illegible]
Expenditure	518	.....	.....	23	224	453	97	48	13	30	572	239	12	
1919 Cost	.....	.....	.....	.....	.....	.....	.....	.....	..		..			..
Int. at 4%	436	712	615	608	590	451	436	658	634	453	245	306	400	3[illegible]
Expenditure	588	.....	150	52	51	38	20	31	51	59	253	154	230	
Av. Cost per Yr.														
Per Mile	**955**	**975**	**751**	**638**	**708**	**595**	**476**	**695**	**660**	**493**	**586**	**499**	**475**	**326**
Per Sq.Yd.	**0.087**	**0.089**	**0.068**	**0.058**	**0.064**	**0.054**	**0.043**	**0.063**	**0.060**	**0.045**	**0.053**	**0.045**	**0.043**	**0.030**

ble blanket. It is then sprinkled with water and when still wet there is sprayed over it a layer of bitumen heated to 250 deg., applied with a mechanical sprayer and at a pressure of 70 to 80 lb. per square foot; and at the rate of ½ gal. of bitumen per square yard of surface. Over this bitumen is laid coarse clean sand, about 0.02 cu.yd. of sand per square yard of surface being used. Another layer of ¾-in. to 1½-in. stone is then spread, bringing the surface to within ½ in. of the finished grade. The whole is then watered and rolled, any depressions filled, and again rolled. It is then watered and while still wet is treated with bitumen as before, though this coat is applied at the rate of ¼ gal. per square yard. Stone chips then cover this bitumen coat, the surface is again wetted and another layer of bitumen applied and covered in the same manner as the previous one, except that more stone chips are used the second time. The whole road is then watered and thoroughly rolled, any excess bitumen being absorbed by the use of more stone chips. Rolling is continued until there is no movement of the surface under the roller and until the road is thoroughly compacted.

Costs Compared

Costs in the comparison do not include grading and drainage. As those items would be the same no matter what type of surfacing is used, varying only with location, they were omitted from the calculations. Absolute comparison was possible by figuring cost per mile for each type on an area of 11,000 sq.yd. Costs in the accompanying table include the annual interest at 4 per cent upon the original cost per mile (foundation and surface only) and the total annual cost of all surface maintenance as reported by District Engineer Johnston to the Division of Highways of the Massachusets Department of Public Works.

The waterbound macadam had an 8-in. broken stone foundation upon which was laid a 4-in. course of crushed stone, the whole watered and compacted and then treated with light oil, ½ gal. to the square yard being used. Maintenance consisted in yearly applications of an average of ¼ gal. of oil to the square yard. The asphalt mix was built of the same 8-in. base upon which was laid 2 in. of crushed stone ranging in size from 2½ in. to that passing a ¼ in. screen, the top course consisting of a 2-in. asphalt-mix blanket. It was maintained by patching and yearly applications of a light coat of sand.

Construction Methods

The 8-in. foundation of the asphalt penetration roads was covered with a 4-in. depth of crushed stone, the upper 2 in. of which were treated with 2 gal. of asphalt per square yard. Maintenance of this type included patching and yearly coats of light sand.

The concrete road was of an average thickness of 6 in., a 1:2:4 mix being used.

The gravel roads were constructed of an average depth of 6 in. of gravel laid upon an 8-in. broken stone foundation. A half gallon of light oil per square yard was used at the time of construction and the roads maintained with yearly application of ¼ gal. of light oil to the square yard.

The tar macadam roads were maintained by spraying, as found necessary, in from three to five-year periods with ⅓ gal. tar to the square yard.

Stadia Survey for Irrigation Project

TOPOGRAPHIC surveys for Toole County irrigation district, Montana are being made by the stadia method, partly because the country is very windy and partly because both the chief engineer and the engineer in charge have had considerable experience in stadia work. Each party is composed of an instrument man, a recorder and three rodmen. The work is run in closed circuits. Starting at a government corner, the elevation of which has previously been established by a level control line, the survey runs out two miles, over half a mile, and back two miles to a corner with known elevation. Each circuit must close within one foot for elevation and within 30 ft. per mile for line and distance, or the circuit is re-run. The party has an automobile to carry it to and from the field and to carry the instrument man and recorder between stations.

The survey system has been planned carefully and satisfactory progress is being made. The largest area covered in one day with one party is 1,920 acres; 900 shots were taken on this acreage, which makes about one shot per two acres. As the land is level, it is well covered by this number of shots. Topographic data are plotted on a scale of 300 ft. to the inch, which permits of 1-ft. contours being plotted over most of the area. The topography party also makes a preliminary classification of the lands as to suitability for irrigation, using growing vegetation and the appearance of the surface as a basis. This information is signalled to the instrument man by the rodman and noted by the recorder.

Reservoir sites are also surveyed by stadia, using practically the same method except that the level control line is the proposed water elevation in the reservoir. Main ditch line surveys are made in the usual way with transit and level, using stadia for topography. Enough information is obtained to make a paper location and estimate of cost.

Surveys were commenced in the fall of 1919 and covered 60,000 acres out of a total of 300,000 acres. The parties were in the field until the middle of December and started again in April, 1920. It is expected to complete the field work this summer and to work up the notes and prepare an estimate of cost during the winter, preparatory to floating a bond issue. The cost probably will be in the neighborhood of $10,000,000. The engineering work is being done by the Gerharz-Jaqueth Engineering Co., Great Falls, Mont., under the direct charge of Henry Gerharz, president, as chief engineer.

Plan Road and Car Viaduct for Duluth

A high-level viaduct connection from the low lying business district of Duluth, Minn., to the high ground behind the city has been suggested by H. C. Ash, assistant engineer of the Duluth, Missabe & Northern Ry., as a possible solution of a local transportation problem. The high ground, with an elevation of 400 to 600 ft., is within ¾-mile of the city, but the steep approaches retard its development for dairy, truck garden and residence purposes. The viaduct with roadways and car tracks would have an easy grade and terminate at the roof of a skyscraper office building about 350 ft., high, with elevators for passengers, automobiles, wagons and street cars. A similar intermediate building might be utilized as a city market and office building. Suburban cars would operate on a loop through the city and then be raised to the track level of the viaduct.

Adapting Motor Truck to Railroad Terminal Expansion

Possibilities for Reducing Multiplicity of Car Movement and Meeting Growing Needs of Industrial Development

Extracts from a paper by B. F. Fitch, president, Motor Terminals Co., New York and Cleveland, presented before Cleveland Engineering Society, Oct. 12, 1920.

NO LESS an authority than Robert W. Woolley, of the Interstate Commerce Commission, is accredited with the statement that less-than-carload terminal costs represent 60 per cent of revenue. The deduction is but logical that the major portion of economies can best be effected through terminal refinements.

Multiplicity of Terminal Car Movements

Were each of our terminal cities building and breaking cars for one station at all the other principal common points in the United States, our transportation problem would be comparatively easy, but when we multiply the number of cities by the plurality of stations within each, from which car loadings must be consolidated for dispatch, to the plurality of stations within each other terminal, the interchange, consolidation and dispatch problem is kaleidoscopic. If we visualize the individual movements of all these multiplied box-car loadings for line dispatch and add the intra-terminal movement of carloads and less-than-carloads from industrial sidings, our sympathies are aroused for railroad talent. If, to this operating dilemma we add the increased tonnage capacity from trackage and equipment improvements which have made our railroads the models of the civilized world, all of which have been successfully developed while our terminals were considered a side issue, it is no wonder that the subject of inadequate terminals has now become the engrossing topic of the hour. The problem is all the more interesting and complex because of the varying restrictions in the form of realty development, street intersections, industrial growth, etc., which makes the extension of centrally located properties impossible, except at prohibitive investment.

At the congested terminal of Cincinnati, Ohio, an expedient has been tested, first in a small way and later universally by the railroads, to ascertain to what extent motor trucks could be adopted by railroads contributing to that terminal as an accessory to transportation. The Big Four R.R. first used the new system, starting operation in May, 1917, between its five main and substation. The original crude installation of open bodies with tarpaulins, moved between these five stations, developed such marked operating economies that its use was recommended for extension to all other contributing lines. With authority of the United States Railroad Administration, a detail analysis of all connecting line and substation intra-terminal movements was made. This disclosed that approximately 800 tons were available for transportation between main stations and 400 tons between main and substations daily.

Adaptation of Motor Transfer

At that time approximately 40 per cent of the main station interchange tonnage only was being transported by horse drays, and the remaining 60 per cent, of necessity, was interchanged by trap cars between these main stations, as well as all substation tonnage. There were 115 heavy drays in service to transport the 40 per cent of inter-line tonnage, and hence to transport 100 per cent, approximately 250 drays would have been necessary. The 400 tons of long-haul freight between main and substations located within a ten-mile zone could not have been so transported by reason of mileage limitations of horse-drawn vehicles. On the other hand, motor trucks could not be profitably utilized by reason of long delays in assembling shipments for loading and in the unloading discharge of same.

To meet this operating dilemma and make possible for the railroads the commercial cartage economies of motor trucks, the Motor Terminals Co. developed the equipment and system of operation which was ultimately universally adopted at Cincinnati. Briefly, this system consists of a plurality of interchangeable bodies, or unit containers, one for each movement demand at each station, electrically operated hoists for the lifting and conveying of such bodies, and a limited fleet of motor truck chassis [fifteen in number with one spare] for the transportation of the bodies over city streets between stations.

A recent analysis of accomplishments disclosed the fact that all such freight interchanges have been expedited 52 hr.; that over 200 cars daily (70,000 annual car days, previously consumed in such service) have been released for main-line movements; that over 300,000 individual switch-cut movements of such cars have been eliminated to the extension of trackage rights for the movement of trains and groups of station cars; that station trackage capacity has been increased 21.4 per cent due to the elimination of trap cars; that station platform area enjoys an increase of approximately 15 per cent, and that total main station realty enjoys an otherwise unobtainable increase of 122,660 sq.ft.

Possibilities of Terminal Expansion

What has been accomplished at Cincinnati is but a meager demonstration of future possibilities. While only the stations of the railroads proper are now equipped for exclusive railroad movements, the service furnishes opportunity for extensions covering all intra-terminal movements to the complete elimination of the trap car, not only in railroad practice but in industrial practice, except for car loadings at sidings for dispatch to common or transfer points beyond the terminal proper.

The over accruing realty values adjacent to central terminals has been an influence to force larger industries into outer districts as soon as their volume shipments warranted siding facilities, and in each and every case the property vacated by these older concerns has been held at a premium. Constantly accruing influences of a short trucking haul for consignees and consignors have developed realty values adjacent to our main freight terminals, so centrally located, to the restriction of extensions. . . . Off-track or zone (motor-transfer) stations can be constructed within each terminal in lieu of physical rail extensions. The number of these off-track zone stations can be from time to time increased in ratio with the ever changing and ever increasing industrial development of each community. These zone stations, as common receiving and delivering points for all shippers and carriers, will ultimately develop warehousing or industrial centers. As commercial activities grow, the transfers to them from cars to truck bodies can be removed from the center of the cities to outer classification yards, thus releasing existing terminal rails for endless increasing carload movements, less all otherwise necessary investments for rail extensions.

Practical Store-Door Delivery

Of course, the natural evolution of this entire program is that of store-door deliveries, of which the railroads are wary, because they fear it will be harnessed on them at no increase in rates. This is but a contingent fear; not an operating dilemma. Under a properly created unit organization, operating in the joint interests of carrier and shipper, the cartage cost could be largely reduced. When industrial centers are thus equipped it requires no vision to conceive of the inter-city through dispatch, from store door to store door, of motor truck unit container bodies, utilizing the cheapest medium of transportation within its zone of most economical operation, viz., motor trucks, interurban cars, railroad flat cars, tow boats, lighters and steamers—without assessment for rehandling cost from each to the other, since the mechanical interchange can be accomplished at no labor assessment and with but minimum delay.

[An article describing the operation of the motor truck system of handling transfer freight at Cincinnati, together with editorial comment, appeared in *Engineering News-Record*, Mar. 11, 1920, pp. 498 and 508.—Editor.]

Engineering Features of the St. Lawrence Waterway

What the Proposed Great Lakes to the Ocean Route Means in the Way of Construction—Preliminary Outline of Work To Be Done

UNDER the provisions of the last River and Harbors Act the United States is co-operating with Canada in the engineering investigation of a proposed deep waterway connecting the Great Lakes with the ocean by way of the St. Lawrence River. For this country Col. W. P. Wooton, Corps of Engineers, U. S. A., is in charge of the studies and for Canada W. F. Bowden, Chief Engineer of the Department of Railways and Canals. The report is not expected until next spring and until it does appear it is doubtful if a true examination of the possibilities and difficulties of the scheme can be made but it is possible to outline the physical conditions which must be overcome, so that engineers may have an idea of the extent of the work. Costs and possible service must await a more thorough official investigation.

In an address before the Western Society of Engineers, Maj. John C. H. Lee, Corps of Engineers, U. S. A., recently gave a succint outline of the engineering requirements of the waterway. From that address the following extracts are taken; the accompanying maps have been prepared by this journal.

Conditions in Great Lakes

The Great Lakes generally are navigable for vessels of 21 ft. draft. The principal ports have been dredged to this depth, but between the various lakes of different level there exist certain natural barriers, which for the most part have been overcome.

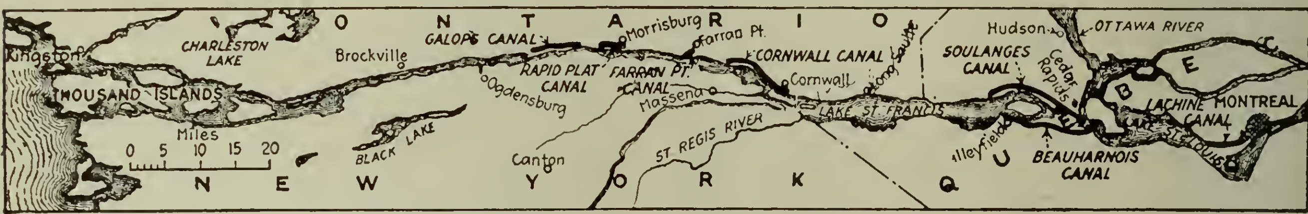
Between Lake Superior and Lake Huron there are the unnavigable St. Marys Rapids tumbling down a fall of 17 to 21 ft., depending upon the stage. The Canadians put in the first lock in 1797-8. In 1853-5 the United States put in its first "State Canal" then the Weitzel Lock in 1870-81. And the Poe Lock of 800 x 100 ft. area and 18 ft. depth in 1887-96. Then Locks 3 and 4 were built in 1908-14 and 1913-19 with dimensions of 1,350 x 80 ft. and a 24½ ft. depth. Meantime in the Canadian side that Government put in its lock of 900 x 60 ft. and 18.2 ft. deep in 1888-95. These take care of the Superior-Huron barrier.

Between Lakes Michigan and Huron there exists a good navigable channel with practically no change in level. Connecting Lake Huron with Lake Erie there is the St. Clair River, a naturally navigable stream except in the lower delta where dredging has been required; then the broad and rather shallow Lake St. Clair through which a good channel has been dredged; and finally the Detroit River to Lake Huron. Through the solid rock bottom of the Detroit River the United States has excavated an excellent channel so that up-bound vessels can draw 20 ft. at low water while down-bound vessels can have 21 ft. For normal stages these depths are 3 ft. better.

Between Lakes Erie and Ontario stands the greatest single barrier—Niagara Falls and the rapids, giving a difference of level of some 325 ft. The American Government has never put in a waterway around this barrier. The state of New York has its barge canal, 12 ft. depth via Rochester and Oneida Lake to Troy on the Hudson. The Canadians, however, have had the Welland Canal, with 25 locks (255 x 45 ft.) affording 14 ft. navigation since 1887. In 1913 they started a project to deepen this canal to 25 ft. with seven locks of 800 x 80 ft. and 46½ ft. lift with 30 ft. in the sills. Due to the war this was discontinued in 1916 with the project about one-third completed. The task was resumed last year and can be finished without difficulty by the time any through channel of equivalent capacity can be completed along the St. Lawrence route below Lake Ontario.

Below Lake Ontario

The barriers below Lake Ontario consist of the rapids of the St. Lawrence River between Ogdensburg and Montreal. Parts of this stretch are navigable. The Canadian Government has for years been operating a series of ship canals giving 14 ft. navigation around the different rapids. Some of the rapids are navigated by down-bound vessels, but up-bound vessels must use the canals. In this section lies the crux of the problem—deep water navigation from the Lakes to the Sea. Below Montreal the Canadians have already provided 30 ft. open river navigation to the Atlantic.



THE ST. LAWRENCE RIVER FROM LAKE ONTARIO TO MONTREAL

It is of interest to look at those characteristics of the St. Lawrence already of record, the better to understand the problem that confronts our engineers. The river's tributaries, above Lake St. Louis, where it is joined by the Ottawa River, are relatively insignificant. Its water, therefore, having been subjected to long periods of sedimentation in the various lakes, is clear and carries practically no matter in suspension. Its flow is governed by the elevation of water in Lake Ontario. As that lake has an extreme fluctuation of about 5 ft. and an ordinary annual fluctuation of very much less, the St. Lawrence naturally has a remarkably steady flow. No other river of its size compares with it in this respect. Its flow varies ordinarily from 200,000 to 280,000 cu.ft. per sec. although during the period 1888-1919 it has at times dropped as low as 186,000 due to a certain amount of ice choking. During extreme high water it has once or twice reached 300,000. Its lack of material in suspension, its constancy of flow, the stiff and stable quality of the material through which it flows, combine to render its banks and bed remarkably constant. Natural changes within the memory of man are practically unheard of.

Just above Montreal, in Lake St. Louis, the Ottawa River offers an additional problem. This stream has a very wide fluctuation, reaching a discharge in high water approximately equal to that of the main river. However, this condition only affects the lower end of the stretch requiring improvement. It is practically a local problem.

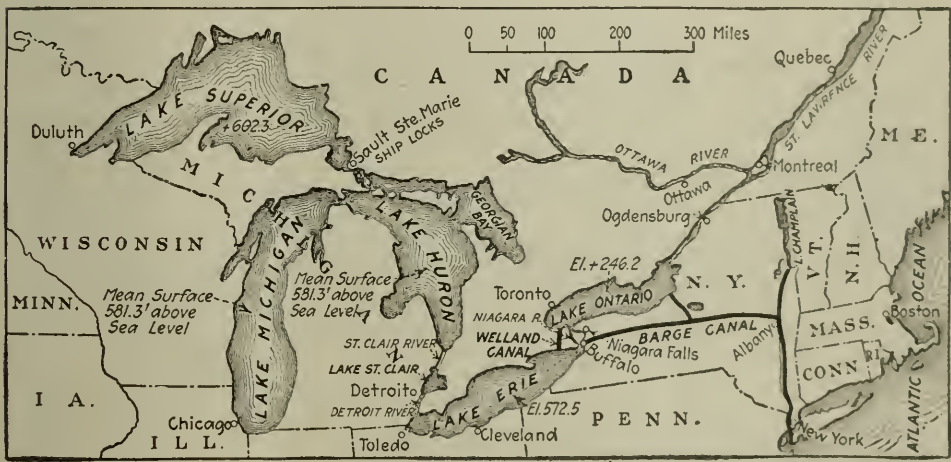
The river distance from Lake Ontario to Montreal is about 182 miles and the total fall is between 220 and 225 ft. Considering that there are several long broad reaches approximately lakes, it is evident from even a cursory examination that this portion of the river naturally divides

itself into several sections of quite different local characteristics, each requiring special study and consideration and each possibly requiring its own special method of improvement.

The Lakes to Lake St. Francis

The first section extends from Lake Ontario to just below Ogdensburg, N. Y. The total fall in this 62 miles is less than one foot. As one would expect, the river is broad and deep, and the velocity is low. The channel gives depths of 120 to 40 ft. Except in two places the width is better than 500 ft. Where it passes the Thousand Islands and again at the Brockville Islands, the present ship channel is only a little wider than 400 ft. and would probably require a little work. For security of deep draft vessels, this stretch should be "swept" in order to locate isolated pinnacles which may have escaped the soundings of previous surveys.

The second section extends from below Ogdensburg to the head of Lake St. Francis, or where the St. Regis river comes in at the international boundary. From this point on the St. Lawrence flows entirely in Canadian territory. The length of this second section is about 54 miles and its fall is about 90 ft. Three rapids account for the greater part of this drop. Just below Ogdensburg occur the Galops Rapids, about 10 ft. fall; near Morrisburg is the Rapid Plat of about 12 ft. drop; just above Cornwall is the Long Saulte with about 40 ft. fall. The remaining fall is found along flatter slopes adjacent to three rapids.



THE GREAT LAKE DISTRICT SERVED BY A ST. LAWRENCE CANALIZATION

The Canadian Government operates side canals affording 14 ft. navigation around these various rapids. The Galops canal takes care of the rapids of the same name. The Morrisburg canal overcomes the Rapid Plat. The Ferrin Point canal provides passage around a small drop of 4 ft. The Cornwall canal takes care of the Long Saulte. Otherwise vessels use the open river. Descending vessels habitually shoot all rapids except the Long Saulte. This rapid is navigated only by passenger boats featuring excitement of the trip.

This second stretch offers quite a problem for improvement. Dams and slack water can hardly be recommended for the entire section because sufficient water to flood out the upper (Galops) rapids would raise the level of the upper river and Lake Ontario something like 15 ft. It would seem after brief study that dredging would be practicable in the upper Galops provided the lower part is drowned out by slack water backed up by a dam further down stream. If dredging here were resorted to, care will have to be taken to provide a sufficiently large cross section to keep down the velocities in the ship channel.

It would seem that a dam in the general vicinity of Cornwall and possibly another somewhere above would provide sufficient depth for navigation while affording the development of well over a million horsepower.

It is understood that a commercial project was at one time planned for a power dam near the head of Croil Island. Our engineers have made borings above Cornwall as well, and have found rock at what might seem to be desirable elevations. The solution of the problem must of course be based on a balance of costs against the facilities developed. If the rock for the foundations of the upper dam is found at about the same elevation as at the lower site, then a single dam project would probably have an advantage in cost of dam construction, cost of power installation and better provision for navigation. The flowage damage or cost of dikes would be increased only between the two sites.

Realizing that the power developed at this section of the river could be delivered to the greater part of New England and New York there should be no difficulty in disposing of it at a figure sufficient not only to pay interest on the investment but also on other work of the same project, if not indeed giving finally a return on the original investment.

Lake St. Francis Section

The third section may be taken as Lake St. Francis, where for some 28 miles the river widens to four or five miles. In some places the channel will require widening and deepening. There is no apparent reason why open lake navigation cannot be provided for ocean going craft at a low cost.

The fourth section is a stretch of 14 miles connecting Lake St. Francis with Lake St. Louis. In this length are a series of rapids; the Coteau, the Cedars, the Split Rock and the Cascade—a total fall of about 80 ft. At present a few down stream boats "shoot" the rapids. The Soulanges canal provides 14 ft. navigation on the northern side. The old Beauarnois canal lies on the southern side.

This section offers a problem similar to the second but probably with not as many factors. Judging from their practice in the past we can expect the Canadians to consider seriously, if indeed not to favor, ship canals around the rapids. A cursory examination would indicate that such a plan is practicable on the southern side. If no great obstacles are encountered such a project should be considerably cheaper than a fixed dam and slack water. Moreover, it is possible that if a fixed dam developing the full power head were installed and power put on the market at the same time as that of section two, there would be little chance of complete utilization for several years. If this is true, if the power could not be immediately marketed, it might prove economical to provide the cheaper ship canal for the first decade or so, and later, if conditions seem to justify, make provisions for further development of power.

There are apparently good general locations for a dam in one or two sections at the head of Lake St. Louis, just above the mouth of the Ottawa River.

Lake St. Louis to Montreal

The fifth section is Lake St. Louis—15 miles long and rather shallow through the greater part of its 5 to 6 mile width. There exists, however, a fairly good channel which will require deepening and broadening at least in parts. Due to the influence of the Ottawa River whose variation in flow is quite large, the characteristics of the St. Lawrence below this point are less constant than above.

The sixth section is 9 miles of river between Lake St. Louis and Montreal. The river pitches down the Lachine Rapids, thence through the Prairie Basin, a broad and shallow lake with low banks. The total fall is about 50 ft. most of it confined to the Lachine Rapids which are navigated only by a few down-bound passenger boats. The Lachine canal passes around them on the northern side, affording 14-ft. navigation. The improvement of this stretch

is a problem in which the Canadian engineers can be expected to have most serious interest. Safeguarding the city of Montreal against the combined waters of the St. Lawrence and the Ottawa will play an important part. A power dam opposite or below Montreal, near the mouth of the present Lachine canal, would require long dikes or levees to protect the city. Moreover, due to the low lying banks, a great flowage or very extensive dike construction would be required on the southern side. This expense coupled with the unreliability of the Ottawa River's discharge would probably cause considerable opposition in the vicinity of Montreal. Moreover, it is understood that practically the only open opposition to the project in Canada is centered around Montreal, the present head of deep-water navigation.

It seems not improbable therefore to expect that some project such as the improving of the existing Lachine canal would be seriously considered. If power is to be developed further it will probably have to be located above Prairie Basin at the foot of the main rapids. If navigation were locked past such a dam, there would remain the shallow Prairie Basin to be considered. The Basin has sufficient slope to make dredging through it a perhaps double task. As in the Galops Rapids of Section 2, if a single 600 ft. channel 30 ft. deep were cut through, hydraulic conditions would be so improved as to develop velocities probably beyond those desirable for navigation. Either additional cross section should be dredged, or the adjacent water kept out by a dike, thrown up from the spoiled material which would be mainly rock.

This brings us to the head of existing 30-ft. navigation to the sea. The Canadian Government has now provided at considerable expense a good sailing channel through which some 4,000,000 tons per season come up and go on through the cramped upper canals, before mentioned, whose locks are only 225 x 45 ft. by 14 ft. dept. The river and canals are usually open to navigation from the middle of April to the first third of December. During the winter and early spring ice closes the route.

Thus we see confronting the engineers and the commission six sections of river, three of which offer little or no difficulty. The upper river and the two "lake" reaches. There remain three stretches of rapids requiring individual study and investigation. Possibly they will require separate and different treatment.

The engineers are confronted with several interesting problems. One of the first is the regulation of water flow in the river by the control of water level in Lake Ontario. A steady flow of large volume is desired in the river, yet a maximum and minimum level must not be passed in the lake. Naturally the property owners on Lake Ontario do not want to be flooded, nor yet left high and dry. The power and navigation interests along the river can't have a perfectly steady flow but it should be possible to guarantee them a minimum of about 200,000 cu.ft. per sec. without detriment to Lake Ontario interests.

Another problem is that of ice. The Canadian engineers largely, and our own to a more limited extent, have been working on the problem for years. Ice packs and gorges with their attendant high water often cause great concern, but the river has a way of working under the ice and freeing itself. The engineers admit that the problem is extremely "interesting" but there is no indication that they think it insurmountable.

The construction of dams in the main river bed should prove an engaging task to the men who may have to do the field work. The choice of dam sites has to be governed somewhat by this consideration. There is no way of shutting off the water during the working season. The flow is then distressingly steady. There is no "low water" as on the Ohio or the Mississippi. The task, if undertaken, must clearly be considered in its entirety; otherwise great difficulty if not disaster, may result to construction work, due to damming below or dredging above.

The economical feasibility of developing the full available hydro-electric power opens a serious question. Between Lake Ontario and Montreal the total theoretical horsepower is readily computed as over 6,000.000. Due to the unusually stable characteristics of the river it seems fair to assume that with a machine efficiency of 90 per cent, at least 75 per cent of the theoretical horsepower is possible of development; i.e., 4,500,000 hp. Whether or not this amount should be made available from the start, or be provided for at an increasing rate, is a problem of industrial economics.

At the present time only about 200,000 hp. is actually being developed. Most of this is at two plants, one at Massena, N. Y., and the other at the Cedar Rapids between Lake St. Francis and Lake St. Louis. Plans for damming the river at the Long Saulte Rapids were prepared by the Long Saulte Development Co. over ten years ago and effort made to obtain the necessary authority from the Canadian and United States Governments. The matter failed to get the necessary legislative approval and the project was abandoned. It is of interest to know that the development of power, not considering the benefit to the country through navigation has been considered practicable and worthy of financial enterprise. Such schemes of course included provisions for passing navigation by locks, as the Keokuk on the Mississippi, but the power company which was willing to finance the matter was to derive little direct benefit from the improvement to navigation

Pennsylvania Registers 600,723 Vehicles

Figures recently made public by the Pennsylvania State Highway Department show that a total of 1,069,603 1920 licenses of all sorts, and 600,723 registration plates were issued up to Sept. 11. The figures show that there was an increase in almost all classes of registrations. Comparative tables are as follows:

Registration plates:	1920	1919
Passenger cars	507,622	429,001
Commercial vehicles	50,226	40,406
Tractors and traction engines	3,160	3,328
Trailers	839	1,291
Motorcycles	23,510	25,123
Motor vehicle dealers	13,761	9,935
Tractor dealers	231	188
Motorcycle dealers	241	*......
Bicycles with motor attached	1,128	*......
Total	600,723	509,272
Licenses Issued:		
Motor vehicle licenses, all kinds	600,723	509,272
Paid drivers	114,345	82,343
Licensed operators	128,291	146,282
Tractor drivers	368	*......
Transfer of licenses	40,736	31,463
Special operators	466	*......
Learner's permit	2,487	*......
Vendee affidavits second-hand cars	180,653	16,344
Dealers in used motor vehicles	1,534	951
Total	1,069,603	786,590

* Classifications as required by new motor law after Jan. 1, 1920.

The decrease in the number of licensed operators is attributed to the fact that all owners of motor vehicles are now given an operator's license free of charge, while persons not owners pay a fee. Department officials are unable to explain the apparent decrease in the number of motorcycles during 1920. There is also a decrease of traction engines and trailers.

That many automobiles change hands during the course of the year is evidenced by the large number of vendee affidavits issued. The law compelling the filing of affidavits relative to second-hand cars was not in effect during all of 1919.

Railway Water Supply at Atkins, Iowa

An inaccurate title was given to the illustration in the article in *Engineering News-Record* of Sept. 2, p. 463, owing to the omission of a cut. The title should have read "Test of Surge Pressure in Pipe Line." The testing of the pipe line was done in lengths of 1,000 instead of 100 ft. The author is assistant engineer of the Chicago, Milwaukee & St. Paul Ry.

Report on a Tentative Zoning Plan for Lakewood, Ohio

Six Use, Four Height and Four Area Districts Provided with Height and Area Districts Superimposed On Use Districts—All Three Classes of Districts Shown on Single Map

By Robert H. Whitten
City Planner, Cleveland, Ohio

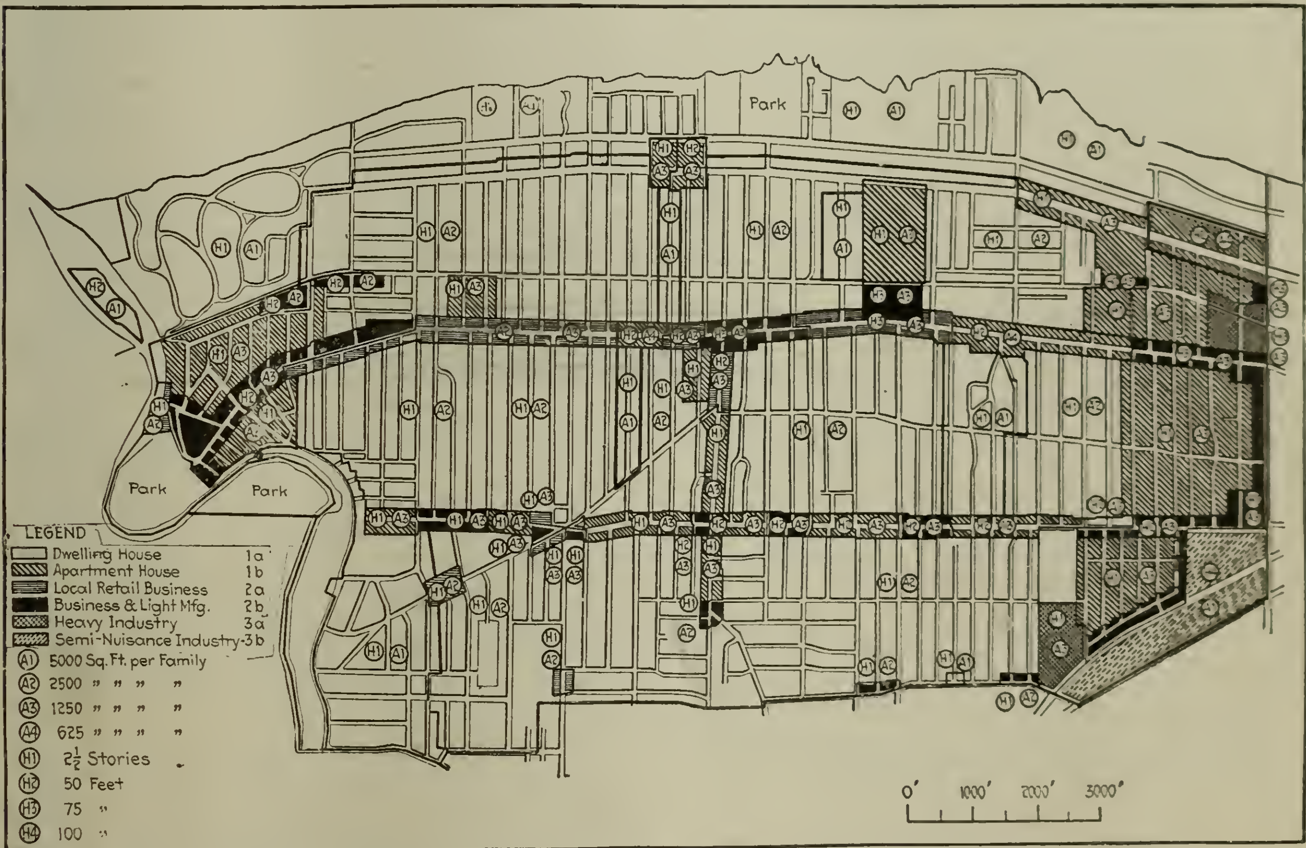
Except for local allusions to streets and avenues, Mr. Whitten's report on zoning for Lakewood, Ohio, is reprinted in full as a clear exposition of zoning principles applicable to many other communities of the same general character. This zoning scheme, Mr. Whitten states, has for one of its main purposes the preservation of Lakewood as a city of homes.—Editor.

The city of Lakewood is divided into six classes of use districts. Two of these are residence districts and four are business and industrial districts. In addition to the use districts there are four classes of height districts and four classes of area districts. The height and area districts are superimposed over the use districts. Consequently each portion of the city is in some one of the six classes of use districts. In some one of the four classes of height districts and also in some one of the four classes of area districts. The boundaries of the various use, height and area districts are shown on the zone map.

1. *Residence Districts*—The two classes of residence districts are (1) Class 1a or dwelling house district. (2) Class 1b or apartment house district. A building arranged for more than two families may not be constructed in a dwelling house district.

One of the chief purposes of the zone plan is to preserve Lakewood as a city of homes. While a certain number of apartment houses are beneficial, they should not be allowed to drive out the private homes. Carefully limited but adequate areas are allowed for apartment house development. The dwelling house districts, permitting the erection of either one- or two-family dwellings but excluding apartment houses, will include a very large proportion of the entire area of Lakewood.

The residence zoning is supplemented by the area district regulations that limit the number of families that may be housed on a given plot of ground and also limit the percentage of lot that may be covered. The area zoning regulations also require side and rear yards for all buildings located within residence districts, whether they are dwellings, apartment houses, churches, schools or other authorized uses. Uniform building lines back from the street line are also prescribed.



MAP SHOWING TENTATIVE ZONING PLAN FOR LAKEWOOD, OHIO

The residence district regulations are also supplemented by the height district regulations. A given residence district may be combined now with one and now with another of the various height and area district classes. The dwelling house (class 1a) districts will usually be placed in the class H-1 height district which limits height to 2½ stories. Other apartment house areas on the side streets will be in the H-1 height district limiting height to 2½ stories.

Trade and industry are excluded from the residence districts. Churches, schools, hospitals, philanthropic institutions, clubs and hotels are permitted in the apartment house district, and with certain important limitations as to location, these uses with the exception of the hotel are permitted in the dwelling house district.

2. *Business and Industrial Districts*—There are four classes of business and industrial districts: (1) Class 2a or local retail buiness district. (2) Class 2b or business and light manufacturing district. (3) Class 3a or heavy industry district. (4) Class 3b or semi-nuisance industry district. The purpose of this classification is to provide locations for all the types of business and industrial use with a minimum of inconvenience and waste and a maximum of efficiency. It is not only necessary to protect the residence sections from invasion by all kinds of trade and industry but also to protect certain kinds of trade and industry from being injured by proximity to antagonistic or deleterious types. A manufacturer of food preparations may be seriously injured by the location nearby of a fertilizer plant. Moreover certain types of business and industrial use may be located close to good residential sections without material injury while other types if located within a quarter of a mile of such sections are a distinct nuisance. It is only by carefully grading the various trade and industrial uses according to their comparative freedom from nuisance characteristics that an orderly and efficient development of the city may be secured.

In the local retail business (class 2a) district, retail trade, offices and small shops for custom work or for the making of articles to be sold at retail on the premises are permitted. The uses permitted in the residence districts are also permitted in the local retail business district. Public garages, light manufacturing and bulk storage are excluded from the local retail business district. This district is suitable chiefly for the smaller retail centers adjacent to the residential sections.

The business and light manufacturing district regulations permit, in addition to all uses permitted in the local retail business district, all kinds of light manufacturing of a non-nuisance character and also public garages, bulk storage and wholesale business.

In the heavy industry (class 3a) district all heavy industrial uses of a comparatively non-nuisance type are permitted in addition to all the uses permitted in the residence and business districts.

In the semi-nuisance industrial (class 3b) district such uses as boiler making, structural iron works, junk storage or carbon works are permitted. The nuisance uses that affect a very wide area such as fertilizer plants, glue manufacture, stock yards or slaughter houses will be excluded from the limits of the City of Lakewood.

The zoning regulations also provide that such special uses as a cemetery, crematory, aviation field or sewage disposal plant may be located only on application to and with the approval of the city council.

3. *Height Districts*—The entire city is divided into four classes of height districts, with maximum height limits as follows: (1) Class H-1, 2½ stories. (2) Class H-2, 50 ft. (3) Class H-3, 75 ft. (4) Class H-4, 100 ft. The height districts are superimposed over the use and area districts. The height regulations, in addition to imposing a maximum height limit for each district, also regulate the height of a building with relation to the distance of the front wall of the building from the center line of the street. The ratio of the building height to the distance of the front wall of the building from the center line of the street is 1 time in the H-1 district, 1½ times in the H-2 district and H-3 district and 2 times in the H-4 district. The limitation of height with reference to the distance of the buildings from the center line of the street adopts the offset principle of permitting a building to be erected at the street line to a certain height, and then to be built higher provided it is set back in a prescribed ratio. For example, in the class H-4 district, where the height limit is 100 ft., a building on an 80-ft. street may be erected at the street line to a height of two times the distance of the building from the center line of the street, or 80 ft., and then by setting back 10 ft. may go 20 ft. higher or the maximum of 100 feet.

The class H-1 height district, with a 2½-story limit, will be applied in most of the residence sections of the city other than certain apartment house frontages on Clifton Boulevard, Detroit Avenue and Madison Avenue.

4. *Area Districts*—The entire city is divided into four classes of area districts, according to required lot area per family, as follows: (1) Class A-1, 5,000 sq.ft.; (2) Class A-2, 2,500 sq.ft.; (3) Class A-3, 1,250 sq.ft.; (4) Class A-4, 625 sq.ft.

The area districts are superimposed over the use and height districts. The area district regulations are intended to promote an appropriate distribution of population and to resist the tendency toward the congestion of population. They are also intended to secure a more open residential development by limiting the percentage of lot that may be covered by buildings in residence districts.

The regulation as to the number of square feet of lot area is based on the number of housekeeping units or families for which the building is arranged or designed. In computing the lot area for this purpose, the area opposite the lot to the center of the street is included. This permits a somewhat more intensive development on the wider streets and on the corner lots. On a street 50 ft. wide, for example, a lot 40 x 100 ft. can be improved with a single-family house in a class A-1 district, a two-family house in a class A-2 district, a four-family house in a class A-3 district and an eight-family house in a class A-4 district.

The class A-1 district requiring 5,000 sq.ft. of lot area per family is applied in those sections of the city where the single family house is the most appropriate development. Two-family houses are not prohibited, but the two-family house would require 10,000 sq.ft. of lot area. This requirement as to lot area, and an additional requirement that not over 30 per cent of the area of the lot may be covered by the building, will in practice tend to limit the construction in class A-1 districts to single-family houses.

The residence sections that are generally appropriate for improvement with either one- or two-family houses will be placed in the class A-2 district, requiring 2,500 sq.ft. of lot area per family. In this district not more than 40 per cent of the area of the lot may be covered by the building.

Most of the apartment house districts will be in the class A-3 district, requiring 1,250 sq.ft. of lot area per family. Certain apartment house areas on Detroit Ave. and on Clifton Boulevard will be in the class A-4 area district requiring only 625 sq.ft. of lot area per family.

In computing the number of families that may be housed on a given lot area, deduction is made where a portion of the lot is used for business or industrial purposes. Thus in a class A-3 area district where four families might be housed on a 40 x 100-ft. lot, if there are two stores on the ground floor, the number of families that can be housed on the lot is reduced by two, or, to be exact, there is a reduction of one family for each 1,000 sq.ft. of lot area occupied for business purposes. The ordinary two- or three-story store and dwelling building is not a desirable type of construction from a public standpoint. The regulations as applied will tend to reduce the number of flats that would otherwise be located over stores.

5. *Yards; Building Lines*—Side yards and rear yards are required in all residence districts. As an exception to the side yard rule, a terrace of not to exceed six single-family dwellings may be built with side yards only on either side of such group of buildings. The width of the side yard shall not be less than one-sixth of the height of the building or not less than 4 ft. in any case. The width of the rear yard shall equal one-half of the height of the building. Forty per cent of the area of the rear yard may be occupied by one-story accessory buildings.

In business and industrial districts side yards are not required but rear yards, with certain important exceptions, are required. No rear yards are required in class 3b industrial districts. In class 3a industrial districts and in business districts rear yards are not required for corner buildings but are required on interior lots that are back to back.

The zone plan does not attempt to provide a complete code for the lighting and ventilation of the building. It simply establishes minimum standards for those open spaces about the building that have a relation to the lighting and ventilation of the adjoining buildings as well as to that of

the building itself. The zone regulations are thus confined to those things in which adjoining owners have a mutual interest. Side yard, rear yard and front yard spaces are required for the mutual advantage and protection of all owners and occupiers of the block. The provision or omission of an interior court, on the other hand, does not affect the neighbor.

Front Yards; Building Lines.—The zone plan establishes building lines on street frontages where an open space between the building and the street line is required in the public interest. These building lines, as shown in detail on a special building line map, are imposed generally throughout the residence districts and also where needed and existing conditions will permit in the business and industrial districts.

In certain business and industrial sections where it is highly desirable to secure a greater distance between buildings on the opposite sides of a street but where a number of existing buildings have been constructed out to the street line, the building line regulations will permit the erection of a one-story building or in some cases of a two-story building between the building line and the street line. This will permit a building to come out to the sidewalk line where otherwise it would be pocketed between existing buildings.

Lakewood has been generally developed with residences setting well back from the street line, affording adequate room for lawn and trees. This makes a healthful and convenient city as well as a beautiful city. Grass and trees make an attractive home environment and are almost essential to a normal and healthful development of the child.

The setting of the buildings back from the street line improves light and air conditions, makes possible the front lawn with trees and shade and removes the dwelling farther back from the noise, fumes and dust of the street. It increases the attractiveness of the section and adds to the health and comfort of the people.

Street widths throughout the city have generally been established on the supposition that buildings were to be set back from the street line. A street width of 40 or 50 ft. is entirely inadequate if residences or other buildings are to be built on the street line. The street is not only a traffic way but should serve the function of securing a more open development, better access of air and sunlight and a chance for trees and other vegetation. A certain minimum space between the buildings located on the opposite sides of a street is also essential to prevent the spread of fire and to facilitate fire fighting.

In order to improve light and air conditions, existing building regulations provide for rear yards. To a certain extent the same reasons hold good for the establishment of front yards. The requirement of a uniform building line means the establishment of a uniform front yard space.

6. *Classification of Uses.*—The classification of uses which is a part of the zoning ordinance divides the various uses of property into groups, classes and subdivisions. The use classes correspond to the use districts. Each use class lists the uses for which the corresponding use district class is specially designed to provide. Starting with the dwelling, the classification enumerates the various kinds of residential, business and industrial uses graded and arranged according to their comparative freedom from nuisance characteristics. In the hierarchy of uses the dwelling comes first and garbage reduction and fertilizer plants last.

7. *Non-Conforming Uses.*—The zoning ordinance does not affect existing uses of property. A use or building existing at the time of the passage of the zoning ordinance which does not comply with the regulations of the use district in which it is located is called a non-conforming use. Such use or building may be continued though not conforming to the use district regulations. The zoning ordinance is not retroactive. If, for example, there is a store in an area that under the zoning ordinance is included in a residence district the store may nevertheless be continued. A non-conforming use may also be changed, subject to the general rule that, if changed, it must be to a higher use as listed in the classification of uses. If, however, the non-conforming use is a Class 3b (semi-nuisance) use or 3c (nuisance) use, it may not be changed unless to a conforming use. A change to another use listed in the same subdivision of the classification is not deemed a change of use under the zoning ordinance. Thus a change from a grocery store to any other kind of a retail store or shop would technically be deemed a continuance of the existing use. A building housing a non-conforming use may not be structurally altered to an extent exceeding during any ten-year period 60 per cent of the assessed value of the building.

While, therefore, an existing non-conforming use may be continued, the limitations imposed on a change of use and on the reconstruction of the building housing the non-conforming use will eventually bring about the diminution of the non-conforming use.

8. *Enforcement; Board of Zoning Appeals.*—The zoning ordinance will be enforced by the inspector of buildings. No building permit will be issued unless the building and its proposed use conforms to the zoning regulations.

In the application of the zoning many cases will arise, especially near the dividing line between two use districts, where the strict letter of the zoning regulations may properly be modified. This can be done in specific cases without injury to the general public purposes of the ordinance while at the same time avoiding unnecessary injury to the individual owner. Strictly limited discretion is therefore lodged in the Board of Appeals created by the building code to make minor modifications and exceptions to the general rules and regulations established by the ordinance.

9. *Amendment of Zone Plan.*—The Council will have full power to amend or supplement the zoning plan. Minor changes will be necessary to correct imperfections in the plan. Other amendments will be required to meet changing conditions of city growth. It is to be expected that the plan will be supplemented and changed when certain fundamental factors affecting the physical structure of the city have been more fully worked out.

While provision should be made for necessary changes, the method of such change should be safeguarded so as to prevent hasty and ill-considered action. A zone plan, in order to afford the protection for which it is designed, should be fairly permanent. Those that build in accord with its provisions should feel reasonably sure that their investment will not be jeopardized by changes in the district lines. On the other hand, the method of change should not be so difficult as to make it impractical to conform the zone plan to changing conditions of city growth.

Under the zoning ordinance any amendment proposed must be referred by the City Council to the City Plan Commission and unless such amendment is approved by the commission, it will require a four-fifths vote of the council to pass the amendment. A similar four-fifths vote is required if there is a protest against the amendment, signed by the owners of 20 per cent of the land adversely affected by the proposed change. If an amendment is proposed by the petition of the owners of 50 per cent of the land in an area proposed to be changed the council must vote on the amendment within 90 days.

Toledo Water Purification Costs

The cost of treating the water supply of Toledo, Ohio, in 1919 was $16.90 per million gallons. Alum, iron, lime and chlorine cost $7.66, $4.46, $3.37 and $0.23 per million gallons, respectively. The average cost per ton of these chemicals was as follows: Alum, $31.85; iron, $17.60; hydrated lime, $14; chlorine, $193.52. Of the $156,912.72 total cost $5,000 was for supervision, $41,-208.42 for labor; $67,340.67 for chemicals, $5,107.36 for maintenance and the remainder for miscellaneous items. Average results in B. Coli content per 100 cu.cm. were as follows: River water, 2,319; settled water, 60; filtered water, 16; disinfected water, 1.7; city tap water, 0.42, equivalent to 99.98 per cent removal by the whole process.

Municipal Milk Plant for Jamestown

BONDS to the amount of $150,000 and the creation of a milk commission to establish a milk bottling and pasteurization plant and a milk distribution system for Jamestown, N. Y., were authorized by a large majority at a popular election held on Aug. 21. The commission will consist of four members to be appointed by Samuel A. Carlson, mayor of Jamestown, who for several years past has been working for the municipalization of the milk supply of Jamestown. A similar proposal was defeated by a large majority a year ago. In a letter to *The American City* Mayor Carlson outlines the municipal milk project as follows:

The plan contemplates the erection of a central station to which all milk from the producer will be brought and tested in a scientific manner, each can from each producer being subjected to an individual test so as to safeguard against bacteria and impure milk. The producer will be paid on the basis of the quality of milk supplied; those having the lowest bacteria count and highest percentage of butter fat will receive the highest price for milk. The milk will be clarified and all milk except Grade "A" raw milk, which comes from tuberculin tested cows, will be pasteurized, and all milk will be placed in bottles under the improved method of bottling, under which the milk is free from the touch of human hands or any contamination. The milk will be delivered at an early hour to each householder. The city will be divided into 30 districts, one delivery man for each district. These 30 men will take the place of the 70 milk peddlers who are now supplying the city with milk, and who are crossing each other's tracks continually and thereby entailing a duplicate expense and waste of effort, which is now borne by the community. The municipal sysem will eliminate the added cost of the present middleman's profit.

Mayor Carlson states that it is expected that the city will be able to sell milk below the present price of 15c. per quart for Grade "B" quality, besides giving a better and richer milk and affording the farmer a higher price. He also says that the municipal milk project is designed to promote health rather than economy. He states that the milk supply for the 40,000 people in Jamestown costs them more than $1,000,000 in a year, or 60 per cent more than the entire municipal tax budget. He also says that the city expects to produce cheese, butter and buttermilk at its bottling plant.

Enormous Rainfall in Hawaii

An inch a day is the average rainfall in the upper Waipio Valley, Hawaii, which makes it one of the areas in the world where the rainfall is heaviest. On the other hand, the rainfall on some of the slopes of Hualalai, on the same island, is only 20 in. a year. The only surface streams on the island are along the northeast coast between Hilo and Kohala. Waipio River, according to the U. S. Geological Survey, has been partly developed for irrigation.

Hydraulicking Methods for a Million Yard Fill

Single Dredge Places Blanket of Clean Lake Sand Over 65 Acres of Marsh Land for a Factory Site

UPWARDS of 100,000 cu.yd. of sand each month is being pumped by a 15-in. hydraulic dredge in making a fill for a factory site at Waukegan, Ill. About $12\frac{1}{2}$ per cent solids are being averaged and at times the proportion has reached 27 per cent. The greatest length of discharge has been 4,700 ft. and later this length will be increased to about 5,000 ft. The fill is clean lake sand to a depth of 6 to 16 ft., with terraced plateaus about 4 ft. higher for the building sites, over an area of about 65 acres, and will amount, it is estimated, to 1,000,000 cu.yd.

As a hydraulic fill operation the work is notable in

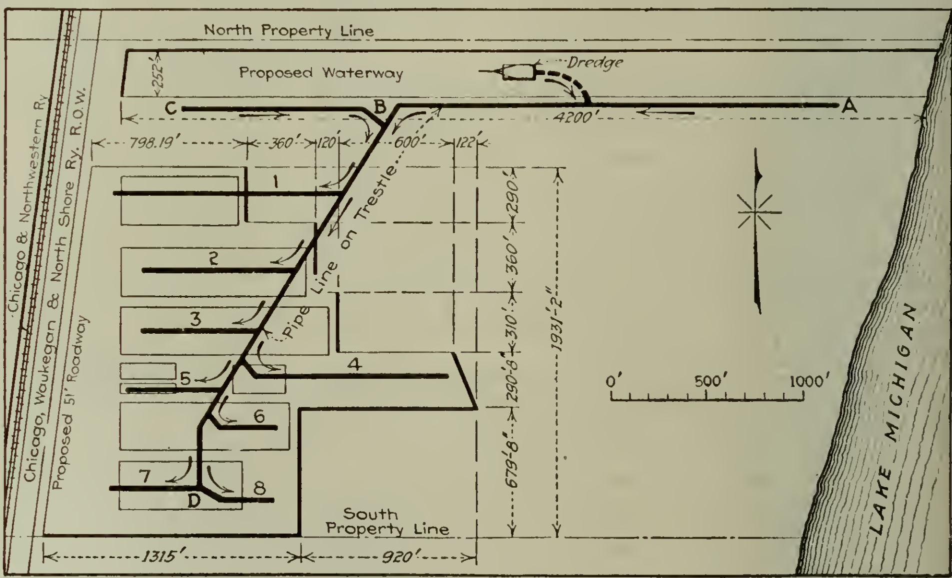


FIG. 1. LOCATION OF FILL AND PIPE LINES

the particulars that (1) it is the largest fill specified to be entirely clean sand, ever made by hydraulic dredge, (2) the distance pumped, without a booster pump, is the greatest ever accomplished in pumping sand, (3) the building areas are terraced above the general fill level and pits, with regular slopes, are left below this level, by water control of the flowing sand, (4) the total lift is accomplished close to the dredge by a steep incline to a pipe on a trestle which constantly descends on a detemined grade to the point of discharge, and (5) the jet pump is connected with the discharge pipe in such a manner that, with the arrangement of discharge just indicated, plugs in the pipe lines are washed out without taking the pipe apart.

As indicated by Fig. 1, the fill covers an irregular area of about 65 acres at the west end of a quadrilateral tract fronting about one-half mile on Lake Michigan. This land, being a part of the old lake beach, is, except for a shallow covering of marsh muck, a fine beach sand, with few pebbles and is free from obstacles to excavation other than the long roots of the marsh plants which tangle into knots and frequently choke the mouth of the suction pipe. A channel 250 ft. wide and 4,200 ft. long, parallel to the north property line, provides the material for the fill. The main fill is to

El. 99.5 or to about 8.5 ft. above lake level, and varies, with the contour of the original surface, from 6 to 16 ft. in depth. At the sites of the building, the foundation fill is 3 to 9 in. above the main fill. Railway tracks and roadways occupy the depressed areas between buildings. A section across the filled area, transversely of the buildings, has the character of a series of wide plateaus separated by narrow valleys and to secure this variation of surface with water-borne sand was one of the special problems of the operation.

FIG. 3. TOTAL RISE IN PIPE LINE KEPT CLOSE TO DREDGE

Both the sequence of excavation and fill and the discharge pipe location were definitely planned. Starting the dredge at about midlength of the channel it was planned to work west to make the southern portion of the fill and east to make the northern portion. This plan kept the average length of discharge pipe about the same for the two portions of the fill. The pipe line consisted of a trunk line *A* to *B* to *C* and *B* to *D*, located as shown, with branch lines Nos. 1 to 8 right and left and longitudinally of every building site. Broadly speaking that portion *BD* of the trunk line across the filled area is permanent while the portion parallel to the channel is installed and shifted as the dredge location requires. The branch lines are installed, shifted and extended as the filling progresses.

In portions of its equipment the dredge is unusual. As indicated by the diagram plans Fig. 2, the dredge pump is a 15-in. centrifugal, set vertical and operated at 440 r.p.m. by a direct connected 600-kw. motor. Its discharge pipe take-off is unusual in the respect that it is arranged to receive a stream from the jet pump the purpose of which is to clear the discharge pipe line from plugs in the manner which is described later. The jet

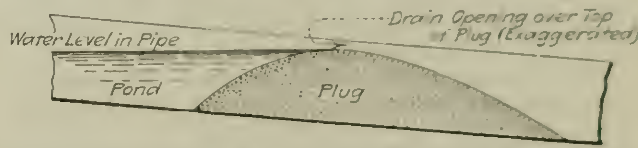


FIG. 4. METHOD OF CLEARING PLUGS IN PIPE LINE

pump has an 8-in. suction and a 6-in. discharge and gives a pressure of 75 lb. Electrical equipment, suction pipe control and other mechanism are of ordinary types.

From the dredge the discharge is horiztonal, as indicated by Fig. 3, to the edge of the channel, and then climbs in one step to the peak lift, which is the trunk pipe line on trestle paralleling the channel. This trestle is about 30 ft. high along the channel bank and then slopes down from *B* to *D* and to the ends of the branches, but all pipe line is on trestle and is laid true to line and grade. This accurate construction of pipe line, with the concentration of the total lift in the short distance between the dredge suction and the channel bank trestle and the discharge line on a constantly descending grade from the trestle top to the discharge end, is the special feature of the pipe line layout.

An important purpose of the constantly descending grade of the discharge pipe line is to remove plugs. A plug forms as indicated by the sketch Fig. 4, but unless a careless pump man keeps driving ahead with a full load of solids, it does not form so solidly that there is not always, due to the inclination of the pipe, a small rill or trickle of the backed up water over the top which leaves a passage open. As soon then, as the pump man's gages indicate that an incipient plug

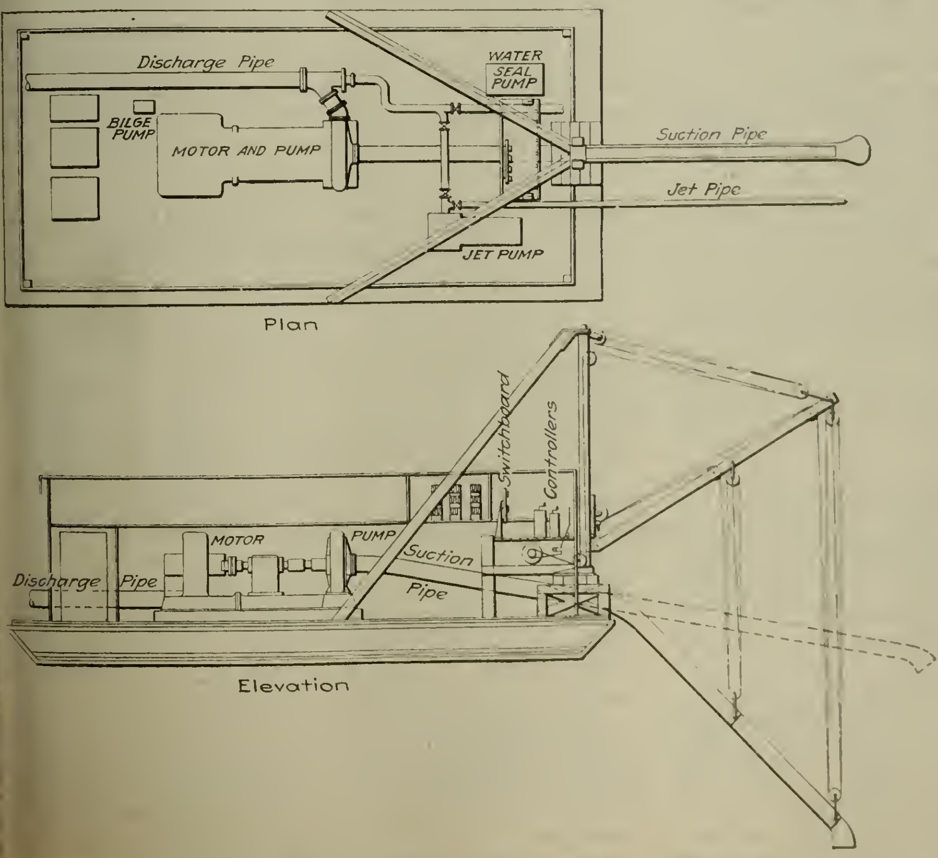


FIG. 2. PUMPING PLANT ARRANGEMENT ON DREDGE

has formed the suction is raised and the pump is stopped. The discharge line from the dredge to the top of the trestle is then drained back into the pit.

To clear the plug the jet pump starts pumping into the discharge pipe through the connections indicated by Fig. 2. As the discharge pipe is filled, the water in the pond behind the plug, as shown by Fig. 4, begins to rise and trickle through the small channel over the top of the plug and with increasing pressure from the jet pump the flowing rill accumulates an eroding velocity which enlarges the channel and cuts down the crest of the plug. When the water is flowing freely, the main pump, taking clear water, is started and the sand is flushed through and the pipe cleaned out.

With this arrangement there has not been a plug in these long discharge lines which has not been cleared in

FIG. 6. OVERFLOW OUTLETS THROUGH LEVEES

40 min., except once when a chance was taken of extending a branch pipe line on the top of the fill and a plug occurred which necessitated the removal of the plugged pipe and many profane hours of picking and washing. A plug of fine beach sand is very hard. It cannot be shaken out by upending the pipe nor can it be punched through with bars. It is best removed by tilting the pipe and hosing from the low end.

From the dredge to the trunk pipe line on trestle the discharge pipe is 15 in.; the trunk line and laterals are

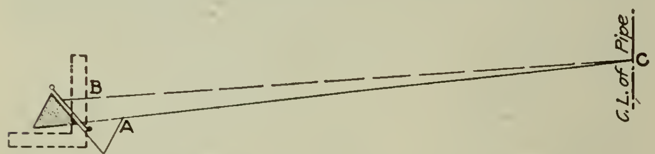


FIG. 7. METHOD OF LEVELING UP FILLS

18 in. to reduce friction. A lock joint spiral pipe is used, with flanged ends and bolted pipe joints. The stream velocity is 12 ft. a second and about 12½ per cent, average, of solids is carried, practically all in the lower third of the stream.

The rectangular fills are built up as indicated by Fig. 5, with levees built by a walking dragline excavator. Timber outlets of the familiar L-shape take the overflow through the levees as indicated by Fig. 6. As the fill is made the sand takes a slope right and left from the pipe toward the levees. To flatten out this slope as from *CA* to *CB* in Fig. 7, a trench is dug and a low levee

FIG. 5. LEVEED BASIN READY FOR FILL

built as indicated. The face of this levee is protected by convass weighted down. As the grade near the levee builds up the wier level of the L-outlet is raised. To go higher than *CB* another ditch is dug and a levee built and the canvass is folded back to protect the new levee face. In this way the 4-ft. building site fills were carried above the level of the main fill and the top surface created, by water cariage alone, did not vary to exceed 1 per cent from true level.

Operating two shifts, the dredge has been pumping over 100,000 cu.yd. a month. This excellent output is due in part to the efficiency of the crews which is being promoted by bonus payments. If the crews reach a monthly yardage of 100,000, each man receives as bonus an amount equal to 10 per cent of his salary. This bonus is increased 1 per cent for each additional 10,000 cu.yd. or fraction greater than a half. With the bonus system the monthly runs have gone up from 90,000 cu.yd. a month to over 100,000 cu.yd., and frequently the 1 per cent additional bonus has been earned.

The fill is being made for the new factory of the H. W. Johns-Manville Co., the contractors are the Construction Materials Co., Chicago, with J. R. Sensibar, president, in general charge of the work. Patents for some of the original methods and devices have been applied for.

Engineering Bodies Study Government Organization

A three-months' study of the administrative organization of the federal government has been undertaken by the budget committee of Engineering Council, the National Public Works Association, the National Educational Association and the American Public Health Association. Representatives of these organizations will remain in Washington until the work is complete. The purpose is to work out a reorganization plan.

Active work has been in progress looking to the creation of a Department of Education. Steps have been taken by others toward securing a Department of Public Health. Still others have been in favor of the combination of the two under a Department of Public Welfare. These measures are being considered in connection with the establishment of a Department of Public Works. The present study is being made with the idea that these various efforts may be amalgamated.

The organizaton making the present study is to be known as the National Committee on Governmental Economy. Stanley H. Howe is the director of the committee and C. T. Chenery is its executive secretary. Other members include Harold N. Graves, John T. Pratt, J. Parke Channing Francis Blossom.

Why Street Railways Should Bear Share of Pavement Cost

Brief of Data from 166 Cities Gives Reasons Why Two-Foot Strip Outside Rails Should Not Be Diminished

As an aid to American cities where efforts may be made to transfer at least a share of the burden of paving expenses from the traction corporations to the cities or abutting property owners, William P. Capes, director of the New York State Bureau of Municipal Information has prepared a summary of the arguments presented to the recent session of the New York Legislature against a proposed revision of the law which requires traction companies to construct and maintain the pavement between and for 2 ft. on either side of street railway tracks. The proposed revision of the law, fostered by the New York State Street Railway Association, would reduce the area of pavement construction and maintenance responsibility to a strip between and for 6 in. on either side of the tracks.

Amendment Opposed

Through the New York State Conference of Mayors and Other City Officials, 59 cities in the state opposed the proposed amendment. At the request of the chairman of the Senate Committee on Public Service, to which committee the bill had been referred, each city, through its mayor and city engineer, compiled a brief giving the reasons for its opposition. The committee also received a report from the New York State Bureau of Municipal Information summarizing the data it had received from 166 American cities of 30,000 or more population. The latter report showed that of these cities, sixty required the street railway company to pay for the construction, reconstruction and maintenance of pavements (original, repavement, temporary and permanent), between and for 2 ft. on either side of their tracks. In fifteen other cities the companies are responsible for the pavement between and 18 in. on either side of their tracks and in eleven others for 12 in. on either side of their tracks. The plans vary in the remaining cities, but in all, except one, the companies are held responsible for the pavement of at least that part of the street surface which is occupied by their tracks.

Following is a summary of the arguments presented, which apparently had their effect upon the Senate Committee on Public Service inasmuch as the proposed amendment was never reported out of committee:

Heavy urban cars, and not the ordinary travel, are responsible for constant repairs to the pavements.

Modern electric cars are from six to ten times the weight of the horsecar formerly used, such a weight producing correspondingly increased vibration and resulting in more rapid pavement disintegration. In addition, the railroad companies run cars over tracks while the pavement is under construction so that a complete bonding of the materials is seldom obtained.

Drainage Difficult

Drainage of pavements upon which there are rails is much more difficult than draining other pavements. The contour of the street must be altered to provide for drainage along and adjacent to the rails as the inability of any roadbed construction to withstand seepage of water into it by creeping along the rails is well known. The rail affords the first opportunity for the water to enter subgrade, and therefore it forms the first point of weakness in the pavement.

It is impossible to maintain any modern satisfactory pavement adjacent to any car track construction unless such track construction is made rigid. The incentive to make such rigid construction now rests with the traction company to lessen the cost of pavement maintenance. With such incentive removed, the company would naturally resort to a cheaper construction resulting in an increased cost of maintenance.

In case the company is to construct a track in a street already paved it becomes necessary to tear up at least 9 ft. of pavement in order to lay the track. This pavement has already been paid for once, and it may be relaid after the tracks have been placed in such a way that it is apparently on the surface as good as new, but there is a longitudinal crack in the base which eventually works toward the surface under the stress of constant vibration.

Tie Replacement Costly

Replacement of ties necessitates pavement cutting to a width of approximately 9 ft. This is a charge which in all fairness should be paid by the railway company. Rigid pavements frequently have to be disturbed before their useful life is spent in order for traction companies to renew bonds, replace broken rails, and retighten joints.

A pavement which has been torn up cannot be restored to as good condition as before; consequently the location of railway track in a street tends to destroy the life of the whole pavement.

General street railroad engineering has established the fact that repairs to paving in the railroad area consumes 17 to 20 per cent of the total cost of maintenance of way, so a reduction of seven-ninths of this obligation would not help the railroad company more than the additional cent charged in a six-cent fare.

The life of the roadbed of a railroad is about twelve years, and the life of a durably constructed pavement is over twenty years.

It is a well-known fact among engineers that no matter how well a pavement is constructed it will heave along the rail line and does not settle back in the spring as it should. Each year increases the degree of trouble. It is also well known that street railroad companies use quantities of salt around switches in the winter time, and this has a very serious effect upon the pavement.

Defective rails cannot be properly removed and replaced in a 1-ft. area, particularly on curves.

Heavier Construction Under Tracks

Cities should not be required to pay for the cost of greater excavation and heavier construction required under tracks, which are necessary purely for the support of a company's cars.

Street railway tracks necessitate special and more expensive pavement construction. The use of T-rails instead of flange rails necessitates the use of a special type of brick contiguous to rails more expensive than the regular paving brick. The fitting of these bricks to the rails also involves additional expense in laying the pavement.

Increased pavement width is usually necessary upon streets where there are railway tracks in order that a line of travel may be supplied on either side of the track.

In repairing or connecting subsurface structures it is frequently necessary to excavate under tracks while cars are in operation, a fact materially increasing the expense of such subsurface installation.

Pavements are damaged by the operation of snow plows and snow sweepers during the winter.

It is fallacious to believe that the conditions existing today relative to the destructive influence of trolley tracks and the operation of trolley cars over them are not the same as they always have been. The traction companies' false idea of economy, in general, has been a reduction of the first cost in ballasting their tracks. This, in conjunction with the rapidly increasing weight of cars, has extended the destructive circle of influence more than 2 ft. outside the outside rail.

If the traction companies are relieved of this obligation the increased cost of pavement and repair is thrown back on the property owners by assessment for local benefits derived, or, if a general improvement, new revenue has to be obtained by an increase of the general tax.

Unjust Taxation

If it is a question of financing the work surely the railroads and indirectly the people who use them and benefit therefrom should stand this cost and not the entire community. Not over 50 per cent of the population has occasion to use the railway, and it does not seem proper to ask those who derive no benefit therefrom to help pay for the construction and repair, which would be the case if the betterment were charged to the city. The statute which it is proposed to amend is fair to the railway company, in that the area of street pavement which it is now obliged to maintain is that area within which experience of many years has shown to be particularly affected by maintenance and operation of its lines.

Presence between tracks of trolley poles limits the surface area of streets available for traffic, making the traffic heavier on the usable portions of the street, thereby causing greater deterioration and increased maintenance cost.

In the case of the presence of channel or slot rails the pavement between tracks is cut up into smaller slabs and the further presence of so-called manhole boxes tends greatly to diminish the life of the pavement, thereby causing much greater maintenance.

Nine-Foot Width Equitable

Nine feet, a dimension controlled by the 8-ft. railroad tie, should be definitely marked off by construction joints, and 9 ft. built and maintained by the railroad company. This places entire responsibility for damages due to subsequent failure within the railway strip where it belongs.

If expense for pavement adjacent to rails and 2 ft. outside has heretofore been deemed a legitimate charge, a change is not considered justifiable now in the light of the use of heavy cars, higher speed and more frequent operation.

A railway company is constantly ripping up pavements to repair its street car tracks. It is absolutely impossible for a company, were it to maintain only a 6-in. width on each side of its rails, to repair its tracks properly without disturbing other parts of the pavement, thus adding expense to the city.

The cities, upon the face of the performance by the street surface railroad corporations of their paving obligations, have granted many franchises on terms more favorable to street surface railroad corporations than they would have had they not assumed that such corporations would be obliged to pave the area described in existing law. If the liability on the part of the traction company existed then there has been nothing that has taken place in the meantime to affect this liability except to increase it.

The original purpose of this law was to place the burden of expense of this portion of the pavement upon the street railway company which enjoys the privilege of the use of the streets to operate a business from which it derives a revenue. Nothing has transpired since the law was enacted which justifies a change which would place the burden of expense upon the taxpayers.

In addition to the foregoing arguments others were offered supported by examples in some cities where existing street railways had been the direct cause of pavement failure or deterioration.

Flow Coefficient in 36-Inch Siphon

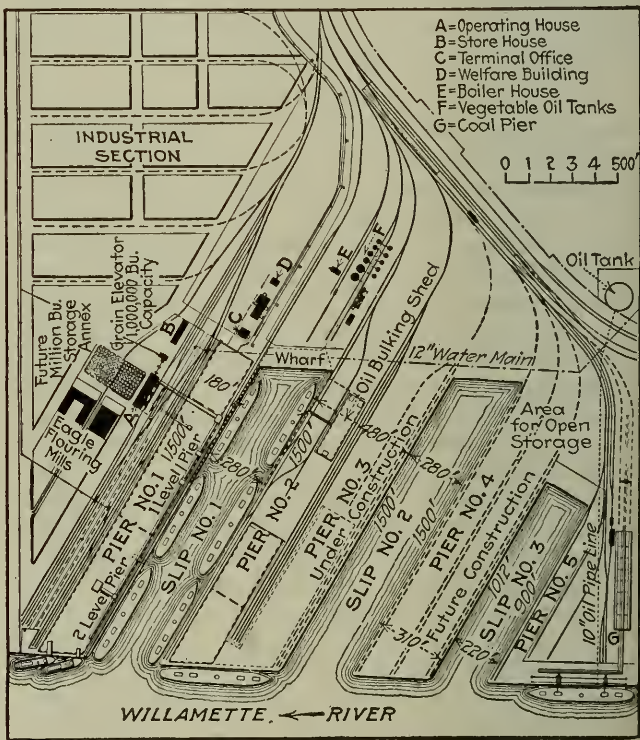
From observations made by the Board of Water Supply of the City of New York the coefficient of flow of the 36-in. flexible-jointed cast-iron pipe of the Narrows siphon was determined to be about 119.5 for the Chezy formula with a flow of about 14,000,000 gal. per day. At this time the pipe-line had been in service about three years. The figures are from the 1919 annual report of J. Waldo Smith, chief engineer.

Port Terminal Pier Design at Portland, Ore.

Considerations Which Led to Adoption of Wide Piers and Handling Machinery in the New Municipal Docks

By G. B. Hegardt
Engineer, Commission of Public Docks, Portland, Ore.

There has been no little discussion of late regarding the proper size and equipment of shipping piers in port terminals, particularly in relation to the Stapleton piers now under construction in New York City. As a contribution to that discussion the experience of the City of Portland, Ore., with its new municipal terminal development, may be of interest. The fundamentals of that development were described in *Engineering News-Record*, Jan. 22, 1920, p. 179. What follows is more an explanation of the design.



PRESENT LAYOUT OF TERMINAL NO. 4, BY THE CITY OF PORTLAND, ORE.

This terminal, designated as "Municipal Terminal No. 4," and the present layout of which is given in the accompanying drawing, is being constructed by the Commission of Public Docks by funds made available from a total bond authorization of $10,500,000 voted for the provision of modern terminal facilities for the port.

The universal custom in waterfront construction by private interests, and until the last few years by the city, was the quay type of docks or wharves. With the constantly increasing shipping and development of the port and the necessity of providing terminal facilities on a much larger scale than had previously been attempted or required, the commission, realizing the vital importance of having the facilities of the port brought up to the highest standard of efficiency, determined to construct a large import and export terminal, using pier and slip construction.

A site containing 159 acres, with a harbor frontage of 2,730 lin.ft., was acquired, as being conveniently located for easy access by the four transcontinental railroads serving the port and of sufficient area to permit of such future expansion requirements as would have to be provided for at a terminal of this magnitude, such as warehouses, cold-storage plants, vegetable-oil tanks, storage bunkers, etc., and extensive trackage facilities to adequately serve all terminal requirements and at the same time eliminate further congestion of existing and already crowded railroad terminals of the port. The acquisition of this large terminal area also contemplated an industrial section of about fifty acres.

While the first improvements contemplated at Terminal No. 4, when the site was selected late in 1917, consisted only in the construction of a 1,000,000-bushel grain elevator and Pier No. 1, with a trackage sufficient to care for these facilities, a complete terminal layout was made of the entire site, which is being closely followed as the construction is being carried to completion.

Principal Factors

The principal factors and problems given special study and consideration in the planning of this important terminal were:

1. Accessibility and ease of berthing vessels.
2. Most convenient and favorable connection with railroads serving the port, having in mind the necessity of eliminating further congestion of existing railroad terminals.
3. Quay or pier construction.
4. Type of structures.
5. Most satisfactory arrangement for an adequate trackage to permit of the expeditious switching of cars to and from the facilities and industries located on the terminal site.
6. Character of cargoes and commodities to be handled and stored.
7. Provision in construction for probable mechanical machinery that would be required in handling cargo.
8. Desirability of including an industrial section in the terminal site.

For the purpose of this article, however, only the matter of type of pier structures and railroad trackage will be covered, as the plan submitted herewith shows the general terminal layout and the facilities constructed, or now being constructed.

The question of width of pier shed that should be adopted as standard for this large terminal was given much study and consideration. In other terminals constructed by the commission the sheds were made only 100 ft. wide, following a practice more or less general at most ports of this country at that time. But as an operating proposition it was soon demonstrated that a narrow shed was a positive agency in producing congestion and that, in any new construction undertaken, a radical change should be made to insure greater efficiency and reduced cost in handling of cargo of the character which was most common to this port.

The construction finally decided upon was for transit sheds 180 ft. in width and, from results obtained during an operating period of over 18 months, this width of shed has fully met every practical and economical requirement in import and export cargo handling, as furnishing adequate floor space capacity for vessels of large size, discharging and taking out full cargoes, usually of many and varied commodities and sizes, permitting, in most cases, large vessels to discharge and take on full cargoes without changing their berth. It will be noted in the plan that these wide piers afford service to vessels from only one side, thus retaining the quay feature in operation, except in the case of Pier No. 4, the rear of the piers having depressed tracks for cars.

In the four main piers of this terminal a length of 1,500 ft. was adopted as furnishing the greatest flexibility and economy in operation, and being at all times ample for the accommodation of inbound and outbound cargo for two large vessels, and in most cases for three vessels of such size, and slips 280 ft. wide, sufficient space for two vessels, in addition to lighters or fuel barges. Besides, the tendency for vessels of larger dimensions in the Pacific trade is constantly growing and this condition must be provided for in all new construction; and the organization and equipment for the operation of one long pier must be relatively much less than for a series of short piers. The fifth pier is approximately 1,000 ft. long. The terminal, when fully completed, will afford, at one time, berthing space for seventeen vessels of a length of 500 ft.

Width of rear platforms of piers is 14 ft. and slip side platforms 34 ft., to permit there of the installation of crane equipment, when such machinery possessing great adaptability is called for and is available.

Probably one of the most important features of this terminal is its terminal and switching trackage. The great depth of the site made it possible to supply adequate trackage to all facilities of the terminal as the leads were amply long to bring them to the piers, grain elevator, oil storage, bunkers, etc., on easy curves, and it is believed that one of the prime requisites of a combined rail-and-water terminal, that of providing for the quick movement of cars, has been successfully solved at this terminal, which, when completed, will have a trackage, within the terminal site, of about 20 miles, exclusive of trackage serving industries.

Test of Automatic Train Control Device

Automatic application of brakes if the engineman on the locomotive should disregard signals is the basis of a train control system developed by C. F. Shadle, efficiency engineer of the Chicago, Indianapolis & Western R.R., and demonstrated recently on a six-mile stretch of mainline near Indianapolis, Ind. This part of the line is equipped with the automatic block system, the blocks being 4,000 ft. long, but with the automatic control system the roadside signals are supplemented by signal lights in the engine cab. On passing a "caution" signal there is a light application of the brakes, sufficient to reduce the speed to a predetermined limit, say 25 m.p.h. The engineman can make a heavier application if he desires to check or stop the train, but he cannot release the brakes until the limit speed has been reached. If a "stop" signal is passed, the brakes are set automatically to stop the train within a distance depending upon the speed. The brakes cannot be released until the train has come to a stop, the engineman then having to get down and operate a releasing device. Each automatic reduction of speed and stoppage of train is indicated on the chart of a speed recorder. Trials made under the supervision of the safety division of the Interstate Commerce Commission showed successful operation at speeds up to 65 m.p.h.

Footway Undercrossing for Busy Chicago Street

Special Details for Conduits in Shallow Roof—Large Sewer in Floor—Waterproofing and Expansion Joints

HEAVY pedestrian traffic to and from the Chicago suburban terminal of the Illinois Central R.R. at Randolph St., on the lake front, is intersected by the dense automobile traffic on Michigan Ave., so that even under the control of the police there is delay and confusion and some danger, especially during the rush hours when both the pedestrian and automobile traffic is at its highest. A spacious footway or under-crossing will relieve this condition, enabling pedestrians to cross Michigan Ave. in safety.

This under-crossing is being built by the railway company as the first step in a comprehensive joint program of railway improvement and city park development on the lake front (see *Engineering News-Record* of Aug. 21, 1919, p. 360). Eventually it will form the main approach to the station, but until the reconstruction of the Randolph St. terminal is undertaken the east end of the footway will terminate at lateral stairways opening on the sidewalk of Michigan Ave. Later it will be extended on a 4 per cent incline into the new station. The footway will be 16 x 8 ft. in section, with a present length of 137 ft. between stairways. Its general design is shown in Fig. 1.

Special considerations influencing the design of the structure included necessity for shallow depth and for watertightness, interference with a sewer, the requirement that pneumatic tubes and electric conduits be carried across the roof, and the urgent importance of rapid construction in order to cause as little obstruction as possible to the extremely heavy vehicle traffic. The last-mentioned consideration led to the adoption of encased I-beams for the entire length of roof, in place of a reinforced-concrete slab (on that portion where the available depth would have permitted its use), as such a slab would have to be left for some time to allow the concrete to set hard before replacing the pavement.

Interference with a 48-in. brick sewer made it necessary to keep the total height of the structure at a minimum. Even with all possible saving in height, however, the under-crossing could not be accommodated in the depth between sewer and street pavement, and therefore the roadway surface will be raised slightly above the present level, necessitating a modification in the street grades.

The soil at the site is mainly in old filled ground. As only half the width of the street can be blocked during construction the work will be done in two sections.

The design is intended to insure watertightness of the structure so far as the exclusion of groundwater is concerned, but a drainage system will be installed for the removal of water used in cleaning and of surface water that may enter by the stairways. Inlets will connect to drain pipes leading to a gravel trap and then to an electric bilge pump beneath the floor, which will discharge the water into the sewer. A 7-in. bed of plain concrete will be laid on the bottom of the excavation, and the 6-in. vertical concrete walls for the protection of the waterproofing will be built upon it. A membrane of felt and pitch will be laid on the horizontal portion of this slab and the inside of the walls, the horizontal por-

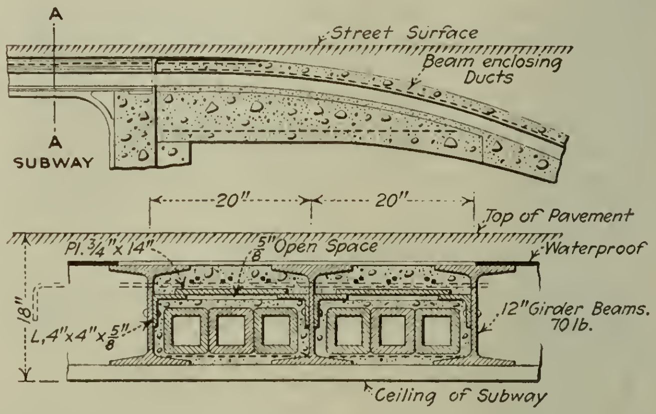


FIG. 2. ROOF OF FOOTWAY KEEPS ELECTRIC CONDUITS CLEAR OF PAVING

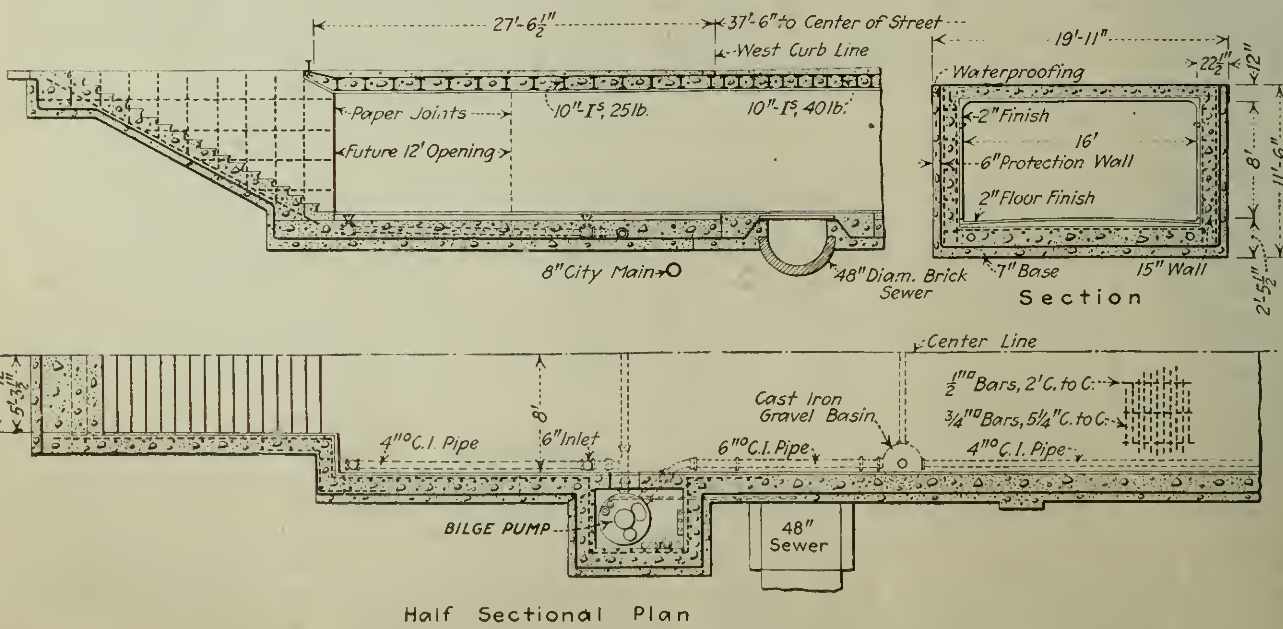


FIG. 1. FOOTWAY CROSSING UNDER MICHIGAN AVE., CHICAGO

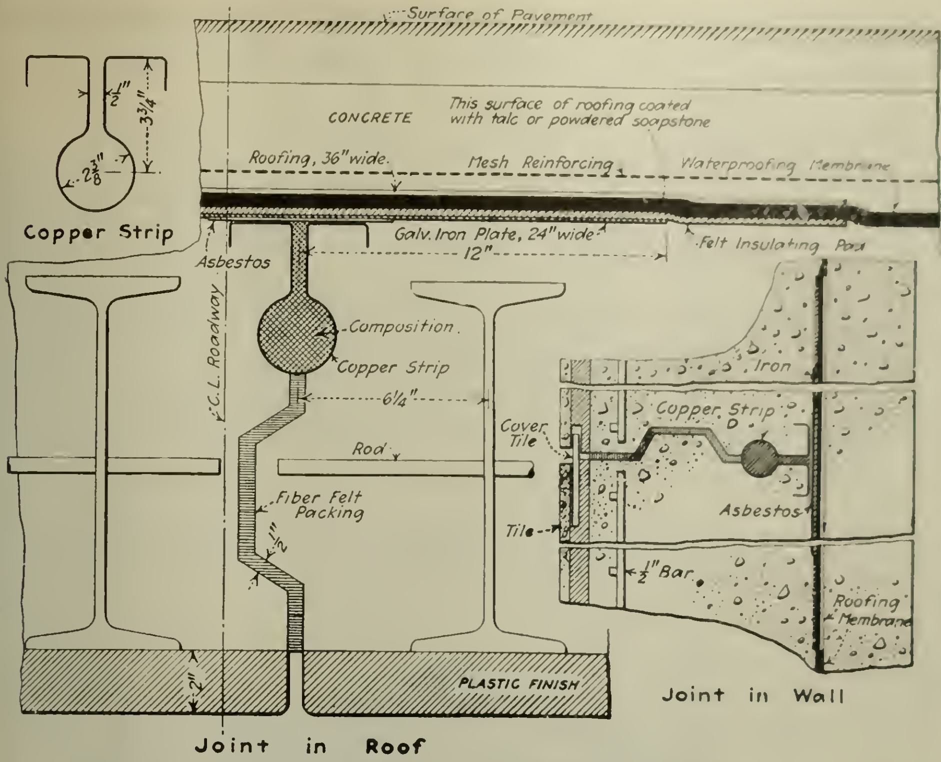


FIG. 3. EXPANSION JOINTS OF FOOTWAY

tion of this membrane being covered immediately with 1 in. of concrete to protect it from being punctured or injured while preparations are being made to pour the 15-in. base slab and side walls.

For the floor there will be a concrete slab 4 to 6 in. thick laid on the 15-in. slab and having a 2-in. wearing surface of non-slip wear-resisting composition, the surface being crowned 2 in. to assist drainage. For the roof there will be 10 and 12-in. I-beams spaced 12 to 24 in. c. to c. and cased in concrete. Between the top of the roof and the concrete base for the street pavement a waterproof membrane will be placed, being so joined to that on the side walls as to form a complete envelope.

Special roof construction with 12-in. girder beams is required to carry tile conduits for electric cables, as shown in Fig. 2. In the street these conduits are laid deep and placed in two layers. As they approach the subway they will rise on easy curves to the level of the roof, where they will be in a single layer, being supported on bars laid across the bottom flanges of the beams and being covered with concrete. Shelf angles on the webs of the beams will carry cover plates standing ⅜ in. clear of this concrete filling and supporting the base of the pavement. The purpose of this open space is to keep the load-carrying part of the roof out of contact with the conduit construction, so that the latter will not be crushed or disturbed in case of deflection of the pavement under loads. Beyond the sides of the footway the conduits will be cased in reinforced-concrete beams until the depth of earth cover is sufficient to prevent breakage by the superimposed live load. Pipes and metal conduits at other parts of the roof will be embedded in the concrete filling between the I-beams.

Expansion Joints.—A single expansion joint will be provided in the roof and in each side wall. As shown in Fig. 3, the inner part of the ½-in. groove will be packed with fiber felt and the upper or outer part filled with a bulb-shaped copper strip containing an asphaltic composition. Upon the flanges of this strip will be a sheet of asbestos insulating fiber, a sheet of iron of No. 26 gage and finally a felt insulating pad upon which the waterproofing membrane will rest. The surface of the iron sheet next to the concrete is to be coated with paraffin to form a non-adhesive surface. The outer surface of the membrane for a distance of 18 in. on either side of the joint will be covered with a sheet of prepared roofing, coated on the inner side with talc or powdered soapstone. By this arrangement the waterproofing membrane will have a free width of 36 in. in which to stretch or contract.

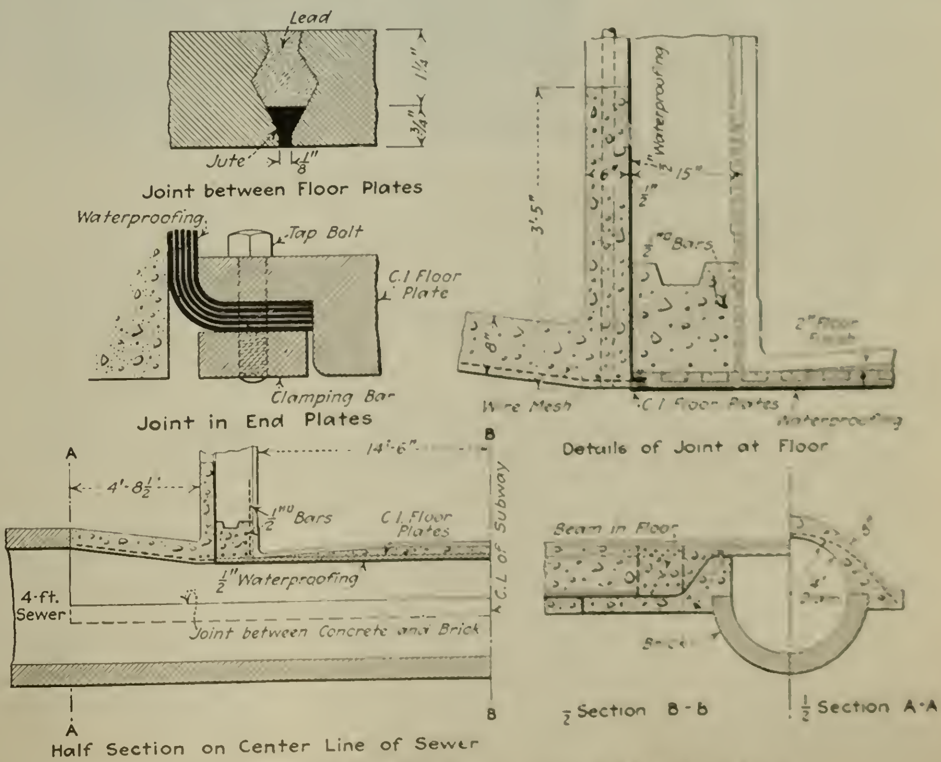


FIG. 4. TOP OF SEWER BUILT INTO FOOTWAY FLOOR

As the floor intersects a 48-in. brick sewer the sewer is converted into a trough section with a flat roof of cast-iron plates designed to be watertight under an upward pressure due to a head of 4 ft., as shown in Fig. 4. The upper part of each side of the trough will be of concrete, extended as a slab to relieve the load on the brick invert. In the floor of the subway will be formed two transverse reinforced concrete beams to carry the load and prevent deflection over the sewer. Anchor bolts will secure the cast-iron roof plates to the concrete walls of the trough. To prevent upward leakage the edges of the plates are shaped to form dovetail packing grooves, as shown in the detail, the lower part being packed with jute and the remainder of the joint then filled in with melted lead. At each side wall the vertical waterpoofing will be turned horizontally under the edge of the cast-iron plate and clamped by an iron bar drawn tight by tap bolts in the plate. Beyond the side walls of the subway a tapering roof of reinforced concrete will connect the special trough section with the normal circular section of the sewer.

White glazed tile will line the sides of the footway nearly to the top. The ceiling and the remaining portion of the side walls will be finished with 2 in. of plaster on metal lath, the top corners being curved to a 6-in. radius. Electric lamps will be placed in these curved corners. Concrete will be used for the stairs, the steps having 6-in. risers and 12-in. treads, with nonslip facing on the treads. Ornamental canopies or kiosks will cover the stairway entrances. This under-crossing was designed under the direction of D. J. Brumley, chief engineer of Chicago terminal improvements, Illinois Central R.R. The plans have been approved by the city authorities and the South Park Commission, and the contract has been let to the Nash-Dowdle Co., Chicago.

Illinois Health Board Assists Engineers

A circular letter to engineers issued by the Illinois Department of Public Health calls attention to the information and assistance that are available through the Division of Engineering and Sanitation. The activities of the division includes stream pollution, sanitary surveys and inspections, malaria control, city waste collection and street cleaning, investigation of typhoid fever and other water borne diseases, and control of water supply and sewerage systems. The division does not attempt to take the place of a consulting engineer, but encourages the employment of engineers by communities and it is believed that this has improved the attitude of the public officials toward engaging engineers in connection with proposed works. Dr. C. St. Clair Drake is director of the Department of Public Health; Harry F. Ferguson is chief sanitary engineer, at Springfield, Ill.

Erecting Cleveland Auditorium Roof with Traveling Falsework

By H. E. Gage
Engineer for United Erecting Co., Cleveland, Ohio

Traveling false work and derrick towers were used in erecting the 209-ft. steel roof trusses of Cleveland's new $5,000,000 municipal auditorium. The plant arrangement is not entirely unusual, but its application to this particular work is interesting in view of the large amount of falsework involved, the application of wooden trusses in the falsework, and the simple rolling arrangement of the plant. Because of the large size of the roof, the trusses weighing 200 tons each, special study was given to the planning of the erection method.

The building is 230 x 430 ft., and is located at East 6th Street and St. Clair Ave. As the first step in preparing for steel erection, a gin pole was set up in the basement excavation, about 22 ft. below street level, and by its means a small wooden derrick equipped with 70-ft. boom was erected. This derrick placed four runs of low trestle bents on plank sills, to form longitudinal runways just above the first floor level of the building; sets of three 8 x 16 in. stringers on these bents formed the track for the derrick and falsework superstructure of the plant. A stiffleg derrick with bullwheel, equipped with 100-ft. boom, was set up on the stringers, and this derrick erected two steel traveling derrick towers (Fig. 1) resting on rollers on the stringer tracks. Each of these towers was 40 ft. square by nearly 80 ft. high, and carried a single derrick at the outer corner facing the south or near end of the building. The derricks in turn erected each other on top of the towers.

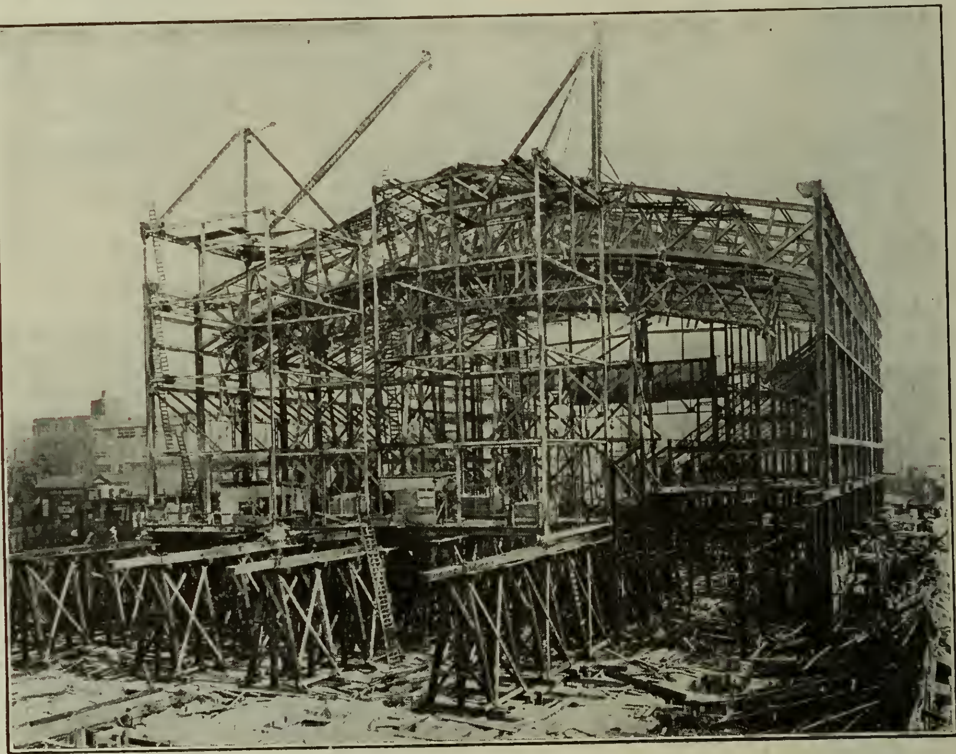


FIG. 1. AUDITORIUM ERECTION PLANT: DERRICK AND FALSEWORK TOWERS COUPLED FOR ROLLING TO POSITION FOR NEXT TRUSS

Arched trusses spanning the full width of the build-

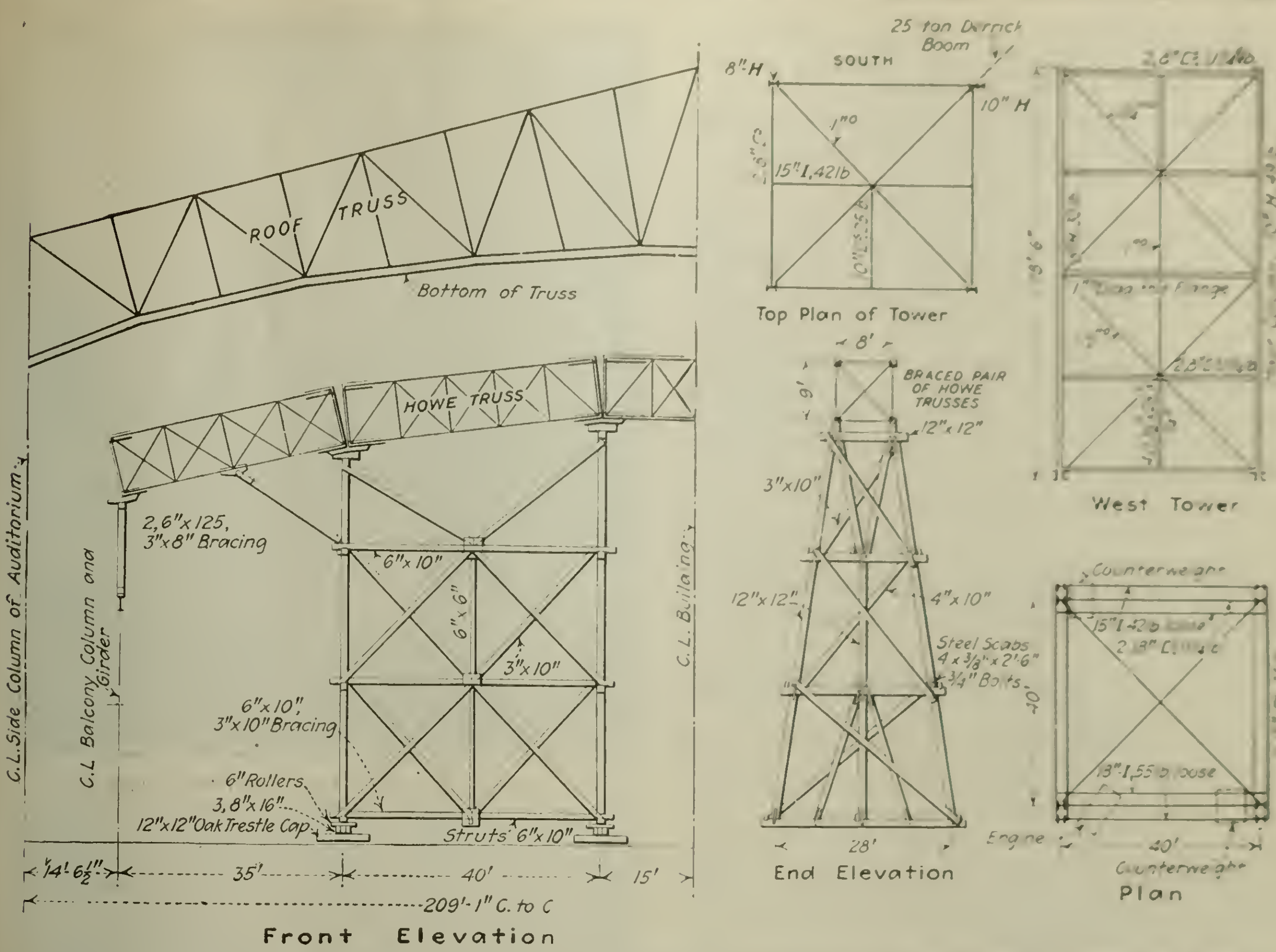


FIG. 2. TRAVELING FALSEWORK AND DERRICK TOWERS IN ERECTION OF CLEVELAND AUDITORIUM ROOF

ing and carried by attachments to the faces of the side columns formed the principal members of the roof that was to be erected. It was decided to erect them on timber towers set just in front of the derrick towers. The balcony framing, projecting about 50 ft. into the hall along each side of the building, could be used for supporting the outer end of the falsework trusses which formed the sills on which the steel was to be assembled. The resulting arrangement of the entire erection plant is shown quite clearly both in the photograph, Fig. 1, and in the sketch of the towers, Fig. 2.

Four large bents about 70 ft. high, set in planes longitudinal to the building, rested on rollers on the stringer tracks. They were braced in pairs to form two towers, one in front of each derrick tower. Together with two small bents carried on the balcony girders, as shown in Fig. 2, they supported a set of five wooden Howe truss spans of 35 to 40 ft. length, and 8 ft. wide by about 9 ft. deep. The tops of these trusses were about two feet below the roof steel, allowing for camber blocking and wedges.

Steel for the building was received by truck and unloaded from the street. The bottom chord of each truss came in seven sections. In placing these, the center section was laid first, its middle point being set accurately to the center line of the building by transit. Then the other sections were successively connected and wedged up to proper elevation, as determined by tape and level. When the complete chord had been bolted up and connected to the wall columns, all web members were set and finally the top chord (shipped in four sections) was set in place. The truss was then riveted complete and swung by cutting loose the blocking.

Moving the plant backward to the position of the next truss was done by rolling the towers, after shifting the small side bents along on the balcony framing, the outer set of Howe trusses being supported by knee-braces from the falsework tower as indicated in Fig. 2. The derrick and falsework towers were coupled together, and were pulled ahead as a unit by the derrick hoist, whose cable was secured at the far end of the stringers, making a turn below the towers and derricks.

In dismantling the erection plant it was necessary to put a jib on one derrick to take down the other derrick and tower. The last derrick was taken down by means of the boom of the other, slung to an end column of the building.

Houses and Housing

Housing development, according to L. K. Sherman, formerly president of the U. S. Housing Corporation at a recent meeting of the Western Society of Engineers, is properly the work of the engineer, although it is often assumed to be that of the architect. House design, said Mr. Sherman, is undoubtedly the province of the architect. But "housing" includes the selection and development of site, the general plan to fit topography, the street layout, transportation to the site, sewerage and drainage, paving, water supply and other public utilities. All work of this kind is distinctly that of the engineer.

Light Railway and Motor Trucks Both Used on Road Job

Pennsylvania Builds Fifteen-Mile Concrete Section From Each End With Own Forces and Own Equipment

DIRECT comparison between the two most used methods of handling materials on concrete highway construction—by motor truck and by industrial railway—is possible upon the job recently begun by the Pennsylvania Highway Department on the Susquehanna Trail along State Route 1, north of Harrisburg and extending from Clark's Ferry through the towns of Halifax and Millersburg. This 15-mi. section, which is one of the most important of those under construction

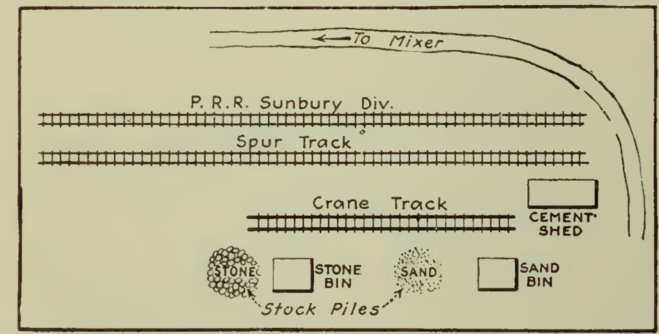


FIG. 1. LAYOUT OF MATERIALS PLANT WHERE MOTOR TRUCKS SUPPLY HAULAGE

in Pennsylvania, is being done exclusively by state forces, and all equipment on the job is owned by the state highway department.

The new highway, which is the Pennsylvania standard design—6-8-in. concrete, 18 ft. wide, of a 1 : 2 : 3 mix, and reinforced with 26 lb. of reinforcing mesh to the 100 sq.ft.—is being built from both ends. The two plant layouts are entirely dissimilar, each one being necessarily adapted to the type of haulage used. On the south end, where the state work connects with a contract job finished during 1919, batches are hauled to the subgrade by a fleet of seven 5-ton trucks, each truck carrying three three-bag batches. A layout of the southern materials plant, which is situated about a mile north of the southern end of the job on the Sunbury Division of the Pennsylvania R.R., is indicated by Fig. 1. Stone and sand are handled from open top cars spotted on a spur track to stock piles and stone and sand bins, of 40-cu.yd. capacity, by a locomotive crane equipped with a $\frac{3}{4}$-yd. clamshell The features of this plant layout are the measuring boxes on both stone and sand bins. One of these measuring boxes, shown in Fig. 2, when filled, contains the exact amount of stone or sand for one batch. Trucks are backed up to stone and sand bins and these measuring boxes emptied into the truck batch compartments.

During the first day's run, hauling four instead of three batches on each truck was tried, but the heavy weight of truck and load was found too great for the subgrade, when wet. In the light of but a few days' experience the foreman on the job recomended the use of lighter truck units hauling three batches.

Though the new highway follows closely the old road alignment, there are places where considerable excavation is being done. The material, a stiff clay, is hand-shoveled direct into bottom dump wagons and hauled

FIG. 2. SAND AND STONE BINS FITTED WITH TWO MEASURING BOXES EACH

away by tractors to a point where it is either spoiled or used as fill. Except when the subgrade is extremely wet, it has been found that a Fordson tractor can handle two loaded dump wagons easily.

Fig. 4 is a layout of the materials plant at the northern end of the job. This plant, as well as the first one, is situated on the main line of the Pennsylvania R.R. Sand and gravel are handled from open top cars to a sand and stone bin 30 ft. wide and 150 ft. long, capable of holding fifty cars of stone and thirty-three cars of sand. A gantry crane, equipped with a $\frac{3}{4}$-yd. clamshell, one of several machines used on this job secured from the War Department, is used to transfer materials from cars to bins. The cement shed is approximately 18 x 80 ft. and has a capacity of fifteen carloads. In transporting materials to the mixer industrial cars are backed from the mixer under the sand and stone bins where they receive these materials through slide gates. Cars are then backed onto a wye and brought up in front of the cement shed. Materials are hauled to the mixer in ten-car trains, five cars being ahead and five behind the locomotive. In this manner if too great a grade is encountered, the five rear cars are cut off and

FIG. 3. TRACTOR REPLACES HORSES IN HAULING DUMP WAGONS

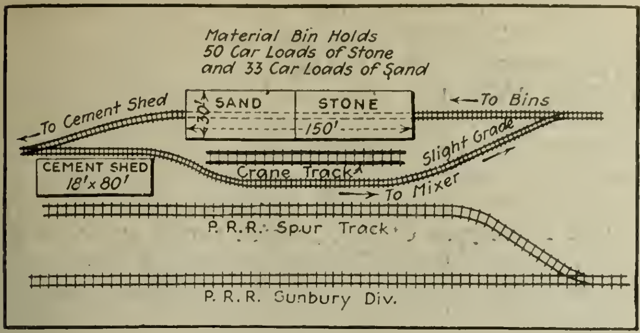


FIG. 4. LAYOUT OF MATERIALS PLANT WHERE INDUSTRIAL RAILWAY IS USED

the five front cars pushed to the mixer, the locomotive returning to pull the other five up. Each industrial car carries material for one mix—a five-bag batch.

On either end of the job expansion joints are placed at the point of curve and point of tangency of both horizontal and vertical curves and at the end of each day's run. Also, at each end of the job the mixer crew, including mixer engineer, men handling batch boxes, men laying forms, men at work on the subgrade and those finishing, is sixteen men. This figure does not include truck drivers in the one instance, and engineers and brakemen on industrial trains, in the other case.

As this is the largest of the jobs being done directly by the state and with its own equipment, complete details are being kept so that when the season's run is finished, accurate comparison between the two methods of materials haulage may be had. Some comparison will also be had between contract work and day labor. As the job had but started early in August it was impossible to secure a comparison in the amount of pavement laid between the two methods used.

FIG. 5. STONE ARCH BRIDGE RECONSTRUCTED WITH CEMENT GUN

The Superintendent of Construction of the Pennsylvania State Highway Department reports to the Chief Engineer and is directly responsible for the job being done by the state forces. On the job he is represented by a foreman who reports to him and who corresponds to the contractor's superintendent. On each of the jobs the engineering department maintains inspectors.

The state is trying an experiment in the matter of housing its own employees. On the job it has erected a number of sectional houses, containing living quarters, mess hall, commissary, offices, etc. The commissary and mess hall are run at cost.

One of the interesting sidelights in the construction of this portion of State Route 1 is the repair of a twin-arch stone bridge, situated about half way between Clark's Ferry and the lower materials plant. The arches have a clear span of approximately 25 ft. The bridge, built in 1840 was designed as an aqueduct and used by the old Pennsylvania Canal Co. It is approximately 30 ft. wide and is now overlaid with several feet of dirt well compacted by many years of travel. The bridge is being strengthened by grouting with a 1 : 2½ cement-sand mix, applied under pressure, 80 cu.yd. of sand and 200 bbl. of cement being necessary. Fig. 5 shows the bridge under reconstruction.

Temperature of Steel Exposed to Sun

OBSERVATIONS made at Balboa Heights, C. Z., during April, 1920, to determine the maximum heating of steel or iron exposed to the sun's rays are reported by H. G. Cornwaite of the U. S. Weather Service, in *Monthly Weather Review* for July. Most of the tests were made on steel blocks 2 x 2 x 12 in., the temperature of which was indicated by a thermometer immersed in a mercury-filled ½-in. hole in the center of the block. The blocks were laid across a 1-in. board, 4 in. wide, lying flat on a concrete pavement, and were sheltered from wind by an 8-in. board on edge a few inches away on the windward side. The highest steel temperature was 133 deg. F., measured at 3:30 p.m. April 26. Mr. Cornthwaite considers that the exposure of the blocks represents approximately that found in the most protected sections of steel structures exposed to the sun, and he estimates that under the most favorable natural conditions possible in the Canal Zone the maximum temperature of exposed steel is not likely to exceed 140 deg. F. Comparing the climatic conditions with those of various parts of the United States, further, he estimates that the maximum exposed steel temperatures in the deserts of the Southwest may reach 169 deg. F. or higher. On account of the importance of such heating he suggests that measurements should be made at a few selected stations in different sections of the United States. That very noticeable effects are produced by the expansion due to one-sided heating has been observed in the case of the steel spillway gates of the Panama Canal, the leakage through which (a very small amount at any time) is greater in the daytime than at night, due to the action of the sun shining on one side and causing the gates to buckle or warp slightly.

Another set of measurements was made to compare the heating of blocks of steel painted with different colors. The curves representing the change of temperature of these several blocks throughout the day (April 20, 1920) are quite consistent and indicate that for the particular paints used the results may be depended upon as approximately correct. At the maximum, from 12 to about 2:30 p.m., with the air temperature in the shade about 88 deg. F., the temperatures of the white, red, green and black blocks respectively were 112, 114, 123, and 128 deg. F. About 2:30 the steel temperatures began to drop, though the air temperature was maintained for another half hour, when the sky was covered with thick clouds and there was a thunder storm in the distance. By 5 p.m., with air temperature 82, the four blocks of steel showed temperatures of 88, 90, 92, and 94 deg. F., in the same order as previously given. In some earlier tests by Mr. Cornthwaite, under slightly different exposure and with different paints, the maximum difference between white and black blocks was 20 deg. F.

Impressions Here and There

The Sacramento River and California's Capitol City

THE really big thing at Sacramento is "The Valley." One's expectation of finding something typical of the center of political activity of a great state is satisfied in the Capitol building, to be sure, but outside the zone of its immediate influence all the bustle and activity, all the visions of the future, center in one way or another on "The Valley."

One to whom this idea was expressed said, "What do you mean, Valley; San Joaquin or Sacramento?" He would not have asked that question had he known the city of Sacramento. Tho two valleys join, it is true, but the San Joaquin belongs to Stockton, to Merced, to Fresno and perhaps others, but the Sacramento Valley is the particular possession of the city of that name—a possession that is prized as highly or perhaps more than the honor of being the Capitol city. And the valley is prized because through its thousands of square miles of rich bottom land flows the Sacramento River.

Sacramento Flood Control—The river is at once the blessing and the curse of the valley. But there is prospect that the flood menace will be relieved by adequate control works. Up to the present time no less than five boards or commissions have been created by state legislative acts to carry out flood protection and drainage work. Some $2,700,000 has already been spent on the advice of such bodies and state and federal governments are committed to the expenditure of $6,000,000 more. Comparatively recently the state engineering department has added to its staff a flood control engineer with the necessary assistants and instead of the spasmodic attention, such as can be given by occasional boards and commissions, a continuous systematic study of river conditions and records is under way.

But the Sacramento River is no simple problem. Although it is the fourth river of the United States, in size, its flood volume as compared to its drainage area, is five times that of any other stream of this country. A commission of eminent engineers in 1904 recommended a flood protection scheme based on the flood of that year and three years later a flood of twice that volume occurred. Moreover, it is now believed that the flood of 1862 carried three times the volume of the 1904 flood.

Just as has long been the case with the Colorado River, state and federal legislators have refused appeals and petitions to provide flood protection on the Sacramento in the form of storage on the headwaters. Even now the best that is in prospect is the construction of bypasses whereby flood waters in excess of a safe amount are to be diverted into prescribed channels leading to Suisun Bay. This is rather discouraging after 40 years of engineering investigations and reports, particularly in view of the fact that engineers agree, in the main, as to the advisability of expenditure for headwater storage. It is to be hoped that the present signs of increasing influence of engineers as a class will take effect in such direction as this.

Salt Water Creeps Up the River—As the channel of the lower Sacramento has been straightened and deepened, the salt water of the bays below has found its way farther upstream. Last year, because of the salinity of water at the intake, the town of Pittsburg had to abandon its pumping works, allow its lawns to die, and bring the water absolutely necessary for domestic use from a point far upstream by means of barges. The sugar refinery at Crockett, which formerly took water for its plant from its own river frontage, now has to go 50 miles upstream for water sufficiently pure for its use.

As the amount of water taken from the river has been increased to serve increased irrigated areas the minimum river flow has dropped to about 2,000 sec.-ft. at the city of Sacramento. With this low flow the water level here is only about 1.5 ft. above mean tide level. A few years ago there was no tidal effect at Sacramento, which is 130 miles from the Golden Gate. but now the tidal range is about 2.7 ft. At Rio Vista the tidal effect has increased 10 in. within the past year and the point of current reversal is now only 6 miles below Sacramento. It will be remembered that Sacramento is just now, after a fight covering many years, committed to a plan for taking its water supply from the river within the city limits.

240-ft. Booms and Speedy Reclamation—A familiar sight as one travels through the valley is the A-frames of dredges projecting above what seem to be rather high levees. The height of the levees ranges up to 20 or 22 ft. above the protected areas. The dredges too are of large proportions. Many have booms over 200 ft. long, the latest addition to a fleet of about ten owned by the Olympian Dredging Company has a 240-ft. boom and a 6¼-cu.yd. bucket. These dredges have been a factor in the rapid reclamation of rich bottom lands. A striking example of their speedy work appears in two pictures within the same frame hanging in Major Norboe's office. One presents a water-line horizon with a huge dipper dredge being towed across the foreground by a stern-wheel steamer. The picture alongside shows a field of grain stretching away to the horizon with a group of prosperous looking barns and farmhouses in the distance, as attractive a farm scene as can be imagined. The inscription under these two pictures reads, "These two Views were taken from the same spot one year apart."

July, 1920. SACRAMENTO.

Rice Culture Effects Potable Waters

Rice farming along streams used as sources of potable water supply has caused some nuisance in California, said C. G. Gillespie at the recent American Public Health Association Convention, by reason of the condition of irrigation water returned to the stream after use on rice fields. The rice is grown under water which is retained in broad shallow pools from June to September under conditions very favorable for algae development. When these pools are drained the quantity of algae discharged is sufficient to seed the entire river system below. On areas where rice culture is just being started mineral salts are often leached from the soil in sufficient quantity to prevent algae growth in the water but this does not improve the situation because the minerals are often more objectionable than are the algae.

ENGINEERING LITERATURE

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Credit for Authorship

Sir—In spite of the fact that the matter of giving credit for authorship has been quite thoroughly discussed in the technical press for some time past, the following example of failure to follow the custom established by many authors is cited with the idea that discussion of the specific case may be invited to secure the opinion of others as to what constitutes "good form." The writer realizes that he is laying himself open to the charge of airing a personal grievance in the choice of the example cited, but this case was selected only for the reason that it appeared to be the one most available. Reference is made to "Excavation" by Allen Boyer McDaniel, S. B., recently published by the McGraw-Hill Book Company.

For the purpose of this discussion, it is proposed that matter secured from other sources may be divided into three classes as to their treatment and as to method of giving credit to the original author. These, with the writer's comments and example from the above-mentioned book, are as follows:

1. Data of a secondary nature or which is of quite common knowledge but necessary to include in the publication in order that it may be complete. The writer feels that an author is justified in omitting specific reference to the original author or to the publication in which such matter may be found, and certainly the quite complete bibliography is sufficient to cover such omissions if they may be considered as such.

2. Original data, with detailed descriptions of cost of work, conditions, etc. Example is found in Paragraph 235 of the book referred to. This quotation covers nearly a full page, contains a description of rather a unique type of dredge and the detailed cost record of operating this dredge for a period of fifteen months. The matter was quoted from an article prepared by the writer and printed in *Engineering News*, April 30, 1914. Credit is given to the publication from which the quotation was made, but the writer has noted that many authors go farther and give credit specifically for such matter direct to the original author.

3. Description of original methods, with illustrations. Example is found in Paragraph 233. While the matter referred to in this example was not quoted verbatim, it is obvious that use was made of the article contributed by the writer and printed in the Dec. 16, 1916, issue of the *Engineering Record*. The cut used is identical excepting that it was reduced slightly to fit the new publication. In this instance, credit was given neither to the publication nor to the original author. While the "original idea" referred to was of rather a trivial nature, the writer has always felt a certain amount of pride in its development and feels that in such cases credit might properly be given to originators of new schemes which are made available for the use of other members of the engineering profession by means of published descriptions. As a matter of fact, the writer desires to take this opportunity of rendering tardy credit to Mr. Roger Holmes, of the La Fourche Dredging Co. for his assistance in working out some of the practical uses of the hydraulic dredge in the land reclamation work referred to in the above article published in the *Engineering Record*.

ARTHUR M. SHAW,
Consulting Engineer.

New Orleans.

Sir—The writer has read Arthur M. Shaw's letter with a great deal of interest and regrets that he is unable to reply to the criticism specifically as a copy of the book referred to, "Excavation, Machinery Methods and Costs," is not available.

The paragraphs referred to are in the second part of the book, which is largely composed of a compilation of data from a great variety of sources. Every effort was made by the writer throughout the book to give full credit to the source from which information was received, as the casual reader will observe from a review of the book. However, the latter part of the book was written during the summer and fall of 1918, while engaged in the stress of war work, and it is highly probable that the article referred to in the third paragraph of Mr. Shaw's letter, and even others, were not properly referenced as to source. On account of the necessity for economy of space, and as the articles were fully listed in the bibliographies at the end of each chapter, only the name and date of publication was given.

The writer heartily agrees with Mr. Shaw in the view that credit should be given the author where original work is quoted. The writer recalls having done this in several cases. Where original work is published in an official or authoritative form, as in the case of research work published in a government or institutional pamphlet, the character and authorship of the work are generally clearly evident, but often in magazine articles these matters are not clearly set forth.

In closing, the writer would urge that full credit for authorship should be given wherever possible. If the writer has been at fault in this matter in his work, he will greatly appreciate having any other cases brought to his attention in order that due credit may be given in future editions of the book.

ALLEN B. MCDANIEL
Development Specialist, Construction
War Plan Division, War Department.

Camp Grant, Ill.

Memoirs of Capt. Andrew Talcott

As a memorial to Capt. Andrew Talcott, Corps of Engineers, U. S. A., the famous pioneer topographer and railroad builder, his son, the late Thomas M. R. Talcott, himself an engineer, prepared shortly before his death an account of his father's connection with the zenith telescope method of determining latitude, which has been named after him. This has now been privately printed and deposited in several of the leading libraries as a matter of record. Capt. Talcott was apparently the earliest user of the zenith telescope for the precise determination of latitude, although a Dane named

Horrebow in the eighteenth century devised a somewhat similar method which has linked his name with Talcott's in the description of the modern method. The memoir, partly made up of a 1893 paper by the late Gen. W. L. Marshall, Corps of Engineers, U. S. A., defends Capt. Talcott's right to complete originality.

A New Book on Dredging

Reviewed By Pierce J. McAuliffe,
Consulting Engineer, New York City

DREDGING ENGINEERING—By F. Lester Simon, B.S. in C.E., Assoc. M. Am. Soc. C.E. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co. Cloth; 6 x 9 in.; pp. 182; illustrated. $2.50.

Engineers and contractors interested in dredging and all who follow the business of dredging will find this volume of unusual value, particularly as it contains some information which, so far as the reviewer has seen, is in no other book. It is apparent, however, that the author did not intend that his book would serve as more than a general guide to dredge designers, for they will find but little to assist them in the design of hulls, engines, boilers, auxiliary machinery or supplementary dredging plant, but no designer can help but benefit from a perusal of its pages.

In the chapters on bucket dredges it would seem very desirable to include a discussion of the merits of simple vs. compound main engines, scotch vs. water tube boilers and positive vs. adjustable friction for hoisting and maneuvering engines. In the chapters devoted to hydraulic dredging the author omits the lateral feeding cutter type developed by Robinson of Montreal and overlooks the fact that the suction dredge without cutter has been used very successfully in making extensive fills.

In the reviewer's opinion it would have been wiser to have omitted Fig. 31, p. 72, or else to have gone into a more complete discussion of absolute velocities and the effects of the various impeller blade angles. Moreover, the statement "There are no discharge vanes in dredge pumps" is apt to be confusing as a large proportion of dredge operators speak of the impellor tips as vanes. The reviewer imagines that the author had reference to diffuser vanes, which are used only in certain types of water pumps.

In defining the total head on p. 73, reference to the location of the point at which the suction-gage pipe enters the dredge suction pipe should have been made, for it rarely happens that this point is at the same level as the center of the dredging pump; therefore, in adding the suction gage reading to the other two components, a correction for the location of this point must be made. Also on pp. 79 and 80, a suction head of 12 in. is selected for a velocity of 10 ft. per sec. and again for a velocity of 17 ft. per sec. If 10 ft. is correct for the first case, it is certain that the suction gage would show from 15 to 18 in. for the second velocity. Moreover, as the medium that is being pumped in these examples is a mixture weighing 68 to 70 lb. per cu.ft. and not water at $62\frac{1}{2}$ lb. per cu.ft. the theoretical horsepower formula, p. 80, should be, with a 10 per cent mixture of sand,

$$\frac{9{,}800 \times 130}{3{,}960} \times \frac{68}{62.5} = 350.$$

From numerous experiments that the reviewer has made, he is inclined to agree with the efficiencies shown by the Morris Machine Works chart, Fig. 34, p. 82, rather than with the author's statement on p. 78, that dredge pump efficiencies are generally 50 per cent or less. In fact, the reviewer believes that with a discharge velocity of 10 ft. per sec. the combined efficiency of the pump and engine can be safely taken as 55 per cent, considering the 1 h.p. of the engine as unity, and that with a discharge velocity of 17 ft. per sec. this combined efficiency may reach 60 per cent.

The reviewer's experience with boosters convinces him that such an installation is not the delicate instrument that author would have us beleive. The initial pump and the booster may even be combined into a compound pump on the dredge hull or the booster may be located at any place in the discharge line so long as the first pump can deliver the mixture to the suction of the booster under pressure. Reference to the Morris Machine Works catalog, Fig. 1122 and 152, will show instances of compound dredging pumps. To avoid high pressures in the pontoon line, however, the booster is usually placed on the shore or on a float at the point where the pontoon pipe line joins the shore line. Moreover, with a variable speed motor driving the booster, there is no need for the extreme caution in opening and closing the valve in the bypass as described by the author on p. 86.

Such a book seems scarcely complete without a reference to the interesting dredging done on the New Orleans Inner Harbor Navigation Canal where conditions were overcome by very clever engineering. A paper (reproduced in *Engineering News-Record*, July 22, 1920) describing this work was presented at the December, 1919, meeting of the American Society of Mechanical Engineers. Chapter IX, under the section covering "Dikes for Impounding Basins," could well have contained a description of the method of building dikes by bleeding sand or gravel from bottom gates in the discharge pipe. A number of articles have appeared in the engineering magazines on this subject, notably *Engineering News*, June 11 and July 27, 1916, and *Excavating Engineering*, May, 1914.

The author presents the advantages and disadvantages of the various type of dredges clearly and fairly. The reviewer has on many occasions been met with the question, "Where can I find a book on dredging?" and has had to answer that the best places to go for information, from the American engineers' point of view, were the manufacturers' catalogs, even though these are, quite naturally, devoted each to the products of one producer. This book, therefore, fills a long-felt want in this respect and a ready reception is predicted for it.

Directing Human Relations in Industry

PERSONNEL ADMINISTRATION: Its Principles and Practice—By Ordway Tead and Henry C. Metcalf, Ph.D., Members of the Bureau of Industrial Research, New York City. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co. Cloth; 6 x 9 in.; pp. 538. $3.

By personnel administration the authors mean "the direction and co-ordination of the human relations of any organization with a view of getting the maximum necessary production with a minimum of effort and friction, and with proper regard for the genuine well-being of the workers." It is the complement of production administration and "a major staff function." It includes not merely the employment of workers, but also the charge of their welfare and of all that makes for their efficiency. It is a new profession and one that demands special education and training.

After an Introduction, the authors take up The Personnel Department, Employment Methods. Health

and Safety, Education, Research, Rewards, Administrative Correlations, and Joint Relations. Each of these parts is divided into two or more chapters. Joint Relations has two chapters on Shop Committee Organization, one on Employee's Associations, two on Collective Bargaining and one each on Employer's Associations, National Industrial Councils and The Purpose of Industrial Government. Useful reference lists follow each chapter.

As may be inferred, the book is broad in scope. While recognizing that the object of industry is production it never fails to consider the worker as a human being, whose various desires and aspirations, and weaknesses as well, should be taken into account. Many of the vexed industrial-social questions of the day are discussed. The attitude throughout is judicial, but humane.

The book cannot fail to be helpful to any employer or director of employees who is willing to learn from its pages how to secure "maximum necessary production with a minimum of effort and friction, and with a proper regard for the genuine well-being of the workers."

Industrial Housing and Town Planning

INDUSTRIAL HOUSING: With Discussion of Accompanying Activities; Such as Town Planning, Street Systems, Development of Utility Services, and Related Engineering and Construction Features—By Morris Knowles, M. Am. Soc. C. E., etc. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co. Cloth; 6 x 9 in.; pp. 408; illustrated. $5.

Mr. Knowles' book promises to be of great usefulness to the rapidly growing number and variety of people who are concerned with providing not merely houses but homes for workers in industrial plants. His conception of industrial housing includes the whole range of modern town planning. In fact, so broad is the treatment that the book might well have been named Industrial Housing and Town Planning.

The author approached his task with a wide training in municipal and utility engineering and industrial town development gained before the war, and in addition with a vast amount of direct experience and observation in the field of industrial housing resulting from his government housing during the war. In addition, he has had the benefit of the collaboration of the various members of his large engineering staff who have specialized in the numerous branches of municipal engineering, sanitation and town planning and housing treated in the book. The result is a volume notable for both breadth and detail.

A concise historical review of industrial housing opens the book. This is followed by a chapter on Fundamental Preliminary Considerations. The next seven chapters deal with town planning and public utilities, site selection, developing a town plan, streets and pavements, water-works, sewers and drains, refuse collection and disposal, gas and electric services. The chapters on streets and utilities are short monographs on their respective subjects, but written always with industrial housing in view and with illustrations drawn from practice.

Having finished with the utilities, the author returns to the more specific subject of housing. A chapter on family houses is followed by one on other buildings, including quarters for single men and women, stores and apartments, special service buildings (such as laundries, bakeries and hospitals), and buildings to meet social needs. This chapter is followed by one on administration and supervision of construction (printed in condensed form in *Engineering News-Record*, Oct. 14, 1920 p. 748), which again is somewhat general in character. The final chapter deals with the various problems of managing industrial towns after they are built.

A considerable number of useful cost figures are given. Notable among these are some showing total and percentage outlays for houses and for accompanying land, streets and utilities. The illustrations include graphic plans and halftones, each kept down to a reasonable number of illustrations that really illustrate or supplement the text.

Altogether, the volume deserves high commendation. It is a pioneer in the presentation of the technical aspects of group housing, and in tying these to both the economies of industry and to town planning.

An Interesting Autobiography Continued

FURTHER INCIDENTS IN THE LIFE OF A MINING ENGINEER—By E. T. McCarthy, A.R.S.M., M.I.M.&M., M.I.M.E., M.Am.I.M.E., F.R.G.S. New York: E. P. Dutton & Co. London: George Routledge and Sons, Ltd. Cloth; 6 x 9 in.; pp. 404. $7.

In noticing Mr. McCarthy's "Life of a Mining Engineer" in our issue of Dec. 11-18, 1919, we expressed the hope that the author would continue his keen and interesting observations of men and things in the out-of-the way places of the world. This he has done in the present volume, which contains his experiences as manager of various mines and later as consulting engineer. Like the earlier volume, this one is non-technical. It contains much about mines and mining but more about men and women, animal and vegetable life, rivers, lakes and mountains seen and enjoyed at and near mines and on long journeys to and from them.

The book begins with Yucatan, Tabasco and Chiapas and tells something about Mexico City. Next the reader is taken to Swaziland, South Africa. Among other countries visited and told of are Madagascar, Dutch West Borneo, Corea, Japan, China, Russia and Siberia and, at the last, Canada. The Boer War, the Boxer Rebellion and the Russian Revolution of 1917 all come into the story. Further evidence of the number and variety of sights and experiences recorded in the book may be presented in the form of entries in the index: Alphabet, Corean; baboons, large troop of; Dyak wedding; exorcising a devil in a Corean mine; fishing with cormorants; roof of Chinese house; travelling in Siberia; and Yi Yong Ik, a Corean Minister of State.

The story of exorcising a devil from a Corean mine is worth retelling in condensed form. Several accidents had occurred at this mine, some fatal. The mine workers were upset and declared that there was a devil in the mine. Mr. McCarthy took the declaration seriously and asked what could be done. The men replied that there was a witch some 30 or 40 miles distant who could get rid of the devil but that it would cost $5. Mr. McCarthy had her brought. The old crone, for such she was, first ordered a large bonfire built at the minehead, then descended into the mine and on down a small shaft in a bucket—for the devil would be found at the very lowest point in the mine. When this point was reached the witch declared that the devil was found and went through the motion of wrapping him in a piece of cloth. She then returned to the surface, ordered the bonfire made hotter and deposited the devil therein, carefully preserving the wrapping cloth. Thereafter accidents at

the mine ceased because—Mr. McCarthy reasons—the confidence of the miners was restored and with it their usual mental equilibrium.

These "further incidents" may be commended to engineers both because of their interest and in the hope that a wide reading of them will stimulate the production of similar interesting, instructive and inspiring books—inspiring because the author modestly relates many dangers overcome through strength of will, keen discernment, quick decision, rugged honesty, fair treatment and human kindness. Not every engineer has so rich a variety of incidents to draw upon but many have sufficient to produce a volume of fair size or at least an occasional paper.

Engineering Applied to Farm Colonies

HELPING MEN OWN FARMS: A Practical Discussion of Government Aid in Land Settlement—By Elwood Mead, Professor of Rural Institutions, University of California, Former Chairman, State Rivers and Water Supply Commission, Victoria, Australia. New York: The Macmillan Co. Cloth; 5 x 8 in.; pp. 228; illustrated. $2.25.

The application of engineering principles to land settlement and development, with state aid in financing farms and houses and in preparing the land for cultivation, are described in this book. The larger part of the volume details what has been done at the Durham colony of the California Land Settlement Board, of which the author of the book is chairman, but considerable space is given to state assistance in land settlement in Australia, and particularly in the State of Victoria, where the author was for some years chairman of the State Rivers and Water Supply Commission. In addition, there are chapters on National Carelessness in the Disposal of Public Lands, State Aid in Italy, Denmark, Holland, and the British Isles, Homes for Soldiers, and the Function of Government in Social and Industrial Development. An appendix gives the California Land Settlement Act under which the Durham settlement was established.

The underlying principle of state aid in acquiring and developing farms is to put the settler on his feet at the earliest possible moment. This means lending him money, if need be, for not only a part of the purchase price of the land, but also for a part of the cost of its improvement, including money for buildings, tools, etc., and livestock. In arid regions, it is recognized that leveling the land and providing otherwise for irrigation is a necessary part of the preliminary improvements. At the Durham colony, the Land Settlement Board took a hand in preparing the land for crops, providing a tractor and, more important still, also an engineering staff.

Many figures cited by the author show convincingly that the money necessary to acquire land is but a start toward establishing a going farm. Thus, at the first Durham settlement the average amount spent in improving thirty-five farms totaled $4,103, divided as follows: Buildings, $1,705; fences, $163; leveling and checking land, $619; stock, $894; equipment, $661. But this was not all that had to be spent before the first year's income was realized, for in addition there was paid out an average of $1,480 for seed, feed, labor, etc., $480 for living expenses and $311 for drugs, doctor's bills, trips for pleasure and the like, or $1,811 more, bringing the outlay in excess of the cost of land up to $5,914. This was for farms having an area averaging 52.08 acres at an average cost of $191.70 per acre and a cost per farm of $8,872. The first payments on account of land (5 per cent) averaged $444.

On this same first unit of the Durham settlement a number of farm laborer's allotments, averaging 1.72 acres each, were provided by the board.

It will be noted that the land comprising the first Durham settlement—the bare land without leveling, fences or buildings—cost an average of nearly $200 an acre. This high cost is due to the potential value of farm land when brought under irrigation in California. In contrast, the author points out that in the states along the Atlantic seaboard "thousands of acres could be bought for less than $25 an acre, in areas large enough to secure co-operative community organizations of from 100 to 200 families." These areas once "included some of the best farms in the country" and "under a carefully thought out program of crop rotation, the soil could undoubtedly be restored to its former condition."

The few details presented in the foregoing paragraphs will suffice, we trust, to show engineers that Dr. Mead's little volume is of country-wide importance.

Plumbers and Plumbing in Massachusetts

SPECIAL PLUMBING BOARD OF THE MASSACHUSETTS DEPARTMENT OF HEALTH: Report Submitted to the Commissioner of Public Health and Public Health Council, Jan. 3, 1920. Boston, Mass.: The Department. Paper; 6 x 9 in.; pp. 73; illustrated.

At the request of the Massachusetts State Association of Plumbers and under authorization by the State Legislature the Massachusetts Commissioner of Public Health appointed a board to consider the formulation of uniform state plumbing laws. The board consisted of six members, including Prof. George C. Whipple from the State Public Health Council and representative of various plumbers organizations. The report outlines the status of plumbers and plumbing in Massachusetts and in general. It concludes that a state sanitary code, to include plumbing, is desirable but does not submit a draft of a statute because there is first needed an adjustment of differences of view in the trade. Scientfic research in the field of plumbing is urged. The report is a valuable study.

Ohio Public Health Journal Resumes

After a lapse of four months the *Ohio Public Health Journal* has resumed publication with an April-August issue. To increase its circulation without added cost of publication the size is to be reduced and it is proposed to print only that which will have a direct influence for better public health in Ohio. The present 6 x 9-in. uncovered journal contains 32 pages, of which 5 pages are devoted to editorials and 9½ pages to a single historical article on "The Development of Public Health Administration in Ohio," the beginning of a series to furnish a background for a better understanding of the period of public health progress.

New Railroad Tie Bulletin

The National Association of Railroad Tie Producers, 900 Fife Bldg., San Francisco, has begun the publication of the *Cross Tie Bulletin*, having discontinued the *Railroad Tie Producer* with the issue of May 31, 1920. The new bulletin will be the official organ of the association in promoting the interests of tie production and in effecting co-operation with the users of railroad ties as well as disseminating in formation bearing on the cross-tie industry, according to the announcement of the association.

Publications Received

ADVERTISING THE TECHNICAL PRODUCT—By Clifford Alexander Sloan, Vice-President, Campbell-Ewald Co., Advertising Manager, Hyatt Roller Bearing Co., and James David Mooney, Vice-President's Staff, General Motors Corporation, etc. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co. Cloth: 6 x 9 in., pp. 365; illustrated. $5.

AMERICAN LUBRICANTS: From the Standpoint of the Consumer—By L. B. Lockhart, Consulting and Analytical Chemist. Second Edition Revised and Enlarged. Easton, Pa.: The Chemical Publishing Co. London: Williams & Norgate. Cloth; 6 x 9 in.; pp. 341; illustrated. $4.

The first edition of this book was favorably reviewed in these pages by Prof. John J. Flather, June 20, 1918, p. 1190. The Preface describes the book as an effort "to bridge the gap between the refiner or manufacturer and the consumer."

AMERICAN SOCIETY FOR TESTING MATERIALS STANDARDS: Adopted in 1920—Philadelphia, Pa.: The Society. Paper; 6 x 9 in.; pp. 128; illustrated.

Among the standards here included are specifications for building brick, clay sewer pipe, cement-concrete sewer pipe, materials for cement mortar grout filler and for cement mortar beds for pavements, yellow pine timber and also piles and poles to be creosoted and wood paving blocks for exposed pavements.

BITUMINOUS COAL STORAGE PRACTICE—By H. H. Stoek, E. W. Hippard, W. D. Langtry. Urbana, Ill.: Engineering Experiment Station, University of Illinois. Paper; 6 x 9 in.; pp. 157; illustrated. 90c.

Has section on actual experience with storage in 1918-19, effect of storage upon properties of coal and storage systems (including cableway conveyors, etc., and underwater storage).

BUSINESS RESEARCH AND STATISTICS—By J. George Frederick, President of the Business Bourse, Int., Inc., Author of "Modern Salesmanagement." New York & London: D. Appleton & Co. Cloth; 5 x 8 in.; pp. 342. $2.50.

THE DESIGN OF HIGHWAY BRIDGES OF STEEL, TIMBER AND CONCRETE—By Milo S. Ketchum, C.E., M. Am. Soc. C. E., Professor-in-Charge of Civil Engineering, University of Pennsylvania, etc. Second Edition, Rewritten. New York, McGraw-Hill Book Co., Inc. London: Hill Publishing Co. Flexible; 6 x 9 in.; pp. 550; illustrated. $6.

ELEMENTS OF ENGINEERING THERMODYNAMICS—By James A. Moyer, Director of the Massachusetts Department of University Extension, formerly Professor of Mechanical Engineering in the Pennsylvania State College; James P. Calderwood, Professor of Mechanical Engineering in the Kansas State Agricultural College and Andrey A. Potter, Dean of Engineering at Purdue University, formerly Dean of Engineering at the Kansas State Agricultural College. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6 x 9 in.; pp. 216; illustrated. $4.50.

An extension of "Engineering Thermodynamics," by the two first-named authors (see *Engineering News*, Feb. 17, 1916). Most of the new material was added by Mr. Potter. The Preface says the book "is particularly intended for use in technical colleges where it is possible to give special courses on the subjects of steam turbines, internal combustion engines, refrigeration and other applications of thermodynamics."

ENGINEERING AND BUILDING FOUNDATIONS: Including Sub-Aqueous Foundations—By Charles Evan Fowler, C. E., M. Am. Soc. C.E.; Member Engineering Institute of Canada, etc. Vol. I; Ordinary Foundations. Fourth Edition, Revised and Enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6 x 9 in.; pp. 531; illustrated. $5.

FUEL OIL IN INDUSTRY—By Stephen O. Andros, A.B., E.M., Member American Institute of Mining Engineers, Former Assistant Professor of Mining Research, Engineering Experiment Station, University of Illinois, etc. Chicago, Ill.: The Shaw Publishing Co. Cloth; 6 x 9 in.; pp. 274; illustrated. $3.75.

Deals with combustion and properties; comparisons with coal as fuel; distribution, transportation and storage; heating, straining, pumping and regulating boiler furnaces and burners; and numerous specific uses, such as in steam navigation, locomotives, iron and steel manufacture, ceramic industries, for heating buildings.

GRAIN DUST EXPLOSION AND FIRE PREVENTION CAMPAIGN: Proceedings of Conference of Men Engaged, and Conducted by United States Grain Corporation in Co-operation with Bureau of Chemistry, U. S. Department of Agriculture—New York: U. S. Grain Corporation, 42 Broadway. Paper; 6 x 9 in.; pp. 159; illustrated.

THE HOUSING BOOK: Containing Photographic Reproductions, with Floor Plans of Workingmen's Homes, etc. Compiled by William Phillips Comstock, Editor of Architecture and Building. New York: The William T. Comstock Co. Cloth; 8 x 11 in.; pp. 132; illustrated. $3.

Brief descriptions of 11 industrial housing schemes by their architects, together with a few pages on "Designs for Single and Double Houses of Moderate Cost" and on "Small Concrete Houses." Numerous floor plans and halftone views of single houses and groups of houses.

HYDRAULIC TABLES: The Elements of Gagings and the Friction of Water Flowing in Pipes, Aqueducts, Sewers, etc.—By Gardner S. Williams, M. Am. Soc. C. E., etc. and Allen Hazen, M. Am. Soc. C.E., Civil Engineer. Third Edition, Revised. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6 x 9 in.; pp. 115; illustrated. $2.

Changes in this edition, as stated in the Preface, are: A new chapter, entitled, "Additional Data," is a brief statement of how the old procedure for pipe flows fits with the numerous additional data now available. A plate has been added to show graphically the relations of the most important results both new and old. Minor additions and corrections have been made throughout the volume. The earlier editions were reviewed in *Engineering News* Sept. 14, 1905 and Feb. 18, 1909.

IRRIGATION SURVEYS AND INSPECTIONS: Report, 1918-19—Ottawa, Can.: Department of the Interior. Paper; 7 x 10 in.; pp. 67; illustrated.

LABORATORY MANUAL OF TESTING MATERIALS—By William Kendrick Hatt, C.E., Ph.D., M. Am. Soc. C.E., Professor of Civil Engineering, and Director of Laboratory for Testing Materials, Purdue University, and H. H. Scofield, M.E., Assistant Professor of Civil Engineering in Charge of Testing Materials, College of Civil Engineering, Cornell University, Member American Society for Testing Materials, Society of Automotive Engineers. Second Edition. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co. Cloth; 5 x [illegible] in.; pp. 177; illustrated.

To bring this book up to date particular attention has been paid to concrete. To make the book more generally useful, there has been elimination of "details of directions and apparatus more or less peculiar to any one laboratory." The first edition was reviewed in *Engineering News*, Oct. 16, 1913.

THE LAW OF THE CITY PLAN—By Frank B. Williams of the New York Bar, Counsel for American City Consultants, Chairman City Planning Committee, City Club of N. Y. Supplement to the National Municipal Review, Oct. 192[illegible]. New York: National Municipal League. Paper; 7 x 10 in.; pp. [illegible]

A general review, with citations of legislation enacted by various states.

MARINE INSURANCE—By Solomon S. Huebner, Ph.D., Professor of Insurance and Commerce, University of Pennsylvania, etc. New York & London: D. Appleton & Co. Cloth; 6 x [illegible] in.; pp. 265. $3.

MILITARY MINING—By Alfred H. Brooks, Formerly Lieutenant Colonel of Engineers, U. S. Army, Chief Geologist of the American Expeditionary Forces. Washington, D. C.: The Engineer School, U. S. Army. Paper; 6 x 9 in.; pp. 43, illustrated.

NATIONAL CONFERENCE ON CONCRETE HOUSE CONSTRUCTION: Proceedings, February, 1920—Edited by the Secretary, Chicago, Ill.: Secretary's Office, 111 West Washington St. Paper; 6 x 9 in., pp. 235; illustrated.

Last February at the time and place of the annual meeting of the American Concrete Institute there was called a National Conference on Concrete House Construction, to which were invited the many interests concerned in housing and construction. The meeting was highly successful in bringing out the development of the concrete house and in illuminating many of the financial problems of housing.

NEW YORK STATE WORKMEN'S COMPENSATION LAW: With Amendments, Additions and Annotations to Aug. 1, 192[illegible] Prepared By The Bureau of Statistics and Information—Albany, N. Y.: The Bureau. Paper; 5 x 8 in.; pp. 114.

THE NEW WORLD—By Frank Comerford. New York and London: D. Appleton & Co. Cloth; 5 x 8 in.; pp. 364. $2.

One of the many books on world reconstruction problems. Devoted chiefly to Europe and particularly to Bolshevism in and out of Russia.

PUBLIC HEALTH AND MEDICAL EDUCATION IN MANY LANDS—By George E. Vincent, President of the Rockefeller Foundation. New York: The Foundation. Paper; 6 x 9 in.; pp. 44; illustrated.

RAINFALL INTERCEPTION—By Robert E. Horton, Consulting Engineer, Voorheesville, N. Y. Reprinted from Monthly Weather Review, Sept., 1919. Paper; 9 x 12 in.; pp. 2[illegible]; illustrated.

A valuable study of "loss of precipitation which would otherwise be available to the soil." Based on the literature of the subject and extended experiments by the author at his private hydrological laboratory.

SEVENTH NATIONAL FOREIGN TRADE CONVENTION: Official Report, 1920—New York: National Foreign Trade Convention Headquarters, Indian House, Hanover Square. Cloth; 6 x 9 in.; pp. 863.

SOUND RANGING: The Location of Guns by Sound with Special Reference to the Bull-Tucker System. Prepared by Edward Beattie Stephenson, Ph.D. in Physics, Physicist, Office Chief of Engineers, U. S. Army, Formerly Captain of Engineers, U. S. Army. Washington, D. C.: Engineer School, U. S. Army. Paper; 6 x 9 in. pp. 25; illustrated.

SPILLWAYS FOR RESERVOIRS AND CANALS—By A. T. Mitchelson, Senior Irrigation Engineer. Washington, D. C.: U. S. Department of Agriculture. Paper; 6 x 9 in.; pp. 4[illegible]; illustrated.

An admirable monograph, which does not attempt complete covering of the subject, but which is very informing, particularly in the treatment of the siphon spillway.

STANDARD SPECIFICATION FOR STEEL RAILWAY BRIDGES—Ottawa, Can.: Canadian Engineering Standards Association. Paper; 6 x 9 in.; pp. 79; illustrated.

THERMODYNAMICS FOR ENGINEERS—By J. A. Ewing, K.C.B., M. Inst. C.E., M. Inst. Mech. E., Principal and Vice-Chancellor of the University of Edinburgh, Formerly Professor of Mechanism and Applied Mechanics in the University of Cambridge. New York: The Macmillan Co. London: Cambridge University Press. Cloth; 6 x 9 in., pp. 383; illustrated. $9.

The "fundamentals of thermodynamics," the author states in his Preface, are presented, first in non-mathematical form as physical realities, with application to practical problems, then in their mathematical relations.

TOWN PLANNING SCHEME FOR JAMSHEDPUR—Report by F. C. Temple, Chief Town Engineer, Jamshedpur, Singhbhum District, India, to the Tata Iron & Steel Co., Ltd., Bombay. (Jamshedpur Social Welfare Series.) Boards, Cloth Back; pp. 17; 2 folding Maps.

Results of five-month's study by Mr. Temple, in consultation with S. K. Sawday, town planner, and T. W. Tutwiler, general manager of the company named above. Outlines scheme for an industrial town of 70,000, with particular reference to roads, water supply, sewerage, parks, race course and playground, churches and cemeteries for various classes of population and "burning ghats" for the disposal of part of the native dead.

Letters to the Editor

What Is Art?—A Defence of the Architect

Sir—It seems to the writer that your editorial "What Is Art," *Engineering News-Record*, Sept. 16, 1920, p. 531, and Messrs. Trautwine's and Hering's comments thereon do scant justice to architects.

To select some examples of exceedingly poor taste in design, and to judge artists and architects as a class thereby is hardly sportsmanlike. The several horrible examples of sham and gingerbread work cited, proved merely that although a man may sign himself architect and actually practice that profession, he is not really one unless properly trained for his work. No one would judge physicians as a class by the malpractice of some "quacks" who hold medical licenses.

Occasionally an engineer designs a bridge or other structure that has beautiful lines and proportions, as for example the Brooklyn Bridge, but more often we get the usual homely type of highway or railroad bridge so common everywhere. They are generally well designed and to quote Mr. Hering will give "The required resistance to every attacking force with the least amount of material, and in the simplest and most direct way." But they are hardly things of beauty except when judged by the rule of "handsome is as handsome does."

In France where engineers are second to none in design, an architect is always associated on important bridge work, and nowhere else in the world are these structures so beautiful as a rule. An architect of real standing was selected to assist in the design of all the large bridges built in recent years at New York. It would take a hardy engineer to say that the appearance of these structures was not greatly helped thereby.

It does the engineers no good to sneer at "art" or architects, because of isolated examples of bad design. The public is coming more and more to understand that rarely does the engineer put into his design the grace and beauty that the well trained architect can give. Hence the ever growing demand that architects, landscape gardeners, sculptors, etc., be consulted on great public works.

Up to about twenty years ago, engineers or "practical builders" designed nearly all the factories and industrial plants. For that time they were very good buildings, indeed, and served their purpose most satisfactorily, but nothing has ever equalled them as a class in sheer depressing and dreary ugliness. Today, architects almost always design these buildings, very often as subordinates to engineers. In spite of occasional examples of poor taste, these buildings are generally at least pleasing, and are often beautiful.

This difference from the old type of factory was not attained by the more common use of terra cotta, steel sash, etc. It lies in the general proportions of major and subordinate masses, the grouping of openings, the correct location of good ornamental design and a studied color scheme; all things of which the great majority of engineers have a very vague understanding.

The writer believes there is glory enough for all in large work, and that the engineer can no more enter the field of the architect than an architect can do engineering.

N. H. Holmes,
Assistant Engineer, Charles T. Main.

Boston, Mass., Oct. 5.

Sir—I have read with interest Mr. Trautwine's criticism of the Bensalem Ave. bridge. There is no doubt that this structure has been marred by ornamentation wrongly applied, but when a man of his standing makes the absurd statement that because the engineer's training makes him an authority on strength it also makes him an authority upon beauty it is time to refute such a sweeping assertion.

The statement that any structure is beautiful which fulfills the purpose for which it is designed, is another half truth. Two men wear suits from the same piece of cloth. One suit has an ugly pattern and a discord of loud colors, but according to his logic, it is as beautiful as the other suit because it fulfills equally well the purpose for which it was made. Beauty is relative. A stone or concrete arch is infinitely more beautiful than any steel truss bridge can possibly be.

One of the first principles of architectural design is that ornament is not sought after for itself alone. Beauty of line and proportion always come first. Ornamentation is a minor detail. If your eye is drawn to the ornamentation first, the structure has not been successfully handled.

Mr. Trautwine forgets that there are any number of bridges in this country that have been successfully treated architecturally, such treatment in no way obscuring the essential structural features. He uses this bridge as a basis for an attack upon the principles of architectural design. One might retort in kind by reminding him that the engineer's "instinct for simplicity" must have been mislaid when the subway layout at the Grand Central Terminal was constructed. The fearful congestion of our cities is partly due to the so-called simplicity of the "checker board" system of laying out streets. The responsibility for the lack of a definite plan of our large cities rests largely upon the engineer because it was he who had charge of laying them out in the earlier days.

It is reasonable to state that while an architect of recognized standing would hardly be so rash as to claim to be an "authority" on beauty, he is by inclination and training better fitted to be a judge of beauty than Mr. Trautwine. There are just as many mistakes and errors of judgment in the design of engineering structures as there are examples of faulty architectural design. Mr. Trautwine should endeavor to correct the errors and omissions of his own profession before attempting to pass judgment upon another.

Pittsburgh, Pa., Oct. 2. S. S. McKay.

Influence of Price Decline

Sir—The editorial in *Engineering News-Record* of Sept. 30, 1920, p. 631, entitled "Influence of Price Decline," states that there is a possibility that in the immediate future the public will be found willing to get along with such housing accommodations as are available rather than pay any greatly increasing cost of providing new and additional housing. My observations in Chicago and other large cities have been such as to lead me to the opinion that the housing shortage is to a certain extent fictitious. It seems probable that the apparent demand for additional housing facilities is as badly inflated as was the apparent demand for numerous raw materials and fabricated materials early in the spring of this year.

It is apparently true that there have been five candidates for every four vacant flats and residences not alone in Chicago but in all other cities of great size throughout the country. It is equally true that owners of habitable properties of the better class have been able to secure most any price for the rental thereof. It is apparent, however, that the demand for high-class living accommodations has increased with greater rapidity than has the population of that class of people who hitherto used accommodations of this class.

So far as Chicago is concerned, before the period of war prosperity, we had approximately 125,000 workers employed in low-wage industries of a class corresponding to the garment workers. Families whose heads and members secured their living in these trades were compelled to live in tenement quarters in unfavorable sections of the city in two and three-room apartments renting from \$5 to \$10 per month. Single men in these industries frequently slept with four beds in a room and with two shifts of sleepers to each bed, one room renting for from \$2 to \$4 per week serving as accommodations for as high as eight men. Since war and post-war prosperity has been in effect the minimum wage in these trades has been approximately \$40 per week. Each one of these many thousand families have thereby been removed from the tenement class and have been placed into active competition with the so-called white-collar class for housing facilities. Each of these men, formerly using from one-quarter to one-eighth of a single room are now

using and demanding a room apiece, and with each of these rooms fully provided with modern conveniences

As the present incipient shrinkage of industry progresses and increasingly large numbers of men and women are forced into the ranks of the unemployed wages will undoubtedly be cut. This great body of the submerged tenth which have for this short period come to the surface, will be forced to return to their previous environment. This will unquestionably be a bad thing for the individuals concerned, but will with equal certainty release the pressure for high-class homes and apartments. There are today standing idle in Chicago, and I presume in other large cities, thousands of these low-class habitations which formerly were teeming with life.

During the period of reduced building which has existed for the past five years, there have been practically no low-priced habitations erected. It seems very evident that when these thousands of temporary bidders for homes in good districts and with good accommodations are forced back to the tenement regions, many thousands of vacancies will occur in the very class of apartments and residences which are now the most hard to find. These facts should tend to render unlikely any unprecedented boom in the construction of buildings for residential purposes in the next year or two.

Does it not seem that producers and dealers in raw materials used in the construction industry would be wise to take these facts into consideration when making bold prognostication of long-continued excessive demand for all classes of materials? O. M. F.

Chicago, Oct. 11.

Jacoby Formula for Inclined Bearing Recommended for Coniferous Woods

Sir—The writer has noted the two articles, "Crushing Strength of Southern Pine at Angles to Grain" and "Inclined Bearing Tests on Douglas Fir and White Pine," and your editorial comment thereon published in your issue of Sept. 30, 1920 (pp. 629 and 653). Mr. Simpson carried out his tests as thesis work at the University of California, and since the writer acted as advisor to him in this work he has naturally read with great interest the articles by Professor Ayres, and has been surprised at the lack of agreement in the results found by the two investigators.

The subject of the safe bearing values for timber on surfaces inclined to the fibers has been discussed at various times in *Engineering News*, *Engineering Record* and *Engineering News-Record*. As has been noted in these articles, Jacoby's formula is a theoretical one, developed in his "Structural Details." It was pointed out several years ago, and has been proved by other writers, that the assumptions on which Jacoby's formula is developed are incorrect, and that theoretically the formula cannot be applied to a material of the nature of timber. Professor Jacoby in answering this criticism acknowledged the fault, but maintained that the formula would give values which were reasonable for design purposes. Since up to this time no tests have been available except those of Professor Howe's, the evidence of the actual tests not unnaturally has carried more weight than the advocacy of a formula theoretically incorrect.

In opposition to your editorial comment, "Since in each case the results are satisfactorily consistent among themselves, it can only be concluded that different kinds of wood are subject to different laws in this particular phase of bearing strength . . . On this account, safety would seem to dictate that in any practical application, the lower of the two existing formulas, the Howe formula, should be used . . .," the writer believes that the Jacoby formula will be found to hold for all coniferous woods, for joints such as are ordinarily used, i.e., similar in general to those shown in Fig. 1 of Mr. Simpson's article.

In the tests of Professor Ayres the pressure was intentionally exerted over the total surface of block, hence no shearing resistance of the timber could come into action. In Mr. Simpson's tests the bearing pressure was exerted over a portion only of the length of the block, although over the whole width, hence the shearing resistance did come into play. This difference may explain the variation in results found in the two sets of tests. In practically every actual joint the bearing pressure is exerted over a portion only of the timber, hence the writer's conclusion that Mr. Simpson's tests are more typical of actual conditions than those of Professor Ayres.

Professor Howe's formula and the test curves were based on a *constant indentation of 0.03 in.*, while the curves of Professor Ayres are based on the values at the elastic limit. Therefore, although the two curves as plotted in the article agree quite closely the agreement is only an apparent one, since the two curves do not represent the same thing and should not be plotted between the same limits. Mr. Simpson's conclusion that safe bearing pressures should be based on the elastic limit of the timber is well founded.

An indentation of 0.03 in. (not a unit deformation) means very little unless the length of stick is known, and is not a proper basis on which to determine values of unit compression.

The writer considers it unfortunate that Professor Ayres did not measure the deformations during the progress of the test and take the elastic limit from the plotted stress-deformation curves. The values for the elastic limit for crushing endwise (average 7,910 lb. per sq.in.) seem very high, even considering the low moisture content and the density of the wood (7 to 14 rings per inch).

To sum the situation, then, the writer is satisfied that the formula of Jacoby or the curve plotted therefrom will give the correct values to be used in the design of joints of Douglas fir and California white pine, and also believes that if tests similar to those of Mr. Simpson are made on Southern pine the same formula, modified as to constants, will be found to hold.

There is another subject in timber design, closely allied to the subject under discussion, which needs investigation by tests. This is the safe pressure to be allowed for circular metal pins bearing across and against the ends of the fibers of the timber. The writer would urge that this particular phase of bearing values for timber be investigated

San Francisco, Cal., H. D. Dewell,
Oct. 7. Civil Engineer.

Shrinkage of Earthwork

Sir—Referring to the discussion that has taken place in the *Engineering News-Record* during the last four months regarding shrinkage of earth in embankments, I think your Mr. Tratman has given a pretty fair outline of the entire matter and that if anyone discusses this matter without taking into account the factors mentioned by Mr. Tratman he will not arrive at a correct solution.

It appears to me that Mr. Marshall and Mr. Oliphant of the Chicago, Burlington & Quincy R.R. are working on the right lines as indicated in the article published in the *Railway Age* of June 4, 1920. As far as my own experience goes I remember, as a boy on the farm, wondering what became of the earth I dug out of the post-hole after the post had been set, when the ground was properly tamped. I remember also some thirty-one or thirty-two years ago, when I attempted to get the chief engineer of a small railroad to insist that the contractors do less wasting in a rolling country, where the soil was a sandy loom, very similar to the soil I was accustomed to on the farm. His answer was: "You had better leave them alone. If they put all the material out of the cuts into the fills, you probably would have to pay them 10 or 15 per cent on account of the shrinkage of the material."

A few years later I had a similar experience in similar ground, where neither the cuts nor fills exceeded a depth of 4 ft. There was about a mile of work where the cutting slightly exceeded the embankment. The work was done with teams and drag scrapers. The material was not hauled over 500 or 600 ft., all done within the limits of the railroad. We were compelled to make borrow to complete the embankment. The apparent shrinkage or subsidence (which I think is quite a factor) amounted to between 10 and 12 per cent.

When a man makes a sweeping statement that "the earth does not shrink," as Mr. Charles Prelini did in a letter in the

Engineering News-Record of Sept. 2, 1920, page 475, without any qualifications of how, when or where the work was done or the measurements taken, it appears to me that the statement is decidedly open to question. I have run across earths that I am sure do not shrink very much and others that have either shrunk or subsided so as to require more material for the fill than was taken out of the cut. For all practical purposes this latter point is what we have to determine.

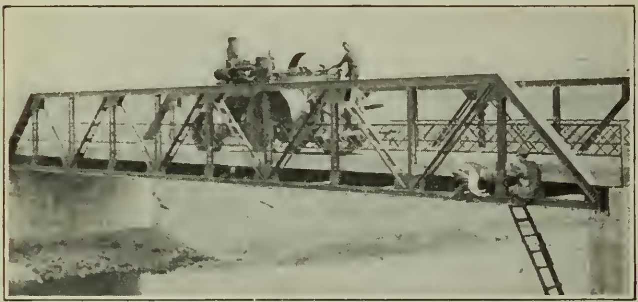
Winnipeg, Man., Canada, Sept. 22. J. G. SULLIVAN.

[A description of the shrinkage tests on the C., B. & Q. R.R. is given on p. 782. As to the last paragraph in Mr. Sullivan's letter, it may be said that we need more definite information as to the relative importance of factors that cause the generally accepted fact of shrinkage. There appears to be some question whether earth shrinks in itself, if placed, for example, on a solid rock bed. If the earth does not "shrink" but is placed on a bed which "subsides" there is still apparent "shrinkage" of embankment as compared with excavation. There may be both shrinkage of the earth mass and subsidence of its bed, so that determination of these independent factors is very desirable.—EDITOR.]

Need for Measurement of Highway Bridge Impact

Sir—I have read with interest the editorial in the Sept. 9 issue regarding the desirability of conducting investigations to determine the effect of impact on highway bridges.

In 1912 the Iowa Highway Commission, in co-operation with the Engineering Experiment Station of Iowa State College, conducted a series of tests to determine the effect of impact of rapidly moving vehicles upon highway bridges. These tests were made on concrete bridges and on steel bridges with wood and concrete floors. The impact instruments used were secured from the American Railway Engineering Association, where they had previously been used in determining impact stresses on railroad structures. With slight modifications these instruments were adapted for use in measuring impact stresses in highway structures.



IMPACT-STRESS MEASUREMENT ON 80-FT. STEEL HIGHWAY BRIDGE, IOWA TESTS OF 1912

Impact stress measurements were made on the structural members of both riveted and pin-connected steel bridges under several types of vehicle and engine loadings traveling at various rates of speed. The photograph shows one of these tests in progress on an 80-ft. riveted steel truss with concrete floor, using a 13-ton traction engine as load.

While this series of tests did not cover all types of highway bridges under all conditions of loading which might produce impact, yet it did indicate that the impact stresses under maximum load were such a small percentage of the total stress that they might with safety be neglected. The greatest impact was observed with light vehicles traveling at high speed, but under such conditions the bridge was not subjected to maximum load and the total stresses observed in the members were well within safe limits.

Since these tests were made there has been a great increase in the use of the heavily loaded motor truck traveling at high rates of speed and it is possible that under these conditions impact stresses might be found which would need to be considered in the design.

No doubt some co-operative arrangement between the Bureau of Public Roads and the state highway departments could be worked out which would provide highway bridge designers with all additional data required on this subject. J. H. AMES,

Bridge Engineer, Iowa State Highway Commission.

Ames. Iowa, Sept. 23.

Sir—The proposal in your editorial of Sept. 9, "A Field for Experiment," that definite experiments be made to determine the actual impact effects of motor trucks on highway bridges, is one that should be heartily supported. Few tests in this field have been made, and those generally before the advent of the present heavily loaded and speedy vehicles. The results of these scanty tests show only that impact is much less for highway bridges than for railway bridges, a result that was anticipated, as the unbalanced driver loads of locomotives are not present. The recent impact tests on highway surfaces made by the Bureau of Public Roads show that impact on even moderately rough road surfaces may be large, and most certainly cannot be neglected in highway bridge design.

When impact has been considered at all in highway bridge specifications it has usually been taken at from one-third to one-half that for railroad bridges, but whether it is that much, or more or less, is not known, and this uncertainty should be finally cleared away by proper experiments. This is particularly true with regard to concrete bridges, for which we have practically no accurate knowledge as to impact, and these should certainly be included in any tests made. It is believed that the impact effect will be less, and probably considerably less, than for steel bridges, due to greater dead load; but, whatever it may be, due economy in design requires that it be ascertained.

Many experiments on all kinds of bridges and roadway floors and for all lengths of span will be necessary, and the actual stresses upon various members should be determined. The expense will be considerable, but is fully warranted by the resulting economy of design, and I am of the opinion that the matter should be taken in hand at an early date and pushed to completion as rapidly as possible.

H. E. WARRINGTON,

Assistant Highway Engineer, California Highway Commission.

Sacramento, Cal., Oct. 2.

Wind-Pressure Coefficient for Cylinders Varies with Dimensions

Tests to determine whether the wind-pressure coefficient for cylinders is constant regardless of the diameter of the cylinder were made recently at the Bureau of Standards, and are reported by H. L. Dryden in Scientific Paper No. 394, just issued. The purpose of the experiment was to test the theory of geometric similarity, used in correlating model tests of airplanes or parts with service results on full-size machines. According to theory, the coefficient of the square of the velocity should be found constant for geometrically similar bodies presented in the same manner to the wind, without regard to size. Tests on wood and brass cylinders ranging from 1 to 6 in. in diameter were made in a wind tunnel at velocities from 15 to 80 miles per hour, the higher velocities being restricted to the smaller cylinders. The cylinders were placed with axis normal to wind, and the arrangement was such as to make the results apply to cylinders of infinite length. It was found that the coefficient does not remain constant, but for a 1-in. cylinder is half again as large as for a 3-in. cylinder. Above a 3-in. diameter the coefficient proved to be practically constant, and equal to 0.426. The ratio of the average decrease in pressure on the back to the maximum increase in pressure on the front was greater for the small than for the large cylinders.

HINTS FOR THE CONTRACTOR

Portable Construction Camps

CONSTRUCTION camps on trailers hauled in train by motor trucks are successfully used by the Pacific Telephone & Telegraph Co., of California, in line construction operations. Each trailer train consists of five four-wheel trailers, which ranging in length from 12 to 24 ft. are fitted with bodies of railroad car type, 8 ft. wide. The steering wheels and drawbars are so connected that every trailer follows in the tracks of the towing truck.

The longest trailer is equipped as a dining car, having a U-shaped counter at one end, with stools for seating fourteen men, and a complete kitchen at the other end. This kitchen has all the appointments of a Pullman car cook room, including a large range, ice chest, dish closet, sink, hot and cold water faucets and bins for flour, sugar and vegetables. Another trailer is a combination office and sleeping car, with a central partition and end doors admitting to the office at one end and to the sleeping compartment at the other. The other two trailers, with center doors, are sleeping cars for the workmen and are fitted with a number of full-sized single berths, wash room, shower bath, etc.

All of the cars are mounted on standard 2-ton trailer chassis, the 25-ft. dining car and 20-ft. sleeping cars having reversible steering, while the 16-ft. office and sleeping car and the 12-ft. water tank and tool car have non-reversible single-end steering.

Handling Device for Concrete Pipe

IN BUILDING a 54-in. concrete pipe line near San Diego, Cal., the contractors, Bent Brothers, Los Angeles, used a device by means of which a team could be

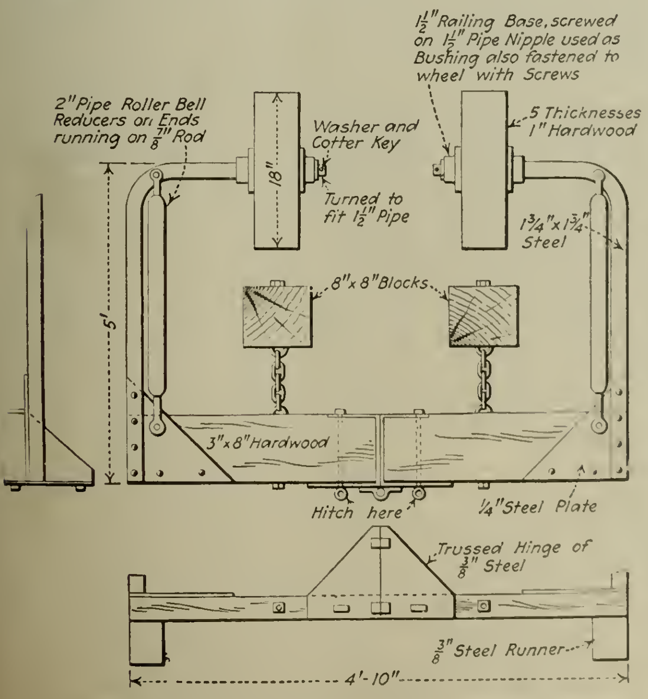


FIG. 1—DETAILS OF DEVICE USED IN TRANSPORTING CONCRETE PIPE

quickly hitched to a pipe section and the section rolled from the casting yard to its place on the line.

The device consisted of a steel frame with hardwood rollers engaging the inner surface of the pipe section.

FIG. 2—TEAM EASILY HANDLES SECTION OF 54-IN. PIPE

Concrete weights were suspended from the frame to keep it from "riding up" to an undesirable height in the rolling pipe section.

Tool for Tightening Mesh Reinforcement

IN placing a 2-in. reinforced gunite concrete lining in the Herron Hill reservoir, Fitchburg, the contractor. A. V. Purnell, is using a simple and effective hand tool for tightening the wire mesh to make the sheets lie flat and taut instead of kinky, as they are when unrolled.

The tool consists of an iron bar with a right-angle bend at one end to give a handle by which the bar can be twisted, and a notch cut in the other end to engage a wire of the mesh. With this tool a workman can easily put a short reverse bend in a wire of the mesh. Putting a similar bend in each main wire of the sheet shortens the sheet and so tends to tighten it in the direction of its length.

News of the Week

New York, October 21, 1920

Land Purchased for Approaches of New Orleans Bridge

(Special Correspondence)

An option on nearly 400 acres of land on the east bank of the Mississippi River above New Orleans has been secured by the Mississippi River Bridge Commission, this land to be used as site of the east approach of the bridge which the commission is charged with planning and constructing. Some time ago the commission bought 300 acres on the west bank. When purchase of the tract on the east side is completed the commission will control enough land for its purposes, and will have spent nearly $300,000. It is probable that the main part of the structure will be about 3,600 ft. long and its approaches on either bank about 2,500 ft. long.

Except for the land purchase, little progress has been made by the commission since its creation just four years ago by an act of the Louisiana legislature. The failure to make more rapid progress is not considered to be chargeable either to the commission or to its advisory board of engineers, but is due to political and business conditions. Despite the obstacles presented by the latter, the commission devoted about two and a half years to making a general study of the problem of crossing the river. A bridge was decided upon, on the ground that the depth of the river made it inadvisable to undertake a tunnel. An approximate location for the bridge was chosen, in the parish of Jefferson, about ten miles above New Orleans. While the navigation requirements as to span and height of bridge have not yet been fixed by the War Department, well-informed men believe that the commission will favor a low-level bridge. The probable cost of the structure at pre-war prices is said to be about $7,000,000, but at the present price level the cost would be more likely to reach $15,000,000.

The bridge commission consists of eleven members, selected from the Public Belt Railroad Commission of New Orleans, of which number five were elected by commercial bodies and exchanges of the city. The engineering advisory board consists of J. V. Davies, Bion J. Arnold and J. A. L. Waddell.

Camp Custer To Be Abandoned

The War Department announces that the Commanding General, Camp Custer, has been directed gradually to abandon and eventually to salvage Camp Custer, Mich.

Municipal Society Approves New Specifications For Concrete Paving, Sidewalks and Curb

Harmony Prevails at St. Louis Meeting—A. A. E. Schedule Approved —Brick and Stone Block Standards Not Changed

Net results of the four-day convention of the American Society for Municipal Improvements ending Oct. 15 in St. Louis, Mo., include approval of three specifications: (1) concrete streets; (2) sidewalks; and (3) curbs. These new standards now go to letter ballot together with two amendments to the constitution, raising the dues and rearranging the standing committee quota. The American Association of Engineers' salary schedule for engineers in municipal service was unanimously approved without debate. Incidental changes or additions were made in three existing standard specifications.

Total Registration 330

One-third of the active membership was present and the total registration reached 330. An extremely full program of papers and committee reports was provided and carried through with a good attendance, even at the last session on the fourth day. By judicious grouping the special subjects of sanitation, city planning and paving were presented at separate meetings, giving guests an oportunity to participate in numerous city inspection trips provided by the local committee in addition to the excellent arrangements for general inspections in which all participated.

Finances of the organization have made it necessary to curtail decidedly the former lavish printing of papers, proceedings and standard specifications. By selling the society's Liberty bonds and putting into effect a 50 per cent increase in dues the directors expect to come out about even for another year. The members number 611 and an active campaign is under way for a substantial increase.

Of the two amendments to the constitution the first will raise the dues of members from $5 to $7.50 and associates from $10 to $15.

Changes in Committees

The second amendment refers to a realignment of standing committees making four of them parent committees to which several sub-committees report. A street committee will have sub-committees on (1) paving, (2) sidewalks and street design, (3) street maintenance and (4) street railway construction. The city planning committee is divided into (1) local subdivision, (2) zoning, (3) utilities and (4) parking and open spaces. Traffic and transportation was with this list but was made a main committee at the insistence of Prof. A. H. Blanchard. Street cleaning is divided into (1) street cleaning, (2) refuse disposal and (3) snow removal; sewerage and sanitation into (1) sewerage, (2) sanitation, including sewage disposal and (3) public comfort stations. There was also added to the list of committees one on foundations and sub-grade and another on street railway pavements, including track construction. So-called double-barreled committees have been tried before without entire success but the amount of detail and number of conflicts has grown too great to be straightened out on the convention floor. This method of clearing seemed the only feasible one.

Specifications

Of the standards adopted and passed to letter ballot the tentative specifications for concrete pavements submitted last year have been redrafted. The principal changes refer to the two-course pavement, which is omitted, and to reinforcing, which the committee, of which E. R. Conant is chairman, feels should be required on certain streets but not be compulsory.

Tentative specifications of the society for concrete sidewalks have been adopted by the American Concrete Institute so they were sent to letter ballot without change, as were those on curb submitted for the first time by the same committee, of which S. Sammelman is chairman. The specifications for curb were made up after comparison with specifications from 50 towns and consultation with quarry operators as to practicable or economical sizes.

The sheet asphalt committee, R. K. Compton, chairman, recommended a number of incidental changes in the present standards and that a complete revision be undertaken with a view to condensation and simplification of matter and arrangement.

To the 1918 brick specifications approved clauses were added providing for a sand-cement cushion and asphalt filler. E. H. Christ is chairman.

A non-bleeding wood-block filler of special pitch has been used successfully in Minneapolis by E. R. Dutton, chairman of the committee on wood block. A specification for it to be added to

wood-block specification was passed for letter ballot. It is to be used only where a bituminous cushion is used.

Uniformity of specification for asphaltic cement used in bituminous macadam, bituminous concrete and asphalt block pavement is desirable according to the committee on these pavements, headed by Linn White. The society now has three separate specifications for asphaltic or bituminous concrete—bituminous concrete with one product of the crushing plant, Bitulithic and Topeka mix. The committee states that all these could now be combined in one since the principal patents on Bitulithic have expired. The society concurred in this opinion.

At the 1919 meeting, T. J. Wasser presented a revised specification for stone block pavements but the present committee, under H. H. Smith as chairman, felt that it was unwise to revamp the existing specification except to add a few incidental changes. With this the convention concurred, the changes to be printed and brought up for adoption in 1921.

Committees Report

The committee on sewers, W. W. Horner, chairman, felt that the society's existing specifications, adopted six years ago, are no longer satisfactory and that they should be rewritten. Agreement has been reached on form only. Part 1 on materials was submitted as tentative for study. Construction methods were not yet covered.

A special committee on foundations, of which R. K. Compton is chairman, submitted a tentative specification for old and new macadam base, an asphaltic base (asphaltic concrete type), and a tar bound base by the cold penetration method. The committee was made a standing committee and instructed to work with a similar committee of the Federal Highway Council.

To sponsor a uniform system of reports on parks and parkways giving physical and financial data in such a manner as to facilitiate comparisons and aid in securing efficiency was the recommendation of the committee on parks and parkways, headed by John M. Rice. The recommendation was concurred in.

Approval was given of standard tests for bituminous materials adopted by the American Society for Testing Materials for specific gravity, softening point of asphalt and tars, distillation, loss on heating oil and asphaltic compounds; by the American Society of Civil Engineers for flash-point, viscosity, float test, ductility and solubility of bitumen, and by the American Chemical Society for fixed carbons. The committee, A. H. Blanchard, chairman, feels that its duty is simply to review new methods as submitted and adopted by these other societies.

The recommendations of the committee on traffic and transportation, A. H. Blanchard, chairman, were approved. They call for design of intersections, where three or more streets intersect, so that rotary traffic may be installed; for careful consideration by engineers of the limits of car-stop zones so as not materially to reduce the roadway; for by-pass highways for transport service to avoid principal business streets, especially where local traffic is heavy; for a consideration by engineers of motor buses in extending transportation service. The recommendations are against excessively wide paved roadways in small municipalities.

The U. S. Government will become a member of the Permanent International Association of Road Congresses if a resolution calling on Congress to pass by December enabling legislation has effect. An invitation to hold the fourth International Road Congress in the United States, if received prior to Jan. 1, must be sent; otherwise the invitation of the Italian Government will be accepted.

In the city planning group of papers conditions in Pittsburgh, Washington and St. Louis were outlined and by illustration George B. Ford, of the Technical Advisory Corporation, New York, indicated suggestions from European practice in municipal improvements in the rebuilding of the devastated areas. Thomas Adams sent a paper on "Regional Surveys" and Harland Bartholomew described the zoning plan recently adopted for Washington, D. C.

The sanitary engineers, led by Langdon Pearse, T. Chalkley Hatton and Dr. Edward Bartow, participated in a spirited discussion on activated sludge, the only technical discussion of note during the convention. In answer to a question by N. T. Veatch, Jr., it was brought out clearly by Messrs. Hatton and Pearse that the activated sludge process can as yet only be considered for special cases and is not at all comparable with sprinkling filters as to cost. J. C. McVea, Houston, reported a cost of $14 per million gallons by the activated sludge method exclusive of overhead and treatment of sludge.

Paving Types Discussed

All of the different types of paving were represented by papers. John D. Hittell gave a valuable description of sheet asphalt paving on a country highway north of Chicago. Dr. Hermann Von Schrenck spoke on the condition of wood-block pavements in many cities recently visited and Philip P. Sharples indicated when it was worth while and when not to protect gravel roads by surface treatments.

An exhibit of materials and devices utilized by municipalities was well attended. At one end of the hall was an exhibit of city plans, photographs and models prepared by the City of St. Louis. Commendation is due the local committee for the clock-like precision and efficiency with which the excursions and other entertainments were managed. Baltimore secured the convention for 1921.

The new officers elected are as follows: President, Col. R. Keith Compton, Baltimore; vice-presidents, E. S. Rankin, W. W. Horner and E. R. D[illegible]; secretary, C. C. Brown, Valparaiso, Ind.; treasurer, Hermann H. Smith, Brooklyn, N. Y.

Great Lakes Engineering Works To Continue Operations

In contradiction of reports current for some time that it will discontinue business and sell its plants, the company, Great Lakes Engineering Works, Detroit, now announces that it will remain in the business of designing, building and repairing steel ships. The company has hull-building yards at Ecorse, just south of Detroit, and at Ashtabula, Ohio. In addition it has an engine building plant and fitting-out yard in Detroit. A. C. Pessano is chairman of the board, and J. A. Ubsdell is president and general manager of the company.

Hetch Hetchy Work To Be Financed Despite Injunction

Pending the outcome of the suit brought against the city of San Francisco to prevent carrying out the cost plus fee contract with the Construction Company of North America, all work on the 18-mile Hetch Hetchy tunnel would have to be delayed unless cash to meet immediate financial obligations were available. Accordingly the supervisors on Oct. 4 voted to buy Hetch Hetchy 4½ per cent bonds with $250,000 taken from the depreciation fund of the Municipal Railway.

Channel Tunnel Project Abandoned

Prospects for the realization of the project for a tunnel under the English Channel to connect England and France have practically disappeared, according to recent reports from English engineering circles. It is thought that military and political reasons played a part in determining an apathetic attitude toward the project, but its great cost and the uncertainty of earnings sufficient to justify the cost were also of influence. Moreover, because of conditions resulting from the war the national energies of England will be devoted largely to maintenance and reconstruction for some years, it is stated, and few new works of magnitude will be undertaken.

A. A. E. Members Enroll in Educational Classes

About 60 members of the Twin City Chapter of American Association of Engineers have signified their intention of joining one or more of the educational clasess to be held by that chapter this season. The chapter is offering thirty-one courses in engineering and general subjects.

The association has opened offices in Boston at 50 Broomfield St. Fred C. Lewis is temporary managing secretary.

Military Engineers Will Meet in New York

The first regular meeting of the New York Post, Society of American Military Engineers, will be held at the Engineering Societies Building at 7:30 p.m., Oct. 26. The general subject for discussion, the army reorganization bill and its bearing on the engineer in civil life, will be treated under the following four topics: (1) History and general features of the bill; (2) War Department's general plan under the bill; (3) plans of the technical services; and (4) co-operation of the engineering profession and its national societies.

Other regular meetings are planned as follows:

Dec., 1920—Relations between command, the General Staff, and the services.

Jan., 1921—Annual dinner.

Feb., 1921—Functional organization of engineers.

April, 1921—Military and engineering defense of New York City.

May, 1921—Trip to West Point, N. Y.

It is desired by Colonel R. D. Black, chairman of the program committee, that the first meeting be attended by all who are interested in the national defense and in fostering effective cooperation between the engineering profession and the army, whether members of the society or not. The subject under discussion is the foundation on which will be built the future relationship between engineers and the service, a subject to which one year's work will be devoted.

New York Port Developments Include 1,000-Ft. Piers

Formal announcement has been made by the Cunard Steamship Co., Ltd., of the proposed construction of a new shipping pier development at Weehawken, N. J., on the Hudson River about opposite 36th St., New York City. The group will comprise eight piers of 1,000 ft. length and one shorter pier. Pier and slip widths and exact details of handling equipment or of layout have not yet been completed but it is understood that the scheme contemplates pier widths of 150 ft. with full width sheds and a multi-story marginal warehouse. Railroad trucks in the preliminary design do not enter the pier but approach the shed entrance from which freight may be transferred by tractor trailers. It is intended that the new group be used only for freight ships the passenger terminals remaining in the Chelsea district of New York City.

At the same time the Department Docks and Ferries of New York announced that it contemplates the construction of three piers each 700 to 1,000 ft. long and 250 ft. wide at Owls Head Bay, on the Brooklyn shore of the inner harbor just inside the narrows. Details of the scheme are not complete enough for further description at this time.

To Discuss Failure of Metals

A joint meeting on failure of metals is to be held in England under the auspices of the Faraday Society, the Institution of Mechanical Engineers and the Institute of Metals. The date of the meeting has not yet been fixed, but it is likely to be early in 1921. Failure under long-continued application of stress and under internal strain such as results from cold working or heat treatment will be dealt with, so that season-cracking and fire-cracking of brass as well as similar failures in steel are to be included. F. S. Spiers, 10 Essex St., London, is secretary of the joint committee in charge of the meeting. According to a preliminary announcement of the meeting in *Engineering*, new matter on the subject to be considered "will be placed at the disposal of the co-operating societies later in the year, and it is thought that this will afford an opportunity for a more comprehensive consideration of the subject than has yet been given to it."

Belle Isle Bridge Contract Is Readvertised

An amended form of contract has been approved by the Detroit City Council and as a result the Department of Public Works has readvertised for bids for the construction of the Belle Isle bridge. According to the contract approved the Commissioner of Public Works can order payment of 80 per cent of the amount of material to be used in the construction of the bridge as soon as the contractor delivers the material on the job. Ninety per cent of the bid price will be paid the contractor upon completed work. After completion of one section of the work the contractor will be entitled to 90 per cent of the contract price of the work done regardless of the remaining parts to be finished.

As a result of amending the form of contract, the date set for opening bids has been changed from Oct. 22 to Oct. 30. This action was taken by the city council upon the recommendation of Commissioner of Public Works Joseph A. Martin, to permit contractors to figure on the difference the amendment will make in their bids. The commissioner pointed out that as a result of the amendment, contractors bidding will not have to figure interest which it would otherwise be necessary to pay on borrowed money providing they were not advanced the 80 per cent on materials.

It is believed that as a result of the amended contract bidding on the bridge contract will be stimulated. The contractor to whom the work is awarded would have to count on between two and three million dollars being tied up for several months under the original type of contract before the amendment was made. This, it is believed, would have resulted in causing many contractors to refrain from bidding.

Active Standardization Work Now Under Way

Preparation of Many Safety Codes Is Progressing—Aircraft and Elevator Studies Being Made

Work on a dozen or two safety codes is now in progress under the general direction of the American Engineering Standards Committee, according to information just made public. In addition, steps have been taken to appoint American representatives of aircraft work to attend the next meeting of the International Aircraft Standards Commission. Work has been initiated in the direction of standardizing elevators.

On the subject of aircraft standards, a conference of five government departments, several societies, and the National Advisory Committee for Aeronautics was held a few weeks ago in Washington to consider an invitation to participate in the next meeting of the International Commission. Subsequently the favorable view of the committee was laid before the president and the latter thereupon requested the National Advisory Committee for Aeronautics to arrange for the presence of American representatives at the conference.

A request for considering the standardization of elevators was received by the Standards Committee from the American Institute of Architects and the Elevator Manufacturers Association of the United States. At a meeting to consider this request, held on Sept. 21, thirteen organizations were represented, and after full discussion of platform sizes, speeds, elevations, capacities, test methods, clearances, and the like, as well as safety provisions, it was resolved "that this conference fully recognizes the need and the desirability of standardizing such features of both passenger and material handling elevators as capacities, platform sizes and methods of test." A committee was appointed to confer with the Elevator Safety Code Committee of the American Society of Mechanical Engineers in order that further steps in elevator standardization might be properly correlated to the safety provisions already under study. It is expected that a report will be made to the American Engineering Standards Committee soon.

Safety code work now in progress under the American Engineering Standards Committee includes separate work on codes dealing with the following subjects: Construction work, electrical fire hazards, electrical safety, railing and toe boards at floor openings, lighting protection, machine tools, mechanical transmission of power, industrial sanitation, stairways and fire escapes, textiles, abrasive wheels, foundries, gas safety, head and eye protection, paper and pulp mills, power presses, nonfired pressure vessels, mechanical refrigeration, and woodworking machinery. The head-and-eye-protection code, which was formulated under the direc-

tion of the Bureau of Standards, has been completed and has been submitted to the American Engineering Standards Committee for approval.

The United States Department of Agriculture recently became a member of the committee. Three representatives have been appointed by the Secretary of Agriculture, one each from the Bureau of Chemistry (D. J. Price), the Bureau of Public Roads (A. T. Goldbeck), and the Forest Service (E. H. Clapp).

Fourteen Organizations Join Engineering Federation

Fourteen engineering organizations are now members of the Federated American Engineering Societies according to a recent announcement of the Joint Conference Committee, representing the four national societies of civil, electrical, mechanical and mining engineers. The latest entrants into the federation are the Kansas Engineering Society and the Alabama Technical Council. The complete list of charter member organizations up to Oct. 19 follows.

American Society of Mechanical Engineers.
American Institute of Electrical Engineers.
American Institute of Mining and Metallurgical Engineers.
American Institute of Chemical Engineers.
American Society of Agricultural Engineers.
Alabama Technical Council.
Technical Club of Dallas.
Detroit Engineering Society.
Engineering Association of Nashville.
Engineering Society of Buffalo.
Florida Engineering Society.
Kansas Engineering Society.
Cleveland Engineering Society.
Society of Industrial Engineers (Baltimore).

A.R.E.A. Directors Meeting Held in Montreal

The Board of Direction of the American Railway Engineering Association held a meeting in Montreal, Oct. 11, presided over by President H. R. Safford of the association, who is assistant to the president, Chicago, Burlington & Quincy R.R. The representatives of the A.R.E.A. were entertained by the Engineering Institute of Canada at a dinner at the University Club, and on the following day the party made a visit of inspection to the Quebec bridge.

Street Cleaning Officials Organize at Chicago

The International Association of Street Cleaning Officials was organized at Chicago Oct. 7 and 8, as a result of a conference called by W. J. Galligan, assistant superintendent of streets of that city. Mr. Galligan was elected president of the association. Other leading officers chosen were: Vice-president, Theodore Eichhorn, superintendent of streets, Erie, Pa.; secretary A. M. Anderson, 1340 Old Colony Building, Chicago; treasurer Robert W. Waddell, city engineer, Kansas City, Mo. The conference was attended by 44 street cleaning officials from 28 cities of the United States and Canada.

Training in Industrial Management Proposed for Colleges

A course in management education, to provide a sufficient number of properly trained executives for the industries of the United States, is to be established in a majority of the 620 American colleges, according to an announcement made to the Associated Press by Dr. Hollis Godfrey, president of the Drexel Institute, Philadelphia, and former commissioner of the Advisory Commission of the Council of National Defense.

The plan, which is an outgrowth of a convention attended by representatives of industry and colleges in Philadelphia last March, is backed by corporations representing a capitalization of $26,000,000,000. It is the result, Doctor Godfrey said, of thes two factors coming to a definite working agreement for the first time through the establishment of the Council of Management Education, an organization formed "to study mutual problems in order that the colleges may render the greatest possible service to industry."

Students and Teachers in Industry

It is contemplated to establish practical courses in schools, and to assist undergraduates and others to choose their life's work, by placing several thousand students and teachers in industry during the summer months and by introducing extension courses for men now in industry. Doctor Godfrey is being assisted in the perfection of his plan by Doctor Samuel T. Chapen, general director of the American Council on Education, representing the 620 colleges and Dr. Frederick C. Ferry, president of Hamilton College.

An annual appropriation of $100,000, entirely borne by American industry, has been made to carry on the work of the Council of Management Education. Part of this money will be devoted to a determination of the extent of field service that each college can cover and part to provide the colleges with all industrial data which may be utilized in forming undergraduate courses, within one year, it is estimated, 100 colleges will have included the extension industrial courses and all will be provided with the industrial material upon which to base undergraduate work. The establishment of industrial executive training courses in colleges will do much, it is estimated, toward the re establishment of industrial needs—increased production, decreased cost, increased stability, and increased incentive in industry.

The executive members of the council, appointed to represent their industrial groups, are as follows: Railroads, A. W. Gibbs, chief mechanical engineer, Pennsylvania R.R.; paper, Colonel B. A. Franklin, vice-president Strathmore Paper Co.; public utilities, H. B. Shaw, educational director, H. L. Doherty Co.; shoes and leather, Frederick B. Rice, president, Rice & Hutchins; mining, J. Park Channing, mining engineer, machinery and metals, Frederick H Payne, Greenfield Tap and Die Co.; rubber, Dr. R. S. Quinby, service manager, Hood Rubber Co.; cotton finishing, J. K. Milliken, president, Mt Hope Finishing Co.; textiles, Albert Bigelow, Ludlow Manufacturing Co.

Educational Group

The educational group includes, besides Dr. Godfrey and Dr. Capen, Dr. Frank Graves, dean of the school of education, University of Pennsylvania; Dr. Charles Tilden, professor of engineering mechanics, Yale University; Dr. David Tennant, professor of biology, Bryn Mawr, College; Dr. Legge Reid, professor of mathematics, Haverford College; C. L. Evanson, professor of engineering administration, Drexel Institute, and J. S. Pearson, professor, Drexel Institute.

The American Council on Education has appointed the following committee as a permanent body to co-operate with the Council of Management Education:

Dr. Capen, chairman; Dr. Charles R. Mann, chairman of the advisory board, educational training of the general staff, War Department; Frederick L. Bishop, dean, engineering school, University of Pittsburgh; Park R. Kilbe, president, Municipal University of Akron; Raymond Hughes, president Miami University.

Pennsylvania R.R. Awards Maintenance Prizes

On the completion this week of the first day's inspection of the main line of the Pennsylvania R.R., Easton region, General Manager C. S. Krick awarded the track maintenance prizes to the supervisors and their assistants who have made the best maintenance record. The first or "Klondyke" prize, amounting to $800 for the supervisor and $400 for the assistant, awarded for maintaining the best section of track throughout the past year, was presented to H. H. Mauffman, supervisor, and J. B. Otto, Jr., assistant supervisor, who have charge of the track between Dillerville, Pa., and Harrisburg. The three other prizes were premiums of $800 each, of which $600 was for the supervisor and $200 for the assistant, for the best line and surface on a main line between New York and Washington, and Philadelphia and Altoona. The prize sections include the track between Elizabeth, N. J., and Plainsboro, N. J.; between Marysville, Pa., and Durward, Pa.; and between Baltimore and Washington. A special improvement premium, $1,000, for having shown the greatest improvement in line and surface was awarded to the supervisor and assistant supervisor for track from 62d St., Philadelphia, to Wilmington.

The awards are made on the basis of inspection by a committee of officers which goes over the line in a special car carrying the instrument to register riding qualities of track.

Oklahoma Engineering Council To Be Formed

At Tulsa, Okla., Oct. 26 and 27, the legislative committees and ways and means committees of the Oklahoma Society of Engineers, the three chapters of the American Association of Engineers, the Oklahoma Section, Am. Soc. C. E., the A. S. M. E. and A. I. M. E. and including also similar committees from the Oklahoma Chapter of the General Contractors of America will meet and organize the Oklahoma State and Engineering Council. A large portion of both days will be devoted to a discussion of proposed legislative enactments covering salaries of engineers in the highway and sanitary state service, reducing the multiplicity of utility reports, amending the special assessments paving law, etc.

The main visiting speakers will be M. O. Leighton, Washington, D. C., F. H. Newell, Phoenix, Ariz., and L. K. Sherman, Chicago, Ill.

Water Power League Meets

That water power matters are coming in for very general study was indicated by the discussions which took place at the convention of the Water Power League of America, which was held in Washington Oct. 7 and 8. When it is considered that the organization is a new one, and that its purposes and policies were not generally known, the attendance was very good. The keen interest in the matters discussed in the addresses was indicated by the live character of the general discussions. Dr. George F. Swain, professor of civil engineering at Harvard University, who accepted the presidency of the Water Power League just prior to the meeting, presided at all of the sessions. As a result of the encouragement given the organization, at the convention, committees are to be appointed to consider various of the problems facing water power development and a Washington office of the League is to be opened.

Commerce Commission Begins Work on Rail Merger Plan

Work has been begun by the Interstate Commerce Commission in preparing a tentative plan for the merging of railroad companies into a limited number of competing systems in accordance with the terms of the Transportation Act. Such mergers, under the terms of the Transportation Act, are permissive and not obligatory to the carriers concerned. The commission has retained Prof. William Z. Ripley, of Harvard University, to assist in working out such a plan. Plans which have been worked out by various interests and individuals will be collected and examined.

When the railroad bills went to conference last December the Senate provision for compulsory consolidation was superseded by that finally adopted for permissive mergers, with the direction to the commission that it should prepare and adopt a plan for the railway properties of the continental United States into a limited number of systems so organized that competition will be preserved and existing channels of traffic maintained.

After the plan for mergers is complete it will be made public and notice filed with the governors of the states concerned, after which the commission will hear persons who file objections to the plan.

New York City Buys 100 Tractors for Snow Removal

As a result of tests of equipment for snow removal, conducted recently, the City of New York has purchased from the Cleveland Tractor Co. 100 small tank-type tractors fitted with winter tracks and covered cabs with two-man seats. Delivery of the "Cletrac" machines to the Department of Street Cleaning is scheduled for December.

River and Harbor Board on Pacific Coast

The Board of Engineers for Rivers and Harbors is making an inspection tour of the principal projects on the Pacific Coast. A public hearing was held October 6 at Lewiston, Idaho, in connection with the improvements on that section of the Columbia River authorized in the 1916 River and Harbor Act. The whole matter of navigation, irrigation and power development will be inquired into. From Lewiston the Board went down the Snake River and the Columbia by boat so as to be able to visualize the territory involved. An inspection also was made of the Columbia River from its mouth to Portland so that a more intelligent decision may be made as to the best plan for improving the channel. Coos Bay, where it is proposed to better the channel, and Gray's Harbor also were visited.

The Board of Engineers for Rivers and Harbors is composed of the following engineer officers: Brig.-Gen. Harry Taylor, Col. James C. Sanford, Col. Charles Keller, Col. William Ladue, Col. John C. Oakes, Major Max C. Tyler, and Major C. S. Ridley.

To Confer on Employment

A conference on employment and education, sponsored by the American Association of Engineers, will be held in the Congress Hotel, Chicago, Nov. 12. The purpose of the meeting is to consider the general problems of employment.

The session will begin at 9 a.m. and after several subjects have been discussed will divide into four group meetings at about 11 a.m., as follows: (1) Employers and employment managers; (2) managers or representatives of free employment bureaus; (3) representatives of educational institutions and (4) those not in any of the three other groups.

The groups will be considered after luncheon into an afternoon session and an evening session.

More Money For Federal Study of Road Problems Indicated

(Washington Correspondence)

It is believed that public insistence has reached a point where Congress will provide adequate money for the economic study of problems arising from the construction of highways. The possibility that such action will be taken is greater because all of the Congressmen have been at home long enough to come in close touch with the desires of their constituents. One of the economic studies which is being insisted upon would look to the development of a system of road management which would insure that funds are expended on the most essential roads and on such types of improvement as will meet the traffic needs. In this connection it is believed to be essential that data be assembled as to the character and amount of traffic passing over the various types of road.

The shortage of transportation and the increase in freight rates have given rise to a demand that information as to the availability of local material be obtained. It is generally accepted that local materials could be used to a much greater extent than they are, but the individual localities, as a rule, are not in a position to undertake this type of study. It is urged that this be done by the Federal Government since it could take advantage of experience and practice throughout the country. Such a study would include proportions of concrete, types of aggregates, the use of blast furnace slag, and the properties of the various kinds of local stone.

In addition, there is an insistent demand for research in matters concerning drainage, impact, and subgrades. Studies already have been instituted by the Bureau of Public Roads to determine which types of soils have high bearing value and how soils of low bearing value can be improved.

Incidentally the users of the highways are beginning to take account of haulage costs. They are beginning to ask how much certain grades add to gasoline consumption. They want to know the effect of the various types of surface on tire wear. There are no comprehensive data on such subjects and it is being asked that the Bureau of Public Roads, which is in a position to make the most effective study of such questions, be given the money necessary to conduct them.

Harrisburg Engineers May Combine With Laymen's Club

After meetings between a joint committee of the Engineers' Society of Pennsylvania, the Harrisburg Club, and the University Club of that city, a resolution was passed voting that the question be submitted to the membership for combining the quarters of these three organizations. It has been felt that additional room and facilities were needed by each, but that it would not be feasible for the individual organizations to undertake expansion separately.

A. S. M. E. to Hold Keynote Session on Transportation

The tentative program which has been prepared for the annual meeting of the American Society of Mechanical Engineers at the Engineering Societies Building, New York City, Dec. 7-10, 1920, includes a "Keynote Session on Transportation," at which various phases of the transportation problem, including railroads, waterways, feeders, motor trucks, and the terminal problems in New York City will be discussed by authorities in these fields.

The sessions of professional sections will include fuels, machine shop, management, railroad, textile, power, woodworking, research, design, and miscellaneous subjects. At the fuels session L. P. Breckenridge will speak on the "Fuel Supply of the World," and the management session will be devoted to the life and work of the late Henry L Gantt. The following speakers and subjects are scheduled for the railroad session: "Static Adjustment of Trucks on Curves," by R. Eksergian; "Increasing Capacity of Old Locomotives," by C. B. Smith, and "Modernizing Locomotive Terminals," by George W. Rink. The power session will be devoted to consideration of the future development of power. At the research session D. E. Foster is scheduled to speak on "The Flow of Fluids Through Pipe Lines, and the Effect of Pipe Line Fittings." N. W. Akimoff will speak on "Foundations for Machinery" at the design session.

Engineer Registration Board Named in Virginia

Members of the state board for the examination and certification of architects, professional engineers and land surveyors, approved on March 19, 1920, have been named by the Governor of Virginia, as follows: P. B. Winfree, engineer, Lynchburg; James F. MacTier, engineer, Roanoke; John Kevan Peebles, architect, Norfolk; Fiske Kimball, architect, University of Virginia; W. C. Noland, architect, Richmond; Thomas M. Fendall, surveyor, Leesburg; L. B. Dutrow, surveyor, Peyersburg; W. D. Tyler, engineer, Dante; C. G. Massie, Amherst.

Reserve Board Finds No Signs of Housing Shortage Relief

In reviewing the general business conditions during September, the Federal Reserve Board has the following to say in regard to construction activities:

The housing shortage continues to be acute in the principal cities. In New York the bulk of the new building is on contracts executed last spring or late in the winter. However, building at prevailing prices has reached or passed its peak. There has been continued wrecking of houses to be supplanted by business buildings. For August, 1,010 contracts were awarded in New York and northern New Jersey, the valuation of which was $38,000,000, as against $36,000,000 in July. In Chicago easing is noted in the building trades. Building enterprises all through the Chicago district are still practically at a standstill. Net costs of building are now 15 to 20 per cent lower than they were a month ago. On the Pacific Coast there was a falling off in building permits from $15,582,000 in July to $13,526,000 for August, but the number of permits issued was larger. The failure to build more freely is still assigned to the high costs of building which are estimated at from two to four times pre-war costs.

Austrian Engineers To Receive American Food Drafts

Engineers and architects of Austria are to participate in the distribution of food drafts, for the payment of which a special fund has been created by the Commonwealth Fund of New York, a private American institution established for the promotion of intellectual development throughout the world. The Commonwealth Fund has provided for food distribution among Austrian intellectuals upon a considerable scale, and engineers and architects who have completed high school training may, if their cases are worthy, secure food drafts, which are drawn in $10 amounts.

Various technical societies in Austria have assumed the responsibility of collecting applications for drafts. The *Journal* of the Austrian Society of Engineers and Architects, in its issue of Aug. 6, carried a half-page notice of the Commonwealth Fund offer pasted upon the front cover. To participate in the food distribution applicants must prove their circumstances extenuating from considerations of sickness, accident, indebtedness, etc.

Construction Service Projects

Projects about to be undertaken by the Construction Service of the Army are as follows: Transmission lines at Muscle Shoals; quartermaster storehouse at Fort Ruger, Hawaii; passenger waiting room, army supply base, Boston; seventy-five foot brick smokestack for hydrogen plant, Langley Field, Virginia.

Aërial Maps on Exhibition

An exhibit of aerial maps was made this month at the offices of the Corps of Engineers in Washington, D. C. The maps were so displayed as to make possible ready comparisons between regular topographic maps and the revised map made from the flyer's mosaic. Several of the Government's map-making agencies contributed to the exhibit. The exhibit was prepared for the meeting on Sept. 14 of the Board of Surveys and Maps. The maps were prepared for presentation by a committee headed by Major E. H. Marks, Corps of Engineers.

A. A. E. Chapters Planning for Club Houses

An option on a $[illegible] four-story brick residence in Baltimore has been taken by a collateral corporation to the local chapter of the American Association of Engineers. The first floor would be rented for offices, the second occupied by the chapter and the other two floors would be rented as bachelor quarters to members.

The St. Louis chapter has similar plans but in addition would utilize much of the space for a graduate school for older engineers and elementary courses for younger members.

Activities of the A. A. E.

The Ann Arbor Chapter, at its opening fall meeting, Oct. 7, was addressed by Gardner S. Williams, consulting engineer, on "The Power Possibilities of the Great Lakes-St. Lawrence Waterway." James S. Bowman of the Fargo Engineering Co., Jackson, Mich., spoke on the need for greater restriction in the development of power in our National Parks. The officers of this chapter for the remainder of the year are: President, G. H. Cissel; vice-president, L. E. Ayers; secretary, Robert Norris; treasurer, George Sandenberg.

The Dunsmuir (Cal.) Chapter has recently been organized with the following officers: President, L. H. Taylor; first vice-president, G. M. Taylor; second vice-president, V. E. Parker; secretary-treasurer, J. G. Standley.

The San Francisco Chapter has organized an employment bureau with headquarters in the Pacific Building.

After a conference between representatives of the federal department of American Association of Engineers, the Navy Labor Board and Secretary Daniels, an increase of 72c. per day was granted Oct. 1 to the navy technical force not receiving the bonus of $240 per year. This is in addition to the recent salary award of the Navy Labor Board of 5 per cent which had a net effect of more than 1 per cent decrease on account of the establishment of Saturday half-holidays.

Civil Service Examination

United States

For the United States Civil Service examinations listed below apply to the United States Civil Service Commission, Washington, D. C.

Senior Civil Engineer, Grade 2, $2,100 to $2,700 a year. Applications will be received until further notice.

Highway Engineer, Bureau of Public Roads, $2,400 to $3,000 a year. Applications received until Dec. 28.

Canada

Application forms may be obtained from the Employment Service of Canada or from the Secretary of the Civil Service Commission, Ottawa.

Junior Engineer, $1,680 to $2,040 a year. File application not later than Oct. 28.

Engineering Societies

Calendar

Annual Meetings

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION, Chicago; Atlanta, Ga., Oct. 26-28.
NATIONAL DRAINAGE CONGRESS, Chicago; Atlanta, Ga., Nov. 10-12.

The Brooklyn Engineers' Club announces the following meetings: Nov. 4, "The German Long Range Gun" by Lt.-Col. H. W. Miller in an illustrated lecture; Nov. 11, "City Planning for the Borough of Queens" by Charles Powell; Nov 18, "Industrial Brooklyn, Paper No. 2" by Walter Pfaendler, engineer for E. W. Bliss Co.; Dec. 2, informal talk by E. C. Wilder, New York Edison Co.; Dec. 9, annual meeting and election of officers.

Engineering Institute of Canada. A local branch was organized at Moncton, N. B., Oct. 11. After an address by Fraser S. Keith of Montreal, secretary of the Institute, officers of the local branch were elected as follows: W. A. Duff, chairman; J. D. McBeath, vice-chairman; M. J. Murphy, secretary-treasurer. Committee: Reid McManus, R. G. Gage, J. E. Dington, F. B. Fripp, S. B. Wass and H. J. Grudge.

The Rochester Engineering Society at its meeting Oct. 8 was addressed by Dr. W. H. Souder of the Bureau of Standards on the advantages and disadvantages of the metric system of weights and measures.

The Oklahoma Highway Engineers' Association, at a meeting held at Oklahoma City, elected the following officers: Will M. Clarke, of Pawhuska, president; Pearl Little, first vice-president; Floyd Frazier McAlester, second vice-president; Frank Herrmann, secretary-treasurer.

Personal Notes

MALCOLM ELLIOT, who served as an engineer officer in the National Army and who recently has been employed as a civilian engineer on the work at the Wilson dam, has accepted a commission as major.

L. G. CARPENTER, engineer, has been employed by the San Diego, Cal., water commission to furnish plans and estimates for converting Dulzura Creek into a conduit to convey the city water supply from Dulzura to Lower Otay.

J. M. BARDE, highway engineer, has been employed by the Carthage, Mo., Special Road District to supervise the construction work on the Carthage section of the Carthage-Carterville concrete road.

STEVENS & KOON is a new firm of consulting engineers organized by J. C. Stevens and R. E. Koon with offices in the Spalding Building, Portland, Oregon.

CLARENCE K. WHITING has resigned as engineer for the Kent County, Michigan, road commission to engage in the contracting business.

J. H. SCOTT has been appointed divisional engineer for the state highway commission, The Dalles, Oregon.

NATHAN I. KASS, recently connected with Hill & Ferguson, consulting engineers, New York City, in the capacity of assistant engineer and chief draftsman, has joined the organization of Redler, Inc., printers and lithographers. It is the intention of Mr. Kass to continue serving the engineering profession by specializing in technical printing.

J. J. MCCABE has been appointed general superintendent of a dam at Decatur, Ill., to succeed Bradley Johnson, resigned.

LT.-COL. L. L. CALVERT, formerly in charge of the construction division of the Construction Service, U. S. Army, has resumed his pre-war position as chief engineer with the Tidewater Building Company, New York.

C. B. BROWN, chief engineer, Canadian National R.R., Moncton, N. B., has been appointed engineering assistant with headquarters at Toronto.

A. F. STEWART, chief engineer, Canadian National R.R., Toronto, has been appointed chief engineer of the company at Moncton, N. B.

H. T. HAZEN, engineer maintenance of way, Canadian National R.R., Toronto, has been appointed chief engineer.

FRANK BIDWELL, assistant engineer, Public Service Railway Co., Orange, N. J., has been appointed executive secretary to the state highway engineer, Thomas J. Wasser.

D. GORDON CALVERT, recently with the Procter & Gamble Co. of Cincinnati, Ohio, on their plant extensions, including a $3,000,000 plant at Dallas, Tex., has been appointed resident engineer in charge of the construction and equipment of the plant of the Fort William Paper Co. at Fort William, Ont., Canada.

J. R. ALLEN of Pittsburgh, Pa., formerly dean of the engineering school, University of Minnesota, and director of the research laboratories, American Society of Heating and Ventilating Engineers, has been appointed consulting engineer on ventilation to the chief engineer of the New York and New Jersey commissions in charge of the construction of the Hudson River vehicular tunnels.

WILLIAM SNAITH has resigned as assistant engineer in the office of Barber, Wynne-Roberts & Seymour to accept the position of chief draftsman for the Riordan Pulp & Paper Co., Ltd., at Mattawa, Canada.

J. M. BEGG, formerly assistant city engineer, Edmonton, has been appointed city engineer of Brandon, Man., Canada.

A. M. GREEN has been appointed engineer of Modoc County, Cal.

H. PRESS SMITH has been elected engineer of Sonoma County Cal., to succeed Lloyd Aldrich, resigned.

L. E. LYON, a civilian member of the Army engineer staff in the Norfolk district, has been commissioned a major.

W. H. LANAGAN has accepted a commission as major of engineers and has been assigned to the Fifth Regiment at Camp Humphreys.

Obituary

HON. W. F. AYLMER, for many years Dominion Engineer in the Kootenay and Revelstoke districts, Canada, died Sept. 22 at Chase, B. C.

ARTHUR C. WHEATLEY, well known in Mexico, where he has been engaged in railroad location and construction at Santa Barbara for the American Smelting & Refining Co., died Sept. 24 at El Paso, Tex. Mr. Wheatley was formerly engaged in railroad surveys for the Mexican Pacific Ry., the Central American Ry., and for railways in Africa.

ERNEST G. HENDERSON, civil engineer, Windsor, Ont., Canada, died on Oct. 13. For a number of years he was engaged in construction work for the Canadian Pacific Railway. Later he became manager and, more recently, president of the Canadian Salt Works, Windsor. Mr. Henderson served a term as president of the Canadian Manufacturers' Association.

MAJOR WILLIAM A. CATTELL, during the war in charge at Washington, D. C., of the historical data section, Office of the Chief Engineers, U. S. Army, died on Oct. 10 of heart failure and complications. Since leaving his work with the War Department Major Cattell has lived at Alhambra, Cal., and although he was not in good health the sudden end was unexpected. Previous to the war, Major Cattell was in consulting engineering practice for many years in San Francisco. During that time he was identified with many important projects and attained a prominent place in engineering circles. He was at one time president of the San Francisco Section, American Society of Civil Engineers. He became widely known in 1915 through his effective service as secretary-treasurer of the International Engineering Congress.

A Consolidation of Engineering News and Engineering Record McGraw-Hill Company, Inc.—James H. McGraw, President

Engineering News-Record

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Another Concrete Standpipe

HIGH concrete standpipes have not lately been so popular as their earlier construction promised. Repeated instances of leakage, notably in the case of the large Attleboro standpipe, discouraged engineers from attempting to make water-tight concrete in such large quantities to resist heads of 30 to 40 lb. per square inch, though much higher heads have been successfully cared for in the thinner but smaller units of reinforced-concrete pipe. The new Kansas City standpipe, described on another page, is therefore a notable instance of confidence in ability to produce a dense and water-tight concrete. The builders have made one innovation that will help to insure a tight structure—the adoption of the sliding form, which obviates the day's-work planes, always danger lines in concrete standpipes. But they have failed to take another precaution which some designers consider necessary—to design the steel for so low a tensile stress as to avoid cracking in the concrete when the steel is stretched under the working loads. It will be interesting to watch the Kansas City structure to see if it continues to be as tight as it now is under its 110-ft. head.

Public Health Education in Europe

IN MOST of the countries of Europe, facilities for training public health officials are very inadequate, according to remarks made by Prof. George C. Whipple in an address before the New York Section of the American Water-Works Association, last week. (See news section.) Until a dozen years or so ago the United States was equally lacking in such facilities, but the deficiency was in part made good by the instruction in sanitation given at some of the engineering colleges. Now we have a goodly number of schools devoted specifically to educating public health officers. The survey of public health education in Europe that Prof. Whipple is making for the League of Red Cross Societies promises to be of great value. It is significant that this survey is being made by an engineer. Prof. Whipple can be relied upon to point out that happy blending of education in medicine, engineering, chemistry, bacteriology, vital statistics and sociology which is essential for the capable public health officer, a course far different than it is possible for a medical school alone to offer.

The Public Works Bill

ENTHUSIASTIC support of the bill for a National Department of Public Works is needed now. If engineers are to be in evidence when this meritorious measure passes from the promotion and propaganda stage into real substance and becomes law they must maintain their moral support consistently. They are not doing it now according to the report of M. O. Leighton to Engineering Council as noted on p. 834. Legislative movements come to a head and to critical periods long before their appearance on the floor of Congress. Committees of the coming Congress will shape the bill although there is almost no chance of action until the succeeding Congress, which without doubt will pass the measure, since both major political parties have strongly indorsed the movement. Adherents of the measure, as originally defined, providing for civilian control, will find their opponents have put the whole department virtually under military control unless vigorous action is taken now to utilize the present recess period in the education of congressmen or prospective congressmen who are now at home finding out the wishes of their constituency.

Street Railways and Pavements

STRONG arguments for placing on street railway companies the cost of pavement construction and maintenance between and for 2 ft. outside their track were summarized on p. 795 last week. The forcefulness of these arguments, combined with statistics of practice throughout the United States submitted with them to a committee of the New York Senate, when joined to the opposition of the mayors of 59 cities, was sufficient to smother a bill before the committee designed to free the street railways of New York State from a considerable part of their pavement obligations. There are few, if any, municipal engineers who will not agree with the reasoning summarized in the article mentioned and heartily endorse the conclusion that since the street railways increase the cost of pavement construction and maintenance their owners, and not the abutting property owners or general taxpayer, should foot the bill. The most plausible argument to the contrary that can be advanced is that the obligation of the city to provide free streets for public travel should extend to the added burden of pavement cost and maintenance caused by the street railways. But if the extra burden on the pavements should be borne by the city, why not the cost of ties and rails? This brings to mind the fact that Liverpool, England, in connection with its municipally-owned street railways, has found it cheaper to take land and buildings for separate rights of way for street railway lines than to stand the extra cost of pavements to withstand the street railways. (See *Engineering News-Record*, Aug. 19, p. 367.) Perhaps the street railways cannot be blamed for trying to utilize the present era of high prices to get rid of the pavement charges, but as we pointed out in the editorial on "The Plight of the Street Railways," on Sept. 2, the franchises and contracts the street railways are now trying to get amended were the results of bargaining, with concessions on each side. In this bargaining the railways agreed to nickel fares and assumed certain pavement charges. If fares are to be raised, or pavement or other obligations cancelled or lightened, then the

entire contracts should be thrown open to rebargaining, or else the changes in favor of the companies should be strictly limited to a few years.

A Railroad Rate Dilemma

THROUGH the order of the Canadian Government referring the recent railroad rate increase back to the Board of Commissioners for reconsideration, the dilemma in the Canadian railroad situation is more apparent than ever. A great Government railroad system, so far a losing venture, is in competition with a great privately owned and operated system earning substantial dividends. It is stated that the rate increase, in considering the needs of the railroads as a whole, will result in unreasonably high earnings by the Canadian Pacific and such a storm of protest has been raised on this ground that the Government has recommended that the Board of Commissioners reconsider the case otherwise than on a basis of the National Railways' needs. In the United States the fear of too large earnings accruing to prosperous roads has been largely overcome by the "take-off" of one-half of all net earnings above 6 per cent of property "value." But in Canada such provision would be so obviously aimed at the great railroad competitor of the Government that it might not be sustained by the courts. There has been the proposal, open to the same objection, that the Government tax the Canadian Pacific for the "excess" of dividends. Surely the present Canadian dilemma holds a lesson for the so-called "prosperous" systems in this country that might benefit only temporarily by a supreme court decision affirming the alleged unconstitutionality of the limitation of earnings by a "take-off." Would it not be better for these companies to let well enough alone, rather than run the risk of throwing the whole question back upon Congress and the Interstate Commerce Commission?

Engineer as a Port Planner

IN HIS effort to glorify the "practical" shipping man, to which class he himself belongs, Director Sproule, of Philadelphia's Department of Wharves, in his recent address before the American Port Authorities, grouped together the politican and the engineer as joint ineffectives in port layout, and relegated the engineer to a position as day laborer to the practical man. The director's opinions are perhaps too biased by his personal position to make a reply worth while, had they not had currency as the expression of an expert. Among other things he said: "In the fact that the development of her ports and her harbors has been intrusted to impractical and technical men lies the reason this country today is secondary in importance to Great Britain and other European nations as a maritime power. The conditions arising from the European war serve to further emphasize that the extension of ports with such problems that present themselves must be intrusted to the experience of shipping and transportation experts, rather than to the judgment of those whose motives are sometimes prompted by selfishness, frequently by favoritism, and often by inexperience. Great harbors are developed only through the energy and knowledge of experienced men. The usefulness of the engineers lies largely in their carrying out scientifically the fundamental ideas of the practical man." Here, obviously, is confusion of both thought and expression. Note particularly the conjoining in the first sentence of "impractical" and "technical," the time-worn and discredited attack of the "practical" and "non-technical" man. Note, too, the misstatement in this first sentence. Quite contrary to Mr. Sproule's idea, in the ports of Europe the engineer is the directing mind, while in this country those of our ports which are most backward are those in which the sinister influence of the shipping companies is retarding proper and economic development. Those which are moving freight fastest and cheapest are headed by engineers who are expert both as planners and builders, as any true engineer must be. It is far from our intention to defend the political control of our ports, to which Mr. Sproule also is in opposition, but to drag in the engineer as a theoretical and detail-making associate of a political control is both inaccurate and unfair. The larger issue of the practicality of the engineer is not worth discussing here. Certainly, in port design and control his superiority has been sufficiently demonstrated to need no defense.

Freight Distribution at New York

AS THE GREATEST shipping center in the United States the Metropolitan District of New York, including adjacent territory in New Jersey and Connecticut, has before it a problem of freight and food distribution that is of more than local importance. Here is the largest concentration of population and of railroad and water transportation, both a point of local distribution and of transfer on a stupendous scale. Discussion of the subject last week at the first monthly meeting of the New York Section of the American Society of Civil Engineers emphasized the long-conceded opinion that present methods are antiquated, unscientific and wasteful. In the words of Shirley Eaton, of the Federal Trade Commission, "It is up to engineers to bring forth a solution." Therefore it is all the more significant that the discussion by engineering authorities brought out general agreement regarding fundamentals both in needs and new methods.

Any attempt to separate the problem of the Port of New York from that of local distribution and transfer would be difficult indeed, but there was evident agreement by the engineers on the following points: Division and distribution rather than concentration and congestion; a belt railroad system; prodigious expansion of storage; maximum movement toward point of ultimate delivery and use of small workable units; a single organization, civic or private, to direct and conduct distribution, both in and outbound, and, finally, store-door delivery. With such striking agreement there is reason to hope for action, either as a result of the coming report of the New York and New Jersey Port and Harbor Development Commission, or through concerted initiative of private shipper and carrier agencies, backed by civic authority or encouragement.

Division and distribution, rather than concentration and congestion, bear a direct relation to the belt-line project, through diversion of cars from crowded tidewater to great joint classification and receiving yards in the New Jersey meadows, and also to the expansion of storage facilities, through providing scattered points of storage and shipment-consolidation. Where present overcrowding will not admit standard-gage track connections, smaller units for transfer must be used. Here may be the opportunity for intensive operation of the motor truck in providing flexibility and maximum

movement toward point of delivery, directed by a central, co-ordinating agency. Through maximum loading and the elimination, so far as possible, of empty movement, there is reason to believe that street congestion of commercial vehicles could, by such operation, be greatly lessened rather than increased. In the city of Cincinnati fifteen motor-truck chassis, in an intensively developed service, have replaced 115 horse drays and are now reported handling 120 per cent more tonnage.

Naturally railroads are wary of store-door delivery for fear of adding to already tremendous terminal costs without additional compensation. But last week there was general agreement that no plan could ultimately succeed that would not include this provision. No attempt should be made to require the carrier to assume the additional cost—now some $2 per ton for cartage—without compensation, nor should the railroads be expected to provide greatly improved terminal facilities at huge capital costs without assurance of sufficient return on investment. Present facilities are adequate for *them* to handle present tonnage volumes, as indicated by the fact that the freight finally gets through. Civic initiative, guided by the judgment of engineers, is needed in such a development for the public good.

From the remarks of Mr. Eaton, who has made an extensive study of the subject for the Federal Trade Commission, the conclusion is easily drawn that the present situation is extremely bad. What is needed, however, is a plan based on evolution rather than revolution, above all to provide for maximum flexibility. As population and shipping have increased, the problem has become more serious, until now there is immediate necessity for action.

Steam Railroad Electrification

DISCUSSION last week at the joint meeting in New York of sections of the national societies of mechanical and electrical engineers brought out several striking aspects of the present status of steam railroad electrification. The three principal papers, extracts from which appear elsewhere in this issue, and the discussion that followed, point above all to the need for and present lack of agreement in fundamental assumptions and bases of comparison between steam and electrical operation. While the advocates of electrification made a strong case out of the probable failure of the steam locomotive to keep pace with growing demands for sustained high tractive effort at greater speeds on dense traffic zones, few engineers will be ready to relegate the steam locomotive to the scrap heap.

It is generally conceded that the large capital outlay, and the problem of disposing of steam equipment, with all its accessories, are the strongest barriers against electrification in the present state of the art. To offset these are operating economies and increases in traffic capacity from electric operation. As one authority has stated the case, "It seems to be a race between the cost of fuel and the cost of electric equipment"—which is particularly pertinent where an economical water power is available.

Possibilities for further development of steam-locomotive capacity and efficiency cannot be overlooked since their influence is to defer the time when it may be necessary to scrap existing steam accessories—including most of the elements of present engine terminals. It has been said that the Mallet locomotive has postponed electrification for fifteen years. Other radical departures in steam-locomotive practice, looking to considerably increased range and efficiency, without exceeding limitations of clearance and wheel loading, have been proposed, and were commented upon editorially in *Engineering News-Record* of Dec. 11-18, 1919, p. 975.

New emphasis has been laid on the lack of available comprehensive cost data in present comparisons of actual operation, taking into account the almost innumerable factors that must enter. While it may require years of further practice to establish such complete data, there is reason to believe that much information based on actual experience to date does exist, but has not been made generally available. If this is the case it is to be greatly regretted. The ultimate test must be whether the balance sheet, over a sufficient period of time, shows red or black at the foot of the column, regardless of operating luxuries, but taking into account all capital costs. The investor must be satisfied. For example, double tracking must frequently be resorted to, even though electrification would accomplish the same object as a temporary expedient. Studies that have been made for electrifying certain western mountain grades did not enter to any extent into the meeting, last week, but throughout the discussion there was recalled the principal points of those studies upon which agreement has been most difficult and upon almost any one of which the decision might hinge. Broadly, these include the questions: What is the highest practicable load factor that can be attained? What will be the cost of maintenance of all electrical equipment and of track as compared to steam operation? On what basis will existing steam equipment be disposed of and written off? Shall electric power be purchased or produced by the railroad and what will be the cost of current per kilowatt-hour? What are the practicable limits of multiple-unit electric-locomotive operation for the purpose of hauling heavier trains at higher speeds without increased crews? How many electric locomotives will be required to replace a given tonnage of steam locomotives?

In each one of these questions—and there are many others of great importance—there has been much disagreement. In a study for electrifying a mountain grade of a western line, one estimate showed a net return on net investment of only one-seventh of that indicated by another estimate for the same area, and not enough by half to justify electrification. The discrepancy was largely accounted for by wide disagreement in answers to the questions enumerated. With the present lack of available cost data from actual operation, conjecture, even though judicious, is necessarily an all too potent factor.

We heartily endorse the statement of Mr. Muhlfeld last week that further electrification studies should be made without prejudice and by joint committees composed of civil, mechanical and electrical engineers, and also representatives of the transportation and accounting departments.

The greatest credit should be accorded those who have developed heavy electric traction to its already remarkable state. Steam railroad electrification can be expected to make important gains in the next decade, but first of all in such special cases as tunnels, busy city terminals, suburban traffic, mountain grades and dense traffic zones. For some time to come the steam locomotive will hold its own for general service.

Photo, Brown Bros.

A Study of Rapid Transit Station Design—Part I

System Capacity Is Governed by Station Headway Rather Than Operating Headway—Possibilities for Great Time Saving in Platform Arrangement

By Olof A. Nilsson
Designer, Transit Construction Commission, New York City

A MODERN steam railway station is ordinarily planned to meet the comfort and convenience of the traveling public. Except as it is affected by the track layout, however, the design of the ordinary station is not influenced by the problem of operating the railroad efficiently and to its full capacity. On the other hand, the rapid transit station in a metropolis offers an entirely different problem. The design of such a station is intimately connected with the operation of the system at its full capacity, and ways and means of securing uninterrupted passenger flow are of paramount importance.

Two factors determine the passenger capacity of a railroad; the capacity of each train and the minimum headway on which it is possible to operate trains. The former, of course, depends on the capacity of each car and the number of cars in the train. The minimum operating headway is determined by one of two independent factors; the safe minimum distance between trains running at a certain speed between stations—"the running headway"; and the time required by the train to pass through a station block—"the station headway." The station headway, again, is primarily determined by the length of the train stop at the station. As ordinarily constructed, the stations are the points of slow train movement, and, in general, the station headway governs, and *the minimum operating headway is fixed by the maximum station headway on the line.*

In view of the growth of traffic on rapid transit railroads and of urban transportation in general, a growth that has been found to be much more rapid than that of the population, it is proper to assume that in time the service on at least some part of any rapid transit system will, during certain periods of the day, require the shortest possible operating headway. Every second, then, that can be cut from the length of the trainstop at the slowest station, by reducing the time required for passengers to pass between platform and train is of value, and the fundamental problem in station planning is to reduce platform congestion to a minimum and to secure a rapid and uninterrupted passenger flow between street and train. This is of particular importance with reference to main stations, at which, on account of their location, dense traffic and other conditions causing congestion and confusion may be expected. At such points an expenditure which, when considered as the cost of one station on the line only, would seem to be unreasonably high, may be entirely justified if it increases the capacity of the line.

In planning a station the starting point should be the ultimate carrying capacity of the line and the ultimate traffic yield of the district tributary to the station. From these factors and from the general scheme of operation the size and capacity of the cars and the number of cars to the train, the train length and train capacity are determined. The train length is the basis for the platform length, while the width of the platforms, the width and capacity of stairways and passages, etc., are fixed with reference to the anticipated maximum traffic flow through the station. This is seldom a simple problem. In American cities past growth is not always a safe guide in making predictions and the establishment of a rapid transit station in a district may itself give the impetus to a development, which in turn will demand additional transit facilities.

The chart on page 829 indicates how traffic has grown in New York City by showing the ticket sales at some of the important stations on the Interborough subways during the months of December for the last thirteen years. Except the Pennsylvania these stations are all on the original New York subway and its extensions to the Long Island Railroad station at Atlantic Avenue, in Brooklyn. The decrease at some of the stations in 1918 is due to the opening of the 7th and Lexington Avenue lines in July of that year, by which Manhattan was given two north and south lines instead of one. Aside from the effect of the opening of new rapid transit lines, all the stations show a continuous growth of traffic from year to year.

The heaviest station traffic in New York City today goes through the Grand Central station. The table

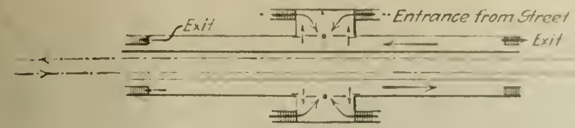


FIG. 1

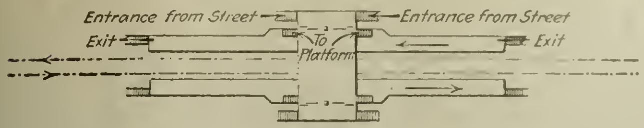


FIG. 2

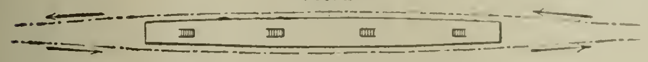


FIG. 3

FIG. 1. SIDE PLATFORM STATION
FIG. 2. SIDE PLATFORM STATION WITH MEZZANINE
FIG. 3. ISLAND PLATFORM STATION

shows more than $2\frac{1}{2}$ million tickets sold there during the month of December, 1919, or an average on week days of between 90,000 and 95,000 per day. Twice this number will represent very closely the number of people entering and leaving the station, as it is well balanced as to traffic. In addition there is a heavy transfer movement to and from the shuttle and the Queensboro stations, as well as transfer across the platform between local and express trains. Observations on the traffic at this point lead to the conclusion that on week days about 350,000 people enter and leave the two platforms of this station, that 40 per cent of this traffic falls within the rush periods of from 2 to $2\frac{1}{2}$ hours morning and evening and that in the morning the southbound and in the evening the northbound platforms have from $\frac{2}{3}$ to $\frac{3}{4}$ of the total rush-period movement. This gives for each platform a period of from 2 to $2\frac{1}{2}$ hours during which about 50,000 people enter and leave it by the stairways, in addition to the people who, without leaving the platform, use it for transferring between local and express trains running in the same direction. The total width of the stairways from each platform is 56 ft. to the mezzanine floor above and $12\frac{1}{2}$ ft to the Queensboro subway below. The platforms are about 485 ft. long, have a maximum width of 24 ft. and a net area slightly over 10,000 sq.ft.

The simplest type of station on a double-track rapid transit railroad is the side-platform station. It consists (Fig. 1) of a train-platform of the required length, which is accessible from the street through an intermediate waiting-room or lobby, where the passenger buys his ticket or pays his fare. The lobby is separated from the platform or the stairway leading to it by a railing or partition, with separate openings for entrance and exit. In reality we have in this type at each stopping place of the trains two separate and distinct stations, one for traffic in each direction.

Where the elevation of the railroad with reference to the street surface permits, the two stations may be combined into one by means of a mezzanine floor either above or below the platform level (Fig. 2). This results in a saving of operating expense, since one ticket agent may, when traffic is light, serve passengers in both directions. It also enables a passenger who may have been carried past his station to return without going to the street and paying an additional fare. These advantages obtain also in the island platform station (Fig. 3). Here the tracks have been spread sufficiently to introduce between them a platform common to both.

On four-track rapid transit railroads, stations that are stopping places for trains on all four tracks must necessarily have island platforms. A usual arrangement is that shown in Fig. 4. The two outer tracks are for local trains and the inner ones for express trains. Transfers between local and express trains in the same direction are easily made by simply stepping across the platform, and the occasional traveler who wishes to turn back, can do so by the use of the mazzanine floor, which communicates with both platforms.

Classified, then on the basis of platform type, all stations are of either the side-platform type, the island-platform type, or a combination of both. With reference to location relative to the line, stations may be classified as:

(a) *Terminal stations*, which may be either the loop-end type (Hudson and Manhattan downtown terminal in New York) or the dead-end type (Brooklyn Bridge terminal New York).

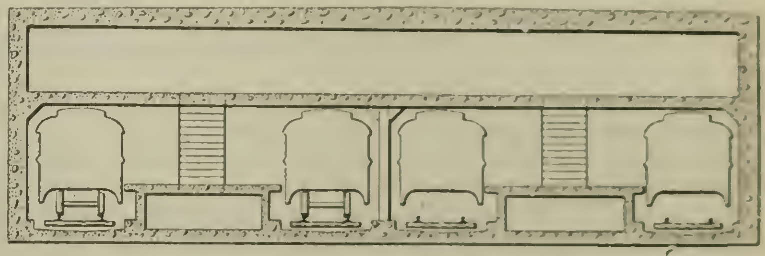


FIG. 4

FIG. 4. CROSS-SECTION OF FOUR-TRACK EXPRESS STATION

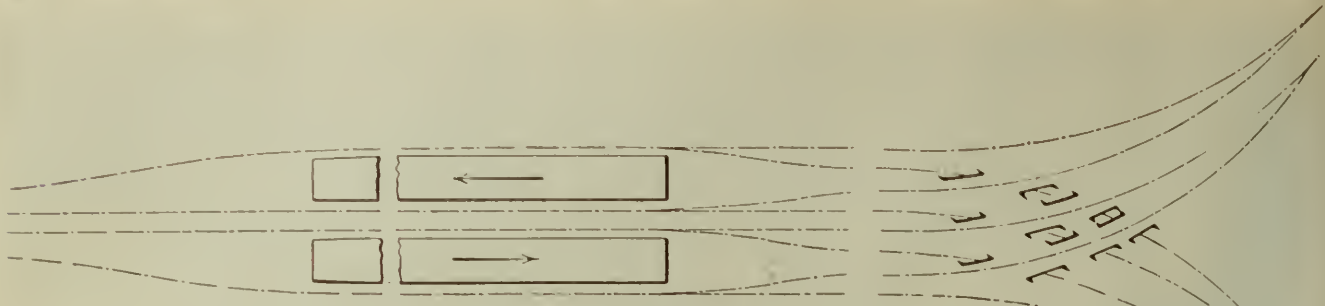
(b) *Intermediate stations.*

(c) *Stations at junction points*, where two or more lines meet, or where one main line divides into branches.

(d) *Stations at crossing points*, where two or more lines cross, either with or without track connections.

Fig. 5 indicates an arrangement at a point where a four-track line divides into two two-track branches Fig. 6 shows how at a crossing of two lines a station may be built common to both.

The simplest conditions for station planning obtain at the intermediate station in the suburban district with largely one-way passenger movement, that is, city-bound in the morning and returning in the evening. A good arrangement is indicated diagrammatically in Fig. 7, and is self-explanatory. The passengers pass in at the entrance in the center and distribute themselves along the length of the platform during the time interval between two trains. When the train pulls in and comes to a stop and alighting passengers have stepped out, they board the train and the platform is cleared. The homeward traffic differs from the outward in this respect: whereas the outward-bound crowd gradually fills the platform during the train interval, the homeward-bound passes out on the platform during the train-stop of a few seconds and continues immediately to the street. It is, therefore, good practice to give the exits greater capacity than the entrances. This is also important for another reason. In case of an accident or a panic it is very desirable and may mean the avoidance of a great disaster to be able quickly to get the crowd to the street. From both of these view-



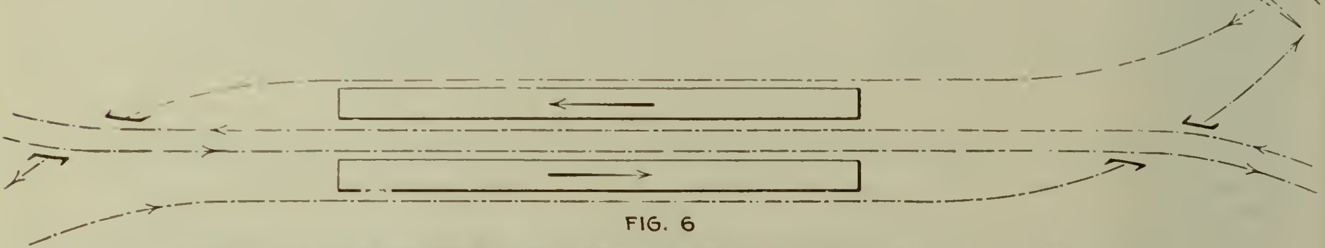


FIG. 5. STATION WHERE FOUR-TRACK LINE DIVIDES INTO TWO-TRACK BRANCHES
FIG. 6. STATION AT CROSSING OF TWO LINES

points, therefore, a station of considerable length with entrances and exits at the center, may also with advantage have an additional exit at each end. If, as sometimes happens, the entrance and the ticket lobby are at one end of the platform, even an unimportant station should have at least an emergency exit at the other end.

In planning entrance and exit stairways it also makes a difference whether the station is elevated or underground. In the former case people entering the station walk up and those departing walk down; in the latter case the situation is reversed. People going down a stairway move faster than when going up, but under crowded conditions the density is greater in the upward than in the downward movement. The net result is that in crowds more people go up a stairway than down in a given period. A convenient and safe rule in figuring the capacity of a stairway is to allow for each lineal foot in width 1,000 people per hour for downward and 1,100 for upward movement. The capacities of unobstructed ramps and passages may be assumed as 2,000 per lin.ft. in width per hour. For an average walking speed of 5 ft. per second this allows 9 sq.ft. of floor space to each person.

These figures apply to stairways and passages where the movement is all in the same direction. Where people move simultaneously in opposite directions under crowded conditions the capacity is less and the width, particularly of narrow stairways and passages, should be increased accordingly. No stairway planned for simultaneous movement in both directions should be less than 5 ft. wide. Sharp turns also seriously retard the movement and should be avoided wherever possible. The maximum grade for a ramp should be 11 per cent; 8 to 10 per cent is better. For stairways the pitch adopted in the New York subways—7 in. rise and 11 in. tread—is good; when conditions permit, it is desirable to reduce the height of the riser and correspondingly increase the width of the tread according to the rule that two times the height + the width (both in inches) should equal twenty-five.

The advantage of additional exits becomes still more pronounced at a station, which by its location has more or less two-way passenger movement, that is, where during the same period passengers arrive and depart in perhaps approximately equal numbers. It is evident that the stream of passengers going toward the exit at the center, if large, will conflict with passengers coming from the entrance and walking toward the end of the platform. With exits at the platform ends this condition is greatly ameliorated; perhaps half of the outgoing passengers will use the end-exits and thus move away from, and not interfere with, incoming passengers.

There is an important difference between a station that has a one-way passenger movement and one where this movement is in both directions. In the former, nearly all the passengers travel in the same direction; during certain hours of the day they depart from the station, during other hours they arrive. At such a station, if it is properly arranged, a large traffic volume may pass through without confusion or delay. As long as the number of passengers accumulated on the platform during the interval between two trains does not exceed the available capacity of the incoming train, the people, on the opening of the doors, will quickly enter the train, and on their closing the platform will be cleared and ready for the reception of another trainload.

It is easy to see that with a simultaneous passenger-movement between train and platform in both directions, a certain number of passengers leaving and another entering the train, the conditions are less favorable to an unobstructed passenger-flow than with a one-way movement. During light traffic it does not necessarily mean confusion or a lengthened trainstop, as the passengers may enter and leave trains and pass away from the platform without obstructing each other's movements. But with dense traffic serious confusion is likely to take place, resulting in inconvenience to passengers and a lengthened trainstop with decreased capacity of the line. In the design of such a station it is therefore necessary to try to avoid interfering and conflicting passenger-movements.

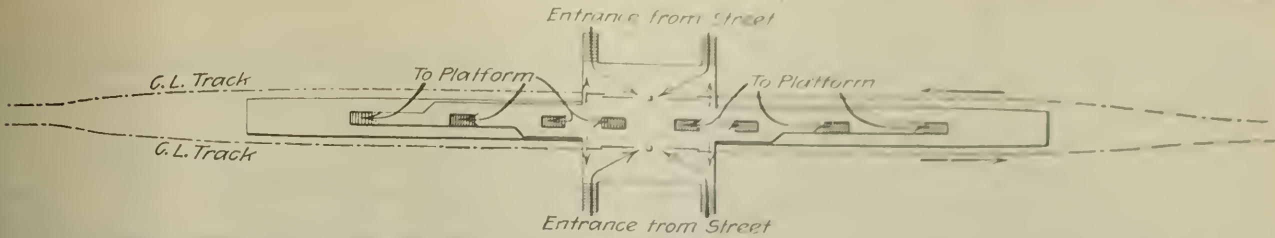


FIG. 7

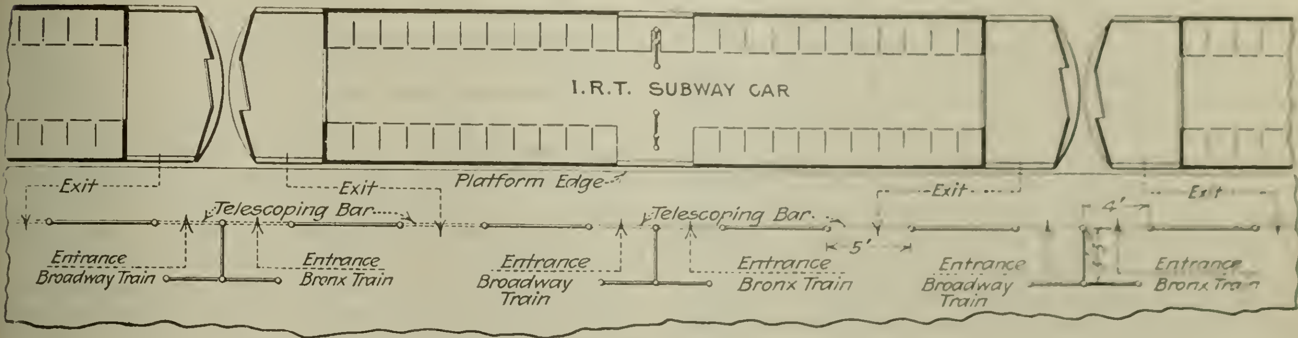


FIG. 8

FIG. 7. ISLAND PLATFORM STATION WITH MEZZANINE TO AVOID PLATFORM CONGESTION
FIG. 8. TELESCOPING BAR RAILING TO SEGREGATE PASSENGERS FOR DIFFERENT DESTINATIONS

Separate loading and unloading platforms may be used. When operating on this system the train enters the station between two platforms, the doors toward the unloading platform are first opened, and immediately after or as soon as room is made by the outgoing passengers, the passengers waiting on the loading platform are admitted. At stations with a large transfer-volume between different trains the adoption of separate loading and unloading platforms would require this transfer to be made through a mezzanine floor, subjecting transferring passengers to the inconvenience of ascending and descending a stairway.

Congestion may be reduced by ample platform width in conjunction with means for rapidly clearing the platform of alighting passengers. The station platform on a metropolitan rapid transit railroad frequently exceeds 500 ft. in length. On such a platform with only one or two exits, alighting passengers, before reaching an exit, must walk on the average one-half to one-fourth of its length. At a busy station with many passengers transferring across the platform between trains on each side and at the same time others moving in both directions longitudinally, people will naturally obstruct each other's movements and congestion and delay will result. The remedy is numerous exits in order to relieve the platform as quickly as possible of outgoing passengers. A design such as is indicated in Fig. 7 will accomplish this. Numerous stairways connect the platform with a mezzanine or passageway, which is nearly the full length of the former and located either below or above it. Outgoing passengers avoid obstructing the platform by using the nearest stairway and incoming passengers may also reach the end of the platform in the same way, and thus avoid the crowds that may have accumulated in its center.

In this connection the relation between the street layout and the design of the station may be mentioned. A station 500 ft. or more in length may have within its limits two or more important streets or other points yielding a large traffic volume. It may, therefore, have two or more entrances or entrance groups—each forming an important point of collection and distribution of passengers. If at all possible these points should be connected by a passageway or mezzanine located intermediately between the street surface and the platform. Such a mezzanine will enable passengers to traverse the distance between one end of the platform and the entrance farthest away from this end without having to work their way through perhaps the entire length of a crowded platform. If one of the streets having entrances to the station yields the greatest part of the traffic it should be near the center of the station. If there are two streets of about equal importance they should be equi-distant from the center; in short the center of gravity of the traffic should coincide with the center of the station.

The confusion incident to the use of the same platform for loading and unloading at stations with a two-way movement may be relieved by the segregation of waiting passengers within spaces enclosed by railings. Particularly where on the same track alternate trains have different destinations and therefore outgoing passengers may have to remain on the platform during two or more train intervals, until the right train arrives, this device should be useful. Fig. 8 shows such a railing which was used on the old Grand Central station of the New York subway. It was installed on the express side of the northbound platform in 1904 and was in continuous use until August, 1918. That is was an effective aid in reducing the trainstop is shown by the fact that during rush hours the average stop of northbound express trains, alternately bound for different destinations, was about 50 seconds, while that of the southbound express trains, which all had the same destination and therefore ran under more favorable conditions, was about 70 seconds. It requires the employment of platform attendants to direct the crowd, open and close the bar across the openings, and close the train doors.

While the value of the device was amply demonstrated, this particular arrangement doubtless can be improved upon. Instead of impeding the movements of alighting passengers by compelling them to make two right-angle turns before reaching the central part

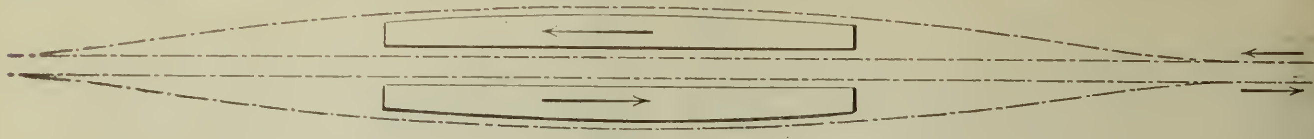


FIG. 9. DIAGRAM OF RESERVOIR STATION FOR TWO-TRACK LINE

of the platform, the enclosure railing should be designed with the end in view of making the passage of both alighting and departing passengers as short and direct as possible in order to reduce to a minimum the total time required for loading and unloading. Each particular design, will, of course depend on local conditions and on the type of car used. While a satisfactory enclosure railing may often be designed to fit a platform already built, the right time to consider the advisability of this device is when the station is being designed, in order that platform width, width and location of stairways, as well as spacing and location of columns on the platforms, may all be determined upon with reference to their relation to the spaces to be enclosed. In other words, the enclosure railings, where their immediate or future adoption seems advisable, should be a part of the design of the station, not an afterthought. There might be on a rapid transit line a station or stations located at important traffic centers, with such dense passenger movement that, with even the best planned layout along the lines outlined above, they would require a considerably longer trainstop than any of the other stations and thus become limiting points for the capacity of the line. At such stations the use of additional so-called reservoir tracks should be considered. By doubling the number of tracks at the station as indicated in Fig. 9 the trains can be run alternately on each side of the platform, so that an incoming train does not need to wait for the preceding train to leave the station. By this arrangement the capacity of the station is doubled and the effect of the trainstop eliminated.

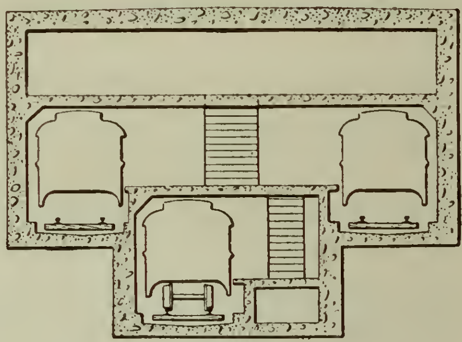


FIG. 10. CROSS-SECTION OF RESERVOIR STATION WITH RESERVOIR TRACK DEPRESSED

Where the crowds go in different directions at different times of the day the two central or reservoir tracks of Fig. 11 may be combined into one. In that case, of course, connections with both main line tracks are retained. On a narrow street the additional track may be depressed under the platform as indicated in Fig. 10. A loop terminal of either a two- or four-track road is easily laid out with reservoir tracks, with or without separate loading and unloading platforms.

For a four-track one-level road it would generally be impracticable to introduce reservoir tracks on all four or even on only two tracks on one level at an intermediate station on account of the great width required. The additional tracks would therefore have to be depressed. An arrangement that would often be economical and convenient with a minimum vertical distance between platforms is indicated in Fig. 11. The upper platform necessarily has a considerably greater width than the lower one, but this is an advantage, since it must be used not only by passengers on the upper level trains bnt also by those going to and from trains on the lower level. By making the stairways between the two platforms narrow and as numerous as possible, the lower platforms could be made quite narrow and yet have the needed capacity. Even with a very narrow platform, however, the width required for a station of the type shown in Fig. 11 should certainly not be less than 120 ft. and would probably have to exceed this figure.

If the line itself is double-decked between stations the arrangement of a reservoir station becomes simply that of the two-track line, bifurcating each track on both sides of an island platform, together with means of transfer between the two levels as indicated in Fig. 12. If separate loading and unloading platforms are desired, the main-line tracks are also spread for the accommodation of an island platform between them.

On the point of safety there is one objection to the use of reservoir tracks—it introduces a facing switch on each bifurcated tracks at the reservoir station. This, however, can be avoided by the use of gauntleted tracks, which in addition would provide guard rails for the entire length of the structure thus equipped. It would, of course, add to the expense, since the tunnel would have to be somewhat wider.

The platform width is an important consideration in all of these different methods of avoiding platform congestion. Wide platforms considerably increase the cost, while, on the other hand, a platform too narrow for the needs of the station will retard train movements and therefore decrease the capacity of the line. A platform used for unloading only may be quite narrow. Even where, as would be the case at some terminal stations, a completely filled train is unloaded, a platform with an unobstructed width equal to that of the cars, say 8 to 10 ft., would be ample, since the stream of departing passengers is constantly moving and the first passengers stepping on the platform will have reached the exits before the last ones are ready to leave the train.

On a loading platform passengers waiting for a train naturally group themselves along the platform edge. Sufficient width should be allowed for these waiting passengers to permit a certain freedom of movement and to give unobstructed passage to incoming passengers. Moreover, behind these groups there should be enough width to permit people to move about between different parts of the platform and the platform stairways. Each station is an individual problem and no definite rule for platform width can be given, except the general statement that the more the conflicting passenger streams are separated into definite channels and the quicker the platform is cleared the better will be the result.

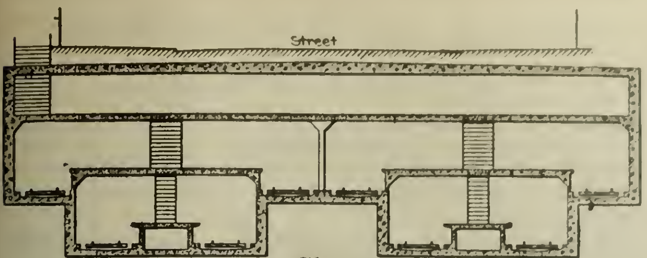


FIG. 11

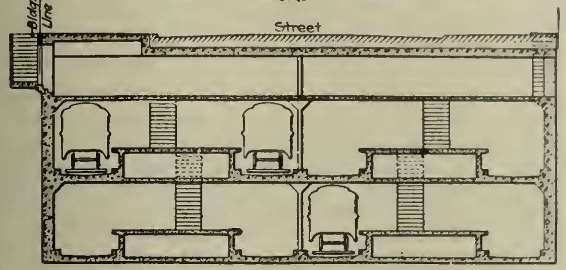


FIG. 12

FIG. 11. CROSS-SECTION OF RESERVOIR STATION FOR FOUR-TRACK LINE WITH RESERVOIR TRACKS DEPRESSED UNDER PLATFORM

FIG. 12. CROSS-SECTION OF DOUBLE DECK RESERVOIR SYSTEM

Intelligent location and planning of the stations on a rapid transit line must be based on *the ultimate capacity of the line.* In outlying districts it may be that initial operation with say a 10- or 15-minute headway (or shorter trains with briefer time intervals) will satisfy the traffic needs even during the hours of peak-loads. But unless the building of the line has been an error, particularly if the costly subway type of construction has been adopted, the traffic will grow so that in time a 2- or 3-minute headway, or less, will be required during certain periods. Either the stations therefore must be built to suit this later condition or they must be so arranged that when the need for it occurs they can be extended without costly reconstruction.

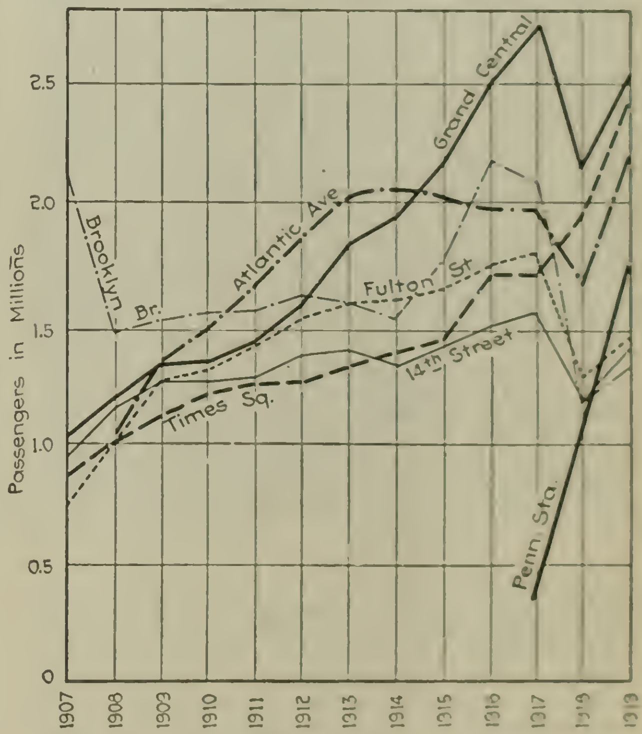
It must also be borne in mind that future extensions and increase in travel on existing lines in the outlying districts all add to the density of the passenger movements in the central district and tend to congest the stations on this portion of the line. It is of primary importance, therefore, that these stations should be capable of handling the traffic flow without impeding the train movements. At such stations it may be found that extensive changes are financially justified in order to get a station that will not limit the ultimate capacity of the line. These changes may include the widening of existing or introduction of new streets or open places as well as the acquisition of adjacent private property and the razing of costly buildings.

It may be well here to point out some factors, which, in addition to that of a well-planned station, are essential to the securing of ideal traffic conditions in general and the absence of congestion in particular. Sufficient and regular train service must be maintained. Unless the trains follow each other regularly at such intervals that all waiting passengers may board the first incoming train bound for their destination without crowding, the train will inevitably be delayed while the waiting passengers are trying to push into already overcrowded cars.

Particularly at a station so located that departing trains turn into branch lines in different directions, an irregular or improperly co-ordinated train schedule may produce almost intolerable conditions. Passengers waiting for a train to a certain point may fill up and congest the platform, while trains for other points are departing only partly filled.

Another important factor with reference both to the comfort of passengers in loading and unloading and to the time required to do this, is the type of car used. Utterly bad in this respect is the end-door car built on the lines of the steam railroad cars in use in this country. This type was adopted on the first New York subway, but it soon became necessary to remodel it, placing a side-door at the center. Compared with the first-mentioned type this side- and end-door car is a great improvement, otherwise little can be said in its favor as a car adapted to conditions that obtain on rapid transit railroads where short train stops are essential and the traffic is heavy.

The type of car in use on the New York Municipal Railway and adopted also in other cities has three side entrances and seats are arranged so that the majority of standing passengers will be grouped near the entrances. This arrangement permits comparatively rapid loading



RATE OF TICKET SALE INCREASES ON NEW YORK SUBWAYS

(Figures are for the month of December in successive years)

and unloading and gives greater ease of circulation inside the car.

Best from the point of view of speed in handling passengers and undoubtedly also from that of their comfort is the so-called Illinois Central type car placed in service on the suburban trains of the Illinois Central Railroad in 1903. Instead of an aisle in the center of the car it has narrow aisles along the sides with the seats placed transversely back to back in the center, and in addition to end doors it has a side door opposite each section of eight seats throughout the full length of the car.

(To Be Continued.)

Safety Hints for the Shipyard

Notes on Safe Practice in Hull Erection, from an Address by T. A. Walsh, of the Merchant Shipbuilding Corporation Before the National Safety Council at Milwaukee, September, 1920.

UNTIL recently it was a foregone conclusion that a real ship is never built without the sacrifice of at least one unfortunate. Since the early days of 1918, however, it has been known that avoidable accidents can be eliminated in shipbuilding as completely as in other fields of construction. By a detailed study of shipbuilding operations it becomes possible to locate the prominent causes of injury and then set about to correct them systematically.

Safe Staging Details—Planks from outside staging should number at least two at any point, and preferably three amidships, while fore and aft on the sheer there should be four, supplemented by solid staging directly aft or on the fantail. Planks should be laid so that the lap does not exceed 18 in. or is less than 12. Each tier of staging should be supplied with at least one substantial guard rail 3 ft. 6 in. above the plank; often two rails will be better. They should be bolted in place rather than nailed. A 3 x 6 timber is preferable to a 2 x 4, as men will sometimes stand or jump on them in going from one level to another.

Staging planks tend to creep from vibration set up in the construction work, and this may be overcome by the use of countersunk bolts in the ends, or by nailing cleats to the underside; both methods have proved effective. Bolting the crosslogs on which the planks rest is preferable to wedging them tight as wedges become loose and the crosslog then may creep and drop.

Ladder and Stair Safety—Ladders for access to the several levels of the staging should be tied securely at the top, should be braced at the middle, and in some cases should be cross-braced to take up sway. As standard practice they should all lean in the same general direction; generally they should lean in the direction of the descending grade.

An investigation of the use of inclines as compared with stairways for the main approach to the deck seems to have proved that the incline is most efficient and is more adaptable to the easily handling of carried loads.

Provision should be made for reaching the lower decks without going up and over, and this may be done by providing a passage through a left-off shell plate at the bow (and sometimes amidships). To reach such an opening temporary stairs have in every case proved most efficient and safest.

Hatch Staging—If the guard rail of hatch staging is left stationary when the platform is raised, so that the rail becomes too low, it may create a greater danger than no rail at all; provision should be made for keeping the rail at proper height. In engine and boiler-room hatch staging sometimes no provision is made for getting from one level of the staging to the next, and the men have to climb by means of the posts and crosslogs, a practice that creates a serious hazard. A ladder should be installed or strips should be placed on the uprights to form a ladder.

For general entrance and exit at the hatches, a temporary hatch stairway is superior to a ladder, as shown by time studies and accident statistics. The stairs will very shortly pay for themselves in reduction of accidents and saving of time of men.

Guard Deck Openings—Hatch openings, ventilators, and manholes should be guarded. Hatch openings should have substantial wooden guard rails. Heavy sections of timber will protect ventilator openings. Manholes and ventilators should have temporary covers of either wood or metal, a hinged metal cover having proved the most efficient protection. One lost-time manhole accident will frequently offset the price of a good many covers, whether of wood or of metal.

Use Goggles—Efficient goggles should be supplied to all men in pneumatic tool work to eliminate eye injuries, and steps should be taken to make sure that they are worn. Goggles should be designed to have sufficient ventilation to relieve condensation, and should be carefully fitted. Where special lenses are required in goggles, it is a wise investment on the part of the employer to see that they are furnished.

Eliminate Unnecessary Air Hose—Often ladders and stairs are cluttered with air lines, which create a serious tripping hazard. Strict supervision by foremen and safety-committee men, and the installation of pipe lines down hatches with manifolds at deck levels, will eliminate this practice; production will be increased and consumption of air hose reduced.

In connection with pneumatic work it should also be remarked that tools should have careful attention before redistribution, and the use of mushroomed sledges, flatters, and mauls, sprung wrenches or defective drift pins should not be permitted.

Safety Work Should Be Organized—Experience in several yards, both wood and steel, has shown that of the accidents in shipbuilding 95 per cent occur on the hull construction. To reduce hull accidents, in addition to providing proper construction and safe tools and methods of working, an efficient safety organization is necessary. The ship carpenter department of one yard held special departmental meetings each month, and this department was held responsible for the safety of several hundred men working on staging; as a result, the work has gone on a full year without one accident being charged to neglect of the work of this department.

As it is important that platforms and staging should be free from all warped, split and burned planks, it is apparent that an efficient staging gang must be employed. When such a gang is operating efficiently, statistics have shown that staging accidents are zero.

Causes of Asphalt Pavement Cracks and Pushing Being Investigated

IN ORDER to determine, if possible, whether cracking occurring in asphalt pavements results from improper drainage or is due to the make-up of the sheet asphalt, lengthy investigations are being undertaken by Major F. S. Besson, Corps of Engineers, U. S. A., and assistant to the engineer commissioner of Washington, D. C., upon Washington's sheet asphalt pavements. Not only is it hoped to arrive at definite conclusions regarding cracking, but investigations cover the causes of the pushing of the surface as well.

Sections have been cut from streets in various parts of the city, such specimens being taken from streets ranging in age from ten to forty years. These specimens are to be listed by degrees relative to their condition, ranging from the pavement which shows the most cracks down to the perfect pavement which neither cracks nor pushes, continuing to the end of the tabulation with the pavement which is most objectionable.

Analyses will be made of the specimens and they will be rated according to the percentages of bitumen and the gradation of the aggregate, also as to the density of the mixture and the ductility of the bitumen. Penetration and pat tests will also be made. The investigations will be extended throughout the winter and it is hoped that data of material benefit will be obtained therefrom. Asphalt considered in the test to be made will be of various kinds: Trinidad, Bermudez, California, Montezuma, Maricaibo, Aztec, etc.

The investigations made so far have led Major Besson to believe that neither do cracks in the asphalt surface relate directly to those in the concrete base, nor does the pushing of the surface depend upon the smoothness or roughness of the concrete base. It is believed that, provided there is a good rigid base, the cracking and pushing of asphalt pavements are entirely dependent upon the make-up of the sheet asphalt.

Development of Local Materials Aids Road Contractor

More Mileage With Fewer Men Result of Crusher Installation and Other Changes in Plant—Nine-Bag Batch Employed

INCREASED mileage over 1919 through the development of local materials supply, the use of a nine-bag batch mixer, and other changes in equipment and methods of operation, is the accomplishment of Quinlan & Robertson, Inc., New York City, who are building a section of reinforced concrete pavement along Route 141 of the Pennsylvania state highway system. This contract, which is one of the 1919 series, is on the Reading-Pottsville Road, lying between the towns of Hamburg and Orwigsburg, in mountainous country contiguous to the Schuylkill River.

Because of the inability of the contractor to secure and hold an adequate force of men, due partly to the remoteness of the job, construction methods followed during the 1919 season, when but 20 per cent of the contract was finished, were abandoned. A study of plant layout and construction methods requiring the least labor forces was undertaken, with the result that a central materials plant was constructed near Molino, and new equipment was purchased. During 1919 concrete was mixed in two 14-cu.ft. capacity mixers, of imported materials hauled to the road in trucks and dumped on the grade. Charging the mixers was done with wheelbarrows. The central materials plant was located at a site along the line of the Philadelphia & Reading R.R., where a deposit of boulder rock was found. The rock is of a high quality, but unfortunately runs only in seams along the mountainside. One of these seams was opened after quarry operations started during the winter. The deposit is located about 300 ft. above the railroad on a mountainside whose slope approaches 45 deg. Rock is conveyed from this quarry to the crusher by means of a double track narrow gage haulage system, in which are used two cars operated by cables wound on a double drum steam hoisting engine located above the quarry on the mountainside. It was at first thought that this material source would be adequate to supply the job with crushed stone, but recent developments show that only half the required material can be had from this quarry, a fact due to the thin deposits in which the boulders are found. The other half of the material requirements must be met by importation from commercial quarries. Fig. 1 is a view of the haulage system as seen from the top of the materials plant.

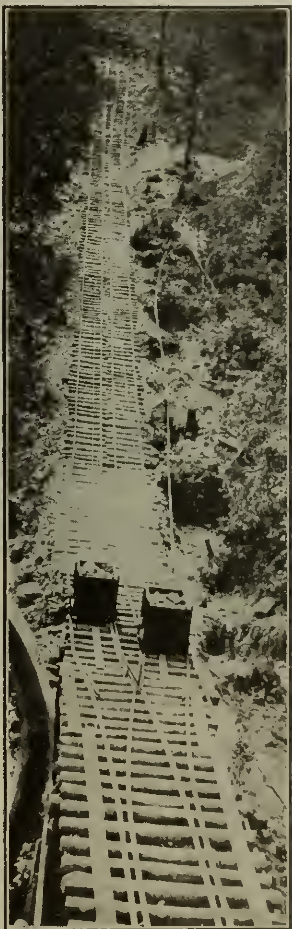


FIG. 1. SYSTEM USED IN HAULING ROCK FROM QUARRY

When the cars from the quarry reach the foot of the incline their loads of stone are dropped into the main crusher through an end door, which is released by the men feeding the crusher. From the crusher the stone is elevated to the top of the plant and put through a revolving screen having circular openings ¾ in. in diameter at the intake, and openings 2¾ in. in diameter over the stone bin. "Overs" are deposited in a chute which leads to a No. 2 jaw crusher. The product of the smaller crusher is elevated and discharged through the main crusher into the elevator to the screen, thence to the proper bin.

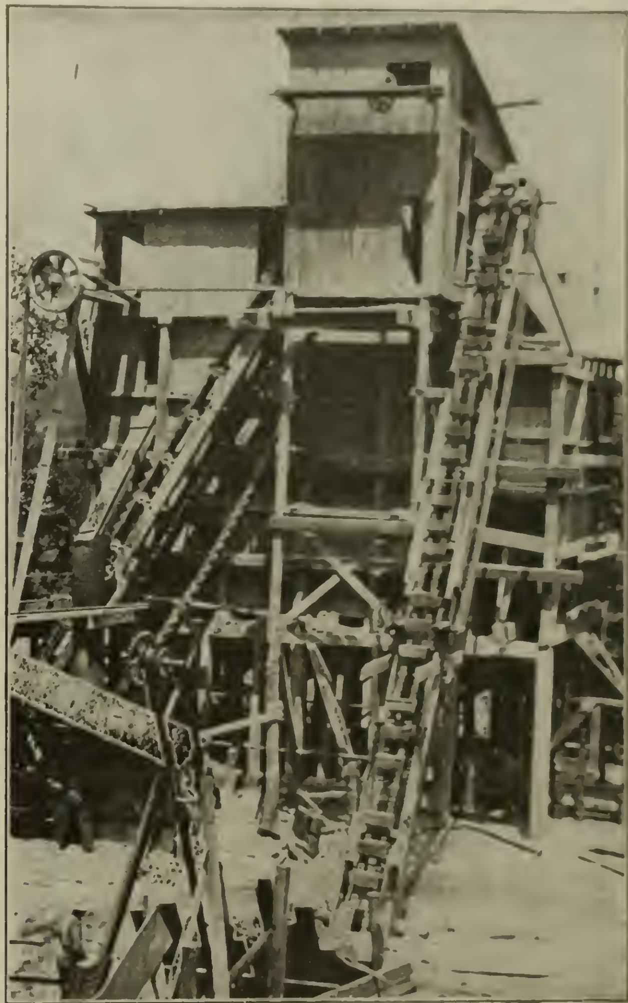


FIG. 2. CLOSE-UP OF MATERIALS PLANT

Sand is imported. It is handled by spotting the open top car over a track hopper into which the sand is unloaded, whence it is discharged into the sand bin by means of an elevator. In case the sand bin is full sand is sent from the track hopper into a small elevator which discharges the material on a storage pile on the opposite side of the track.

Fig. 2 is a close-up of the materials plant showing the sand elevator on the right and the stone elevator on the left. The return chute for oversized stone is seen over the stone elevator.

Material bins are hopper-bottom and fitted with

FIG. 3. CEMENT HOPPERS AND MATERIAL CARS READY TO DISCHARGE TO BATCH BOXES BELOW

slide gates. A train of four batch cars of 45 cu.ft. capacity each is run under the bins and filled with the sand and stone. The cars are divided into two compartments which, when filled level, contain the exact amount of sand and stone necessary for one batch of concrete. They operate over a track which connects the materials plant with the cement house by means of a haulage system similar to that which supplies the crushers with stone.

The cement house consists of a storage house whose floor is approximately 10 ft. above the ground line. Storage is supplied for about 4,000 bbl. in this room. A covered loading platform opens off the storage room on the opposite side from the railroad siding and to this loading platform batch cars are drawn and spotted over openings in the floor. Four cement hoppers are built into the floor opposite the openings for sand and stone. Nine bags of cement are placed in these hoppers for each batch of sand and stone. These cement hoppers and the material cars in place are shown in Fig. 3. Four 5-ton trucks drawing 5-ton trailers are used for haulage of batch boxes from materials plant to the mixer. Each truck train carries four batch boxes—two on each truck and two on each trailer. The truck and trailer drive under the loading platform and receive the charge of cement and aggregates from the platform above. Cement is discharged into a separate covered metal compartment, with which each batch box is fitted. The operation is illustrated in Fig. 4.

The mixer, whose capacity is 28 cu.ft., is charged by a double-drum, continuous tread, steam shovel rigged as a crane. The dipper stick and crowding engine were removed from the shovel and the boom was extended about 5 ft. by channel irons fastened to either side of the outer end. Four sheaves are fitted on a shaft to the end of the boom which carry the two boom lines and the fall and dump line. The mixer and crane run near the left hand form. The trucks with trailers run to within 50 ft. of the crane, where the trailer is uncoupled and waits until the truck which continues on within reach of the crane is unloaded. The truck then backs past the waiting trailer to a point where a few omitted form lengths allow it to turn around and back up to the trailer again. While the truck is turning around, the trailer is drawn up to within easy reach of the crane by means of a cable reaved over the winding drum on the mixer. By the time the trailer is unloaded, the truck has coupled on the other end and is ready to move out.

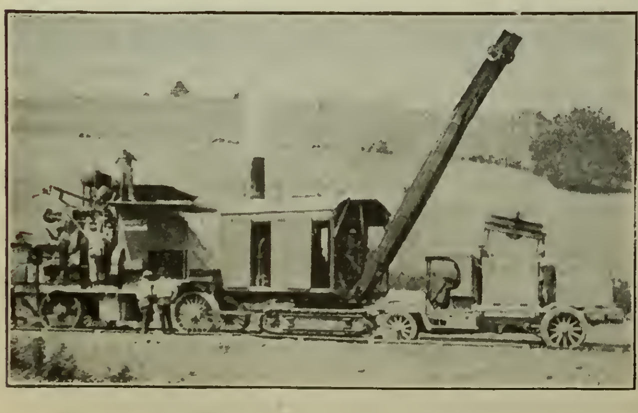


FIG. 4. STEAM SHOVEL REFITTED FOR USE AS CHARGING CRANE

The four trucks and trailers in use on the 2-mi. haul make the round trip in about 40 minutes. Twenty-one minutes are required to make the run from the plant to the mixer, due to the heavy grade. A truck and trailer are unloaded in seven minutes. As the net time of mixing on the job is one and one-half minutes, it requires an average of two minutes, gross, per batch. This would indicate that the handling of the batches by the crane is well proportioned for the speed of the mixer under this mixing specification.

FIG. 5. FIRST FINISHER STRIKES AND TAMPS; SECOND TAMPS AND BELTS

The mixer is fitted with an overhead hopper which discharges directly into the drum through a slide gate. The rated capacity of the mixer calls for a seven-bag batch of a 1:2:3 mix. After some experimenting with an eight-bag and then a nine-bag batch, the contractor determined upon the latter as a standard size batch. Though the mixer is loaded over its rated capacity, there appears to be ample power and drum capacity to carry the extra load. The entire batch, however, cannot be conveniently carried in the discharge bucket, a small amount of concrete—approximately 10 per cent of the batch—being deposited on the grade directly from the mixer. The mixer is mounted upon wide steel tired wheels.

The finishing is done by two finishing machines, the first machine striking and tamping only, the belt being removed, and the second machine tamping and belting.

On July 27, 492 ft. of 18-ft. pavement, 6 in. thick at the edges and 8 in. thick in the center, were placed in 8 hr. elapsed time, that day being the twelfth day of operation of the plant. Prior to that time attention had been paid to details of operation and not to speed. That length is at the rate of 20 batches an hour. The contractor believes that as soon as the wrinkles in operation methods have been straightened out, an average of 30 batches an hour can be maintained, provided material supplies are adequate. The contractors' belief that increased mileage will result from perfection of organization is borne out by a recent report that in a 9-hr. day the following records were made: Aug. 26, 600 ft.; Aug. 27, 664 ft.; Aug. 28, 677 ft. With the use of a nine-bag batch 3.3 ft. of road are laid at one batch. This means that the mixer can work in one place for four batches and can use the time between truck arrivals in which to move ahead.

The following is an arrangement of all the labor used on the job:

At the mixer:
- 1 foreman fine grading and form setting
- 2 form setters
- 2 form setters' helpers
- 15 laborers, fine grading between forms
- 1 concrete foreman
- 1 hoist engineer
- 1 hoist fireman
- 1 mixer operator
- 1 mixer operator's helper
- 4 laborers handling batch boxes, trucks, trailers, etc.
- 5 concrete spreaders
- 2 finishing machine operators
- 1 finishing machine mechanic
- 2 finishers, edging, touching up
- 2 laborers, general work. Total: 41 men.

Hauling:
- 4 truck drivers
- 1 mechanic
- 2 helpers on truck repairs. Total: 7 men.

Cement House:
- 6 laborers handling cement and charging cars
- 1 engineer on haulage system. Total: 7 men.

Power House:
- 1 engineer
- 1 helper. Total. 2 men.

Materials Plant:
- 3 laborers feeding crusher
- 3 laborers unloading sand
- 1 mechanic
- 1 oiler. Total: 8 men.

Quarry:
- 1 foreman
- 8 laborers (this number varies with supply)
- 1 haulage engineer. Total: 10 men.

Total force employed: 75 men.

A. D. La Roche is manager for Quinlan & Robertson.

Activated-Sludge Plant for Reading, England

A loan of £148,000 ($719,000) for an activated-sludge plant to treat the sewage of Reading, England, has been authorized by the Ministry of Health. According to the London *Surveyor*, the activated-sludge process "is ecpecially applicable to Reading, as a complete exclusion of rain-water from the sewerage system is effected." Plans for the new works have been made by G. Midgley Taylor, Westminster, England.

Line Controls County Road Traffic

By K. I. Sawyer,
Superintendent of Highways, Ishpeming, Mich.

PAINTED lines on the road surface, as shown by the accompanying view, have proved as useful in controlling traffic on trunk line highways in Marquette Co., Mich., as have similar control signs on city streets.

The road illustrated was originally laid out as an ore teaming track from the iron mines at Ishpeming to the boats at Marquette, and, of course, was designed only for team travel. As the road drops 900 ft. in 7 mi. through a hilly country there are numerous curves and grades. The maximum grade is 6 per cent, but some of the curves are sharper than is now considered good design for motor traffic. The traffic, which exceeds

CURVES MADE SAFE BY PAINTED CONTROL SIGNS

1,200 vehicles per ten-hour day, was beginning to be dangerous to itself, as the visibility was low on these curves, due to the shoulders of the hills and the heavily timbered country which borders the roads. To relieve this situation the writer painted white 8-in. center lines upon the black surface of the road at the more dangerous curves, with an arrow pointing down the right hand side of the road at either end. The purpose was to counteract the tendency of drivers to hug the inside of a curve regardless of the danger of hitting the traffic approaching, which might be invisible to them at the time. The effect was immediately apparent. The drivers, used to obeying control signs in the cities, immediately responded to the appeal of the white line and kept to the right hand side of the road. The immediate reduction in the number of accidents indicated that the plan was worth while.

The white paint used for this work is a whitewash prepared according to the formula used in the United States lighthouse service. The patrolman touches up the center line every Saturday morning, but unless the rains are especially severe the line will last a month.

Enormous Rainfall in Hawaii

An inch a day is the average rainfall in the upper Waipio Valley, Hawaii, which makes it one of the areas in the world where the rainfall is heaviest. On the other hand, the rainfall on some of the slopes of Hualalai, on the same island, is only 20 in. a year. The only surface streams on the island are along the northeast coast between Hilo and Kohala. Waipio River, according to the U. S. Geological Survey, has been partly developed for irrigation.

The National Department of Public Works Situation

Report of M. O. Leighton to Engineering Council States That Moral Support Is Needed Now To Finish Legislative Program—Engineer Corps Will Control Unless Civilians Act, He Says

A CALL for moral support from engineers for the bill providing for a National Department of Public Works is contained in a report which Engineering Council received at a meeting in Chicago Oct. 22 from M. O. Leighton of its National Service Department. Civilian engineers, it is claimed, will be outmaneuvered by the Corps of Engineers, U. S. Army, unless there is a decided revival of the interest in the public works department exhibited 18 months ago. Other professions and organizations, it is pointed out, are taking up the engineers' program and will follow it through. Extracts from Mr. Leighton's report follow:

Resumption of legislative effort in support of a National Department of Public Works will take place prior to the next meeting of Council. It therefore appears advisable to make a rather complete report on the progress of that movement.

Two outstanding facts may be mentioned: The first is that the engineers of the country in good faith started in 1917 something which they do not now seem inclined to finish. The second is that the scope of the movement and its ramifications extend beyond all limits written or spoken of at the time.

The writer is unable to suggest any adequate reason why the original enthusiasm of so many engineers has apparently been reduced to a passing interest. Engineers responded warmly to it in the first instance and it therefore may safely be assumed that they had an original and genuine regard for it. The writer has considered the possibility that the engineers may be discontented with the conduct of the public works campaign and the personnel engaged therein. This, however, seems doubtful, because of the fact that the campaign has been successful to a degree beyond that anticipated at the beginning by those most familiar with the situation.

No doubt the enthusiasm of many engineers has been cooled, and in some cases their active opposition has been brought about by the very skillful campaign carried on by members of the Corps of Engineers, U. S. Army. We do not complain of such activities of the Army engineers. Their opposition to a public works department was expected. Many of the civilian engineers on whom we counted for support have been won over to the cause of the Army engineers, and as magnanimous opponents we must congratulate the Corps on its achievement.

Government Reorganization

The fundamental arguments for a department of public works apply with equal force to the entire Government organization. There has grown in a short space of time a country-wide movement for Government reorganization. The National Education Association, the Women Voter's League and the Federation of Women's Clubs are supporting a proposed department of education. The American Public Health Association and other organizations in the realm of sanitation and preventative medicine are supporting a department of health. Certain welfare organizations are advocating a department of public welfare, and there is also a movement for a department of aeronautics; and, as some of you are aware, an old movement for a department of mines still exists. The National Budget Committee, having practically completed its labors in behalf of a budget system of Federal finance, is actively turning its attention to the entire field of Federal reorganization.

The National Budget Committee, the Public Works Department Association, and the National Education Association are participating in the activities of what is known as the National Committee for Government Economy, the purpose of which is to make and report upon a complete study for governmental reorganization. The report is practically completed. In all of these organizations, with possibly one exception, the creation of a department of public works is an accepted doctrine.

Early in October there was a meeting in New York City, attended by John T. Pratt, the head of the National Budget Committee; Herbert Hoover; Henry L. Stimpson, former Secretary of War; Paul Warburg; Major C. T. Chenery, and the writer, at which matters of Government reorganization were discussed, and particularly the need for and the possibility of amalgamating all reorganization efforts under a commonly accepted and supported program. It was brought out that if the many organizations conduct campaigns separately, each for its own particular project, the confusion created in Congress will probably result in no legislation. It was therefore decided to call a meeting of delegates from the several organizations advocating reform in the Government departments, for the purpose of organizing a Federal Reorganization Council, which would be the common body through which an accepted program would be carried forward.

A meeting of such delegates was held in New York on Oct. 14 at which time the nearly completed report of the National Committee on Governmental Economy was presented. That program provided for a general rearrangement of Government activities along functional lines, including the creation of a department of public works by a reorganization of the present Interior Department. The meeting for final organization will take place on or about Nov. 15. The prospective field of such a council is not limited to the mere reorganization of Federal activities. It should, if properly conducted and supported, become the authoritative unofficial body to engage in the work which will eventually lead to a distinct separation of the political features of our Government system from the conduct of departmental business.

There is also being discussed the consolidation of the Public Works Association with the National Budget Committee. This move appears to be wise from the standpoint of efficiency and economy.

The obvious result of all this is that a department of public works, if created, will not be an achievement of engineers and architects solely, but of men and women of many professions and vocations. Such credit as will come to the engineers will be merely that of starting a good thing, unless the members of the profession revive their interest and resume a leading part in the campaign. If such a revival does not take place the cream of achievement will be skimmed by the members of other professions.

To summarize as to the prospects for a department of public works: It is the writer's belief that the principle is thoroughly settled in the minds of the public and of a majority of the members of Congress. The important question remaining is the kind of a department that we shall have. This involves a discussion of the matter of engineering control of the Government operations. Shall it be civil or military?

Civil or Military Control?

It is easy enough for the thousands of engineers of the United States to assert that the engineering work of the Government shall be under civilian control, but it is quite another thing to establish that control. It is not difficult for the civilian engineers of the country to set up the claim that our military engineers are not well-rounded engineers; that they are inbred; that the greater part of their meritorious performance is done by their civilian assistants who secure no credit therefor; that the Corps of Engineers is an autocracy and therefore unsuited to the control of public operations in a democracy.

Unless one scans the record very closely he will fail to

appreciate how intimately the military organization has interwoven itself into the structure of civil government, and with what ingenuity it has placed landmarks that stand as a constant reminder of the civil achievements of the military engineers. These landmarks are placed where they will most frequently fall under the eye of the members of Congress. If a new road is built in one of the parks of the District of Columbia—just an ordinary road involving horse sense and an adherence to fundamental principles —it is likely to be named after the military head of the office under which the construction happens to fall. If dam construction is proposed, the lake behind the dam is named for some military engineer. By constant application and attention to detail these military engineers have, during past years, created in Congress the habit of providing that the Engineer Corps shall do thus and so, and whenever a civilian engineering organization is designated the first process is to overcome the aforesaid habit.

When Government reorganization takes place the provisions made for engineering control will crystallize and will not become mobile again for at least a generation. It all comes down to a question of what the civilian engineers want and what they will work for. They are strong enough numerically and powerful enough in influence to guide the decision if they choose to do so, but they must not entertain the notion that their adversary is asleep.

Broad Training for Army Men

If the testimony of some of the line officers, some of the engineer officers, and many of the reserve officers, be correct, the Corps of Engineers exhibited in the late war the not wholly commendable results of their high state of specialization. This ought not to be so. Our corps of military engineers should be given responsibilty and experience in every line of engineering laid open by Government activity. They should take their place in the engineering work of the arid lands and the swamps, the highways and the forests, the mines and the laboratory. They should be given the financial and the commercial training necessary to the proper conduct of operations, so that in war exigency they shall be entirely competent to perform all the engineering functions that present themselves. These facts, which it is believed no thoughtful person will deny, bring us to the forks in the road. Shall, by reason of this necessity for broad engineering training, the corps of military engineers be in command of all the Government's public works functions, to the perpetual subordination of the civilian engineer? Or shall they constitute, as was originally intended, a military arm of the Government and be given their training and experience by temporary assignment to positions in the civil work, by transfer therein according to plans most advantageous for the acquirement of such experience?

The civilian engineers of the country must decide, and if they are defeated in the forthcoming contest the fact will, in the opinion of the writer, be an evidence that the military engineers deserve their success, for it will show that whatever may be their engineering qualifications and however severely their ideals may depart from those which are supposed to constitute the cornerstone of democracy, these men do, nevertheless, possess an essential characteristic which the great body of civilian engineers does not, namely, that they know men and are ever vigilant in the exercise of their knowledge.

Rubber as Road Surfacing Material

To deaden the sound of traffic, according to the London *Surveyor*, there is now placed on Borough High St., at Southwark, London, an experimental stretch of road which is faced with rubber sheeting. Only half of the road is now being laid so as to afford a comparison in efficiency. The new material is being laid in flat slabs ?-in. thick attached to steel plates, from which project broadly flanged studs which are gripped by the concrete foundation.

Export and Import Statistics Indicate Industrial Trend

By O. M. Fox
Construction News Department
Engineering News-Record

[The course of business in the next six months is of such interest to every engineer and contractor that the following analysis of export and import figures merits a wide reading. The trend is not an encouraging one, but it should be in the minds of all who appreciate the all-pervading influence of our industrial situation.— Editor.]

PRICES are never "too high" or "too low," for a long period because they invariably react to the conscienceless law of supply and demand. Such a long period of high and climbing prices as we have experienced in 1918, 1919 and until recently in 1920, would have been impossible had it not been for the loss of Europe to the world's producing or supply capacity for over four years and the devotion of America's production to engines of destruction and war-consumed goods for an equal period.

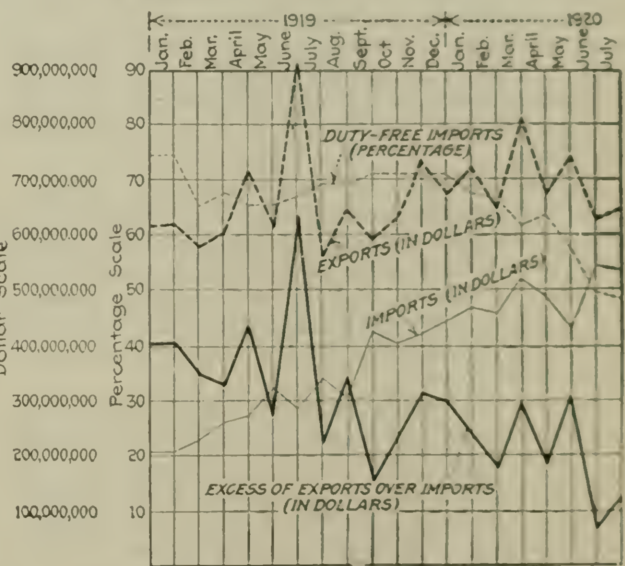


FIG. 1. PERCENTAGE OF DUTY FREE IMPORTS (LARGELY RAW MATERIALS) RAPIDLY DECLINING—EXPORTS STEADY—IMPORTS REGULARLY INCREASING

When a nation is selling more than it is buying, exporting more than it is importing, it is enjoying financal prosperity and experiencing relatively high prices at the home markets. Such has been the case in America for the past few years. An approaching change in this condition is looming every day, and presents one of the fundamental reasons for the initiation of price cutting inaugurated by the Detroit auto king on Sept. 20.

Our exports from Jan. 1, 1919, to July 31, 1920, a period of nineteen months, have totaled \$12,649,000,000, an average of \$666,000,000 a month. During the same period imports have amounted to \$7,386,000,000, an average of \$388,000,000 a month. Excess of exports over imports has totaled for the period, \$5,263,000,000, an average of \$277,000,000 per month.

This excess of exports, or supposed factor of safety in international trade relations, as it might be termed, is rapidly decreasing. Of these nineteen months' total, 47 per cent of the imports have been brought in and only

40 per cent of the exports have been shipped out in the last seven months—37 per cent of the time. Exports have remained practically stationary, at around $650,000,000 a month for these seven months, while imports have grown from a January-February average of $470,000,000 to a June-July average of $540,000,000. This rate of increase holds good for the entire nineteen months. The monthly figures of imports have steadily increased, with only minor downward reversions, from $213,000,000 in January, 1919, $235,000,000 in February, $267,000,000 in March, to $553,000,000 in June and $537,000,000 in July, 1920. The spread between the two, or the excess of exports over imports has therefore steadily decreased from $409,000,000 in January, 1919 to $114,000,000 in July, 1920.

This is best represented by the appended graph which shows steady convergence of the plotted lines representing exports and imports, and the corresponding steady drop of the line representing excess of exports toward the zero line. The natural bent of a student of graphs is to extend the lines in an effort to foresee the future, as moving forces tend to expend their energies along their direct lines of impulse. This must be done with caution in this case, bearing in mind that while there is a probability that the export and import lines on this chart will cross, and that before the close of this year, there is a limit beyond which they cannot pass, this limit being Europe's producing capacity and consumption requirement, coupled with our own consumption capacity.

The lines will probably tend to converge. Their approaching convergence, or crossing, will reverse the situation of the past three or four years and we will become, from a nation of profit-taking sellers, a nation of profit-paying buyers, and our commodities, following that previously mentioned immutable law, must rank lower in financial value scale and our financial prosperity must diminish.

The available statistics of the custom house show still another factor which tends to disturb our equanimity. Bear in mind that, of goods which come into this country from abroad duty-free, by far the greater portion is raw material. In order of their monetary value, the ten leading duty-free items of import are raw wool, raw vegetable fiber; raw silk; india rubber; raw chemicals; copper; crude vegetable oil; hides; tin and coffee. These are the commodities of which we must import vast quantities to keep turning the wheels of our mills and factories. The principal dutiable articles of import are sugar, tobacco, manufactured cotton, manufactured silk, manufactured wool, manufactured vegetable fibers, chemicals and similar products of foreign industry.

One of the most fruitful causes of the self satisfied days in America during the post-war period was the selfish thought that the manufacturing capacity of Europe was so crippled that for a period of years American fabricated products would not only be free from foreign competition at home but would also be free to corral the trade of the world. The figures of the government report disclose the fact that, during the nineteen-month period under discussion, while imports have been increasing nearly three-fold, the percentage of duty-free imports has decreased from 74 per cent to 49 per cent.

During this period, while our importation of raw materials has increased 68½ per cent, or $106,000,000, our finished product importation has increased 389 per cent, or $218,000,000. Foreign manufacturing interests are speedily resuming their former position of active competitors of American industry both in our own land and abroad. By just the value of these increased dutiable importations has the home market of American manufacturers been diminished, and it is interesting to note that nearly all this increase has taken place in the last seven months and is now at its highest figure in several years. The increased supply of foreign fabrications is thus seen to be co-incidental with the stagnation of American markets which has culminated in the present period of sharply shrinking values. The percentage of duty-free importations is graphically shown in the accompanying diagram.

If American business has a besetting sin, it is probably optimism, and of recent times this over-optimism seems to take the form of over-estimating markets. Our reason has been dulled by the fact that all industry is turning out and selling more production, in dollars and cents, than ever before and we have lost sight of the fact that owing to high prices the swelled financial figures represent a lessened actual material production. If less units are being sold, less manufacturing capacity is required, regardless of the total monetary value of the units themselves. A clothing factory turning out 10,000 suits at a current valuation of $500,000 is using only half the material, less labor, less power and less equipment that one turning out 20,000 similar suits currently valued at $400,000, although the first plant's money production is 25 per cent in excess of the second.

Business must therefore translate the meaning of these three shadows: (1) Imports rapidly increasing to a point where the United States no longer occupies a favorable trade position; (2) entry of foreign fabrications into active competition in domestic markets and similar competition to be met abroad; (3) consumption of goods much smaller in actual quantity, though larger in current monetary value, than has been realized. As the nation as a whole, and as the individual business units thereof, properly penetrate these shadows with the light of clear business sense, and as our economic and industrial sails are trimmed to cope with the gusts and eddies that the shadows portend, just so shall the nation and the individual business units thereof prosper in the coming year and decade.

Snow Removal From Highways

Efforts are being made to secure an announcement of policy from the Bureau of Public Roads in regard to snow removal. It is evident from these requests that the desire is that general endorsement be given snow removal on the ground that the highways represent too great an investment to be allowed to become impassable for even a short time. Thomas H. MacDonald, Chief of the Bureau of Public Roads, has taken the position that the matter of snow removal is entirely a local question. In some instances, he said, it is obvious that snow removal should be vigorously carried on, but over the great portion of the highway mileage of the country, in the snow region, he believes careful figuring must be done in order to ascertain if the expense of snow removal is justified. Where the snowfall is excessive, as in Maine, for instance, he is of the opinion that it would not be economical to attempt to keep many of the roads free from snow.

Charts for Solution of Manning's Hydraulic Formula

By Elmo G. Harris

Department of Civil Engineering, Missouri School of Mines, Rolla, Mo.

UP TO a recent date hydraulic engineers have accepted the formula $v = c\sqrt{rs}$ and Kutter's formula for c as the best available guides for computations relating to the flow of water in any kind of uniform channel. However, writers have very generally expressed the belief, and hope, that eventually a formula, equally reliable but less tedious in solution, would be found.

It is the writer's opinion that such a formula is now offered in what is known as Manning's formula which is

$$v = \frac{1.486}{n} r^{\frac{2}{3}} s^{\frac{1}{2}}$$

Any unprejudiced reader after familiarizing himself with the able and excellent discussions of this formula by King ("Handbook of Hydraulics") must concede that computations with Manning's formula will check with those computed by the Chezy and Kutter formulas to a degree well within the errors due to uncertainty in the value of n as used in either formula.

If there remains a doubt in the mind of anyone as to whether it is safe to use Manning's formula instead of the older ones he should be reminded that they are all empirical, that they all depend for their accuracy on a coefficient that must be determined by experiment, and if that coefficient is correctly determined the formula will be correct. Any formula can be made correct by applying a proper coefficient. It is to our advantage to adopt the formula that is least laborious in the solution and then give chief attention to the determination of a proper coefficient. Manning's formula is well adapted to this purpose and it has the very great advantage that it is adapted to the values of n as already determined from a vast number of experiments. However, the reader should not fail to appreciate the fact that if Manning's formula should come into general use (which it probably will) we are perfectly justified in adopting values for n other than those fitting Kutter's formula, if in so doing we make Manning's formula better fit the facts.

The writer's contribution to the further adaptation of Manning's formula to the needs of practice follows:

In Manning's formula (see above) for v substitute

$$q/a, \text{ then } q/a = \frac{1.486}{n} r^{\frac{2}{3}} s^{\frac{1}{2}}$$

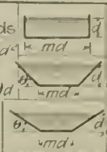
in which q = water flowing per second in cubic feet, a = area of water section, r = the hydraulic radius and s = the slope, or drop divided by distance.

It is well known (from plane geometry) that in similar figures the areas vary as the *square* of the similar linear dimensions; and the hydraulic radius of any similar set of water sections varies *directly* as the similar linear dimensions. If, then, we assign the symbol d (see cuts accompanying tables) to any one of the dimensions of a series of water sections, similar in shape but variable in dimensions, and then assign the symbol a_1 to the area of the shape when d = unity, the area of any one of the other similar sections with dimension d (other than unity) will be $a = a_1 d^2$. Similarly, if we assign the symbol r_1 to the hydraulic radius when d is unity, for any other size of the similar sections the hydraulic radius will be $r_1 d$. Hence we can modify the last equation thus

$$\frac{q}{a_1 d^2} = \frac{1.486}{n} (r_1 d)^{\frac{2}{3}} s^{\frac{1}{2}}$$

The most frequently occurring problem in hydraulic engineering is to find a dimension (as a depth or a diameter) of some specified shape of water section to carry a given quantity (q) with a given slope (s).

FIG. 1 DATA FOR SOLUTION OF MANNINGS FORMULA



For all Trapezoids: $a = (m + \cot\theta)d^2$; $p = (m + \frac{2}{\sin\theta})d$; $r = \frac{a}{p}$

$\theta = 90°$, $\sin = 1.0$, $\cot = 0.0$ — Rectangle: When $d = 1$: $a_1 = m$, $r_1 = \frac{m}{m+2}$

$\theta = 45°$, $\sin = 0.707$, $\cot = 1.0$ — Side Slope 1 to 1: $a_1 = m + 1$, $r_1 = \frac{m+1}{m+2.83}$

$\theta = 33°44'$, $\sin = 0.555$, $\cot = 1.5$ — Side Slope $1\frac{1}{2}$ to 1: $a_1 = m + 1.5$, $r_1 = \frac{m+1.5}{m+3.6}$

For all Sections: $d = k\frac{(qn)^{\frac{3}{8}}}{s^{\frac{3}{16}}}$; $k = \left(\frac{1}{1.486 a_1 r_1^{\frac{2}{3}}}\right)^{\frac{3}{8}}$; a in feet, q in sec.-ft.

m	Trapezoids, Logs of k: Rectangle	1 to 1	$1\frac{1}{2}$ to 1	Circles Partly Full: h/d	a_1	r_1	Log. k	Egg Shape: H	a_1	r_1	Log. k
0.6			$\bar{1}.8899$	1	0.7854	0.250	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.828		$\bar{1}.9124$		0.95	0.7708	0.286	0.1145	1.00	1.1485	[illegible]	[illegible]
1		$\bar{1}.8931$	$\bar{1}.8525$	0.9	0.7445	0.298	0.1150	[illegible]	0.7558	[illegible]	[illegible]
2	$\bar{1}.8979$	$\bar{1}.8083$	$\bar{1}.7750$	0.8	0.6735	0.304	0.1291	0.333	0.2840	[illegible]	[illegible]
3	$\bar{1}.8121$	$\bar{1}.7506$	$\bar{1}.7321$	0.7	0.5874	0.296	0.1543	0.267	[illegible]	[illegible]	[illegible]
4	$\bar{1}.7538$	$\bar{1}.7072$	$\bar{1}.6930$	0.6	0.4920	0.278	0.1900	0.220	[illegible]	[illegible]	[illegible]
5	$\bar{1}.7100$	$\bar{1}.6723$	$\bar{1}.6610$	0.5	0.3927	0.250	0.2382	0.200	[illegible]	[illegible]	[illegible]
6	$\bar{1}.6874$	$\bar{1}.6438$	$\bar{1}.6341$	0.4	0.2934	0.214	0.3023	[illegible]	[illegible]	[illegible]	[illegible]
7	$\bar{1}.6459$	$\bar{1}.6192$	$\bar{1}.6147$	0.3	0.1981	0.171	0.3909	[illegible]	[illegible]	[illegible]	[illegible]
8	$\bar{1}.6211$	$\bar{1}.5977$	$\bar{1}.5905$	0.2	0.1118	0.121	0.52 6	[illegible]	[illegible]	[illegible]	[illegible]
9	$\bar{1}.5994$	$\bar{1}.5790$	$\bar{1}.5723$	0.1	0.0408	0.063	[illegible]				
10	$\bar{1}.5804$	$\bar{1}.5617$	$\bar{1}.5559$								

In all Cases $r = r_1 d$, $a = $ area and [illegible]

Then for convenience we adapt the above equation to the solution for d, thus

$$d = \left(\frac{1}{1.486\, a_1 r_1^{\frac{2}{3}}}\right)^{\frac{3}{8}} \frac{(qn)^{\frac{3}{8}}}{s^{\frac{3}{16}}}$$

or

$$d = k\frac{(qn)^{\frac{3}{8}}}{s^{\frac{3}{16}}} \qquad \text{I}$$

Where

$$k = \left(\frac{1}{1.486\, a_1 r_1^{\frac{2}{3}}}\right)^{\frac{3}{8}} \qquad \text{II}$$

In these formulas the symbols are as follows:

d is a dimension, in feet, of the water section, or of the conduit, chosen for convenience.

q is the quantity of water flowing in cubic feet per second.

s is the slope, or drop in free water surfaces divided by distance.

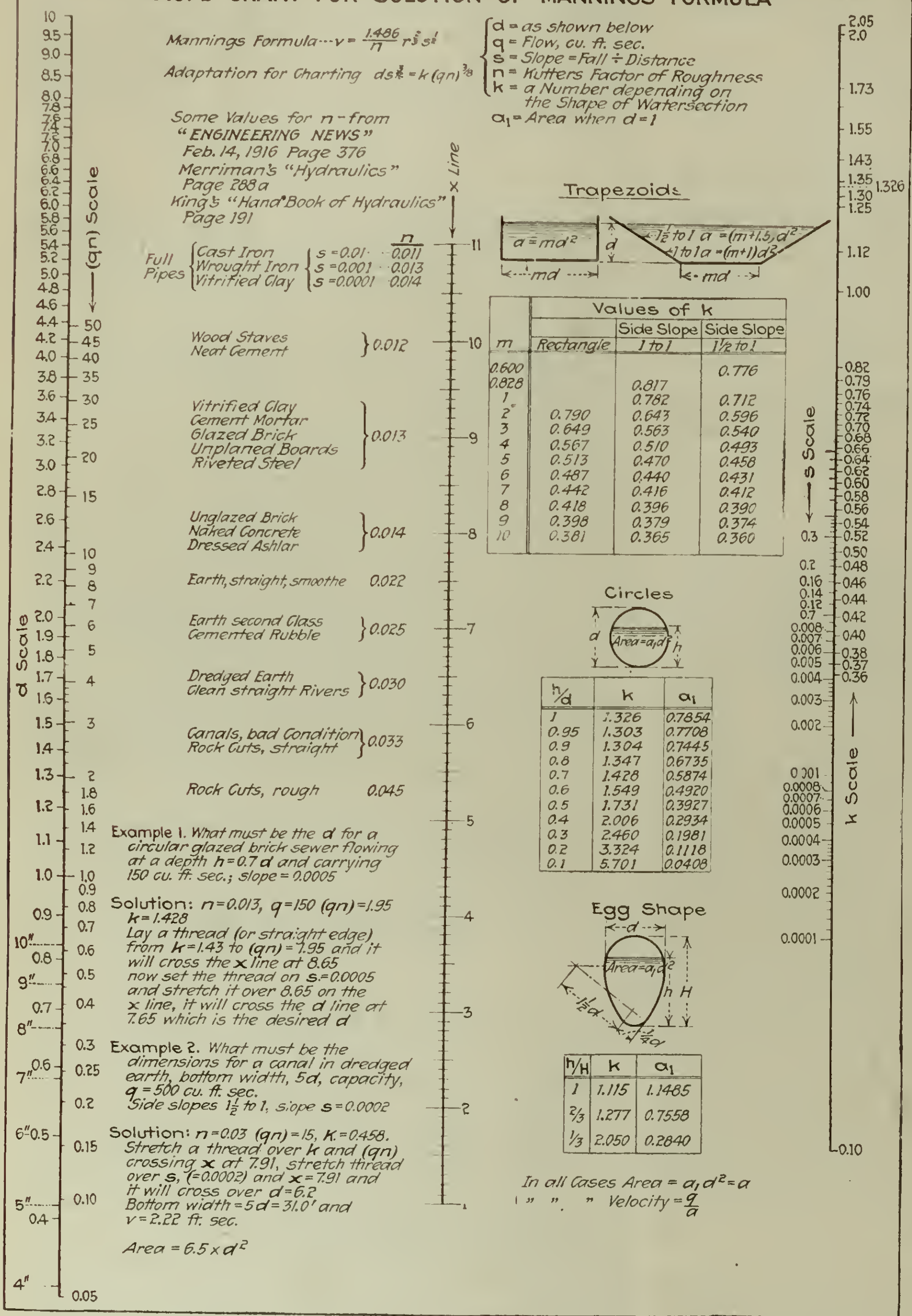
n is the roughness factor, and is the same as would be used in Kutter's formula (with exceptions as noted).

k is the shape factor in which: a_1 is the area of water section when d = one, and r_1 is the hydraulic radius of the water section when d = one

In Fig. 1 is brought together most of the special data for computations with formula I. Since the computations must be made by use of logarithms, the logarithms of k are given in the tables, thus saving the time and chance of errors in taking them out of other tables.

The data a_1 and r_1 for computing k for egg-shaped sewers is found in Folwell's "Sewerage," p. 54, and doubtless in other text books. In the table for trape-

FIG. 2 CHART FOR SOLUTION OF MANNINGS FORMULA



zoids the log k at top of column is that for the most economic section.

Formula I can be readily solved (by means of logarithms) for any one of the variables d, q, s, n or k, but since n will be known in all cases (except research work seeking values for n) it will save time and confusion to combine (qn) as one quantity. Then if the problem be to find q, we will first compute (qn) and divide by n.

Example I: Determine the dimensions of, and velocity in, a canal in dredged earth with side slopes $1\frac{1}{2}$ to 1 and slope 0.0005; capacity to be 750 cu.ft.sec., the cross section to be the most economic.

Solution: For dredged earth n 0.03 (see Chart II). Then $(qn) = 22.5$ and in column $1\frac{1}{2}$ to 1 under trapezoids, we find for most economic section (at head of column) log. $k = \bar{1}.8899$.

With these data inserted equation 1 may be written

$$\log d = \bar{1}.8899 + \tfrac{3}{8}\log 22.5 - \tfrac{3}{16}\log .0005$$

Confusion, if any, will develop in working out the last term. The process follows:

$\log .0005 = \bar{4}.6990$ or $-4 + .6990$ and $3(-4 + .6990) = -10 + .0970$

To avoid confusion the first number (or characteristic) must be exactly divisible (in whole numbers) by 16. To get this condition add -6 to the first number and add $+6$ to the second, thus, $-16 + 6.0970$. Now divide by 16 and get $-1 + .3811$.

Then $\frac{3}{16}\log .0005 = \bar{1}.3811$

The complete computation can now be carried out as follows:

$$\begin{aligned} \log k &= \bar{1}.8899 \\ \tfrac{3}{8}\log 22.5 &= 0.5071 \\ &\overline{0.3970} \\ \tfrac{3}{16}\log .0005 &= \bar{1}.3811 \\ \log d &= 1.0159 \\ \text{whence } d &= 10.4 \end{aligned}$$

Bottom width $md = 0.6 \times 10.4 = 6.24$, and top width $= 37.4$

Area $= a_1 d^2 = 2.1 \times (10.4)^2 = 226$, and $v = \frac{750}{226} = 3.32$

This velocity would be too great for earth. If the s cannot be reduced the most economic section must be abandoned and a flatter section adopted that will give greater friction and so reduce the velocity. Try a section in which $m = 8$.

The only change in data will be in log k, which now becomes log $k = 1.5905$. Repeating the computations we get

$d = 5.2$; bottom width $= 41.6$; top width $= 57.2$

$a_1 = 9.5$, $a = 9.5 \times (5.2)^2 = 257$ and $v = 2.92$

Example 2: Given, a vitrified brick sewer with 5 ft. diameter ($d = 5.0$), and $s = .002$; what quantity is passing when the sewer is flowing with depth $= 0.4d$?

Solution: From equation I $(qn) = \left(\frac{d\, s^{\frac{3}{16}}}{k}\right)^{\frac{8}{3}}$

$$\begin{aligned} \log 5 &= 0.6990 \\ \tfrac{3}{16}\log .002 &= \bar{1}.4940 \\ &\overline{\bar{1}.1930} \\ \log k &= 0.3023 \\ &\overline{\bar{1}.8907} \end{aligned}$$

$$\log (qn) = \tfrac{8}{3}(-1 + .8907) = \tfrac{1}{3}(-8 + 7.1256)$$
$$= \tfrac{1}{3}(-9 + 8.1256)$$
$$= -3 + 2.7085 = \bar{1}.7085. \text{ Therefore}$$
$$qn = .511$$

For unglazed brick $n = .014$, therefore $q = .511 \div .014 = 36.5$

If the problem be: To find the depth h, at which water will flow in a sewer when given d, q, s, and n, we would workout log k and go into the table to find the ratio h/d, which ratio multiplied by d gives h.

A further reduction of the labor of computations in hydraulics is offered in Fig. 2, which is designed to solve Equation I.

The casual reader will not appreciate what is offered in the chart, but one who has struggled with the Chezy and Kutter formulas can appreciate it.

To those who may be interested in how this chart was designed the key lies in writing equation 1 thus:

$$d\, s^{\frac{3}{16}} = x = k\, (qn)^{\frac{3}{8}}$$

Here are two equations, each with three variables, (qn) being considered as one quantity and x being the same in both equations. Two charts were designed, one for each equation with the condition imposed that the horizontal spacing should be the same in each. These charts are placed one over the other. Note that we are not concerned with the numerical value of x, we need only to know the *point* on the x line that would represent x in the equation. Examples of the use of the chart are given thereon.

Finally it should be understood that Manning's formula was not designed primarily to apply to cast- and wrought-iron pipes flowing full, and for such it does not check so well with the Chezy formula. In order to get a more satisfactory check the n has been modified (varying slightly with s) as shown at top of the list of values of n on the chart. These modified values of n should also be used in computations from Fig. 1 and it would seem rational to use them for vitrified sewer pipes.

It is the writer's opinion that the chart will give results with a degree of accuracy consistent with that possible in determining n.

Since this article was prepared, a valuable contribution to information on flow of water through pipes of clay and of concrete has been supplied by the United States Department of Agriculture, Bulletin 854. The matter was prepared by D. L. Yarnell and Sherman M. Woodward, from experiments of State University of Iowa. The experiments included diameters from 4 to 12 in. The final formula recommended by the authors for such tile flowing full is $V = 138 r^{\frac{2}{3}} S^{\frac{1}{2}}$. This would give 0.0108 for the n in Manning's formula. This seems independent of S, hence, we may take $n = 0.011$ for all cases of clay and concrete tile running full. The authors do not mention Manning's formula. Evidently they derived the exponents of r and s independently, a fact that should add confidence in the Manning formula.

Government Railroad Guarantee

During the six-month guarantee period, $567,000,000 was paid to the railroads. The guarantee period ended Aug. 31, and the Treasury of the United States will be relieved of that expenditure.

Tarred Macadam Scores High in British Road Tests

An ordinary tar-macadam road, constructed of a blue basaltic stone impregnated with tar and its surface sealed with distilled tar, was considered the best of a number of types including waterbound macadam, surface-treated macadam, and tar and bituminous macadam, by certain British road engineers upon observing their condition recently after subjection to five years of main-line travel. The tarred macadam was one of nine experimental lengths of roadway laid in 1915 on the Great North Road at Dunblane, West Perthshire, Scotland. Each section was about 100 yd in length and all nine were laid at a total cost of £663. The sections are on an approximate 2½ per cent grade, in a climate where the annual rainfall is about 40 in., where temperature variations are not excessive, and where the duration of frost is normal.

The forms of construction under test were: Section 1, ordinary waterbound macadam; Section 2, waterbound macadam surface treated with distilled tar; Section 3, macadam 3 in. thick grouted with a mixture of pitch and sand; Section 4, macadam 3 in. thick grouted with pitch and oil; Section 5, macadam 3 in. thick grouted with a mixture of refined Trinidad bitumen and tar; Section 6, ordinary tar macadam composed of a tarred material surface sealed with distilled tar; Section 7, macadam impregnated with two parts of tar and one part of refined Trinidad bitumen; Section 8, a tarred material, surface sealed with Mexican bituminous mixture; and an extra section of macadam grouted with 80 per cent mexphalte and 20 per cent fluxphalte. The stone csed in all sections was blue whinstone, and according to the Road Board's provisional classification of road stone was classified as "very poor." This classification is based on physical tests only, at the National Physical Laboratory, and takes no account of the cementing properties of the stone.

Tar Macadam Section Best

Engineers making the investigation upon the test lengths agreed that Section 6 was the best and stood alone. Observations show that the average convexity of the surface on this secion had slightly increased. The surface was found waterproof, dustless, non-slippery, and durable, and not affected by atmospherical changes. It was agreed that such construction was suitable for main-road traffic under all conditions and its construction could be expeditiously carried out.

Less successful results, though not at all unsatisfactory, were secured in constructing all the other experimental sections save the first and second. These two methods of construction were condemned as entirely inadequate to main-road traffic. The slightly unsatisfactory results on other sections were due to the apparent lack of affinity between the tar surface dressing and the bitumen with which the rock was impregnated. The conclusion drawn from this observation was that where bitumens are used for the main body of the roadway it necessarily follows that the surface coat should be of bitumen as distinguished from tar. In commenting upon ths particular point W. L. Gibson, county road surveyor and engineer, Western Division, Perthshire, asserted, according to *The Surveyor*, that, as the temperature at which the bitumen is used is 400 deg. F. while the temperature of the tar rarely

exceeds 250 deg. F. one cannot expect the two materials which have no affinity to amalgamate properly.

The principal feature of the test was the almost imperceptible wear, despite heavy traffic sustained by all sections, a fact due mostly to the care taken in preparing foundations and in exercising "stitch-in-time" maintenance methods.

Coefficient of Roughness for Drainage Ditches

Photographs Aid Selection of Values for Proposed Channels—Tests Show Actual Values for Varying Conditions

A WIDE range in the roughness coefficient for the Kutter formula, as applied to flow in existing drainage channels, and a suggested use of photographs or pictures to assist in the selection of the coefficients for proposed channels of this kind, are the main points of a recently published report on the flow of water in dredged drainage ditches by C. E. Ramser, senior drainage engineer, U. S. Department of Agriculture.

To determine the value of the coefficient of roughness n in the Kutter formula under the conditions existing in dredged ditches an extended series of observations has been conducted at different points in the central, south and southwest sections of the country. The minimum values thus obtained range from 0.0128 to 0.0253 and the maximum values from 0.0550 to 0.1620. The extremely low figures of 0.0128 and 0.0140 were obtained in Iowa and are attributed mainly to the lining of the channels with a slimy and slippery mud which reduced the friction materially. The excellent condition and uniformity of section of the channels were minor factors in the result. The excessively high figures of 0.1500 to 0.1620 were obtained in Tennessee, in a crooked channel having irregular slopes and bottom, caving sides, trees and bushes on the slopes and logs and drift on the bottom. A close second to this record was obtained in Florida, with values of 0.1400 and 0.1080 in a straight stretch of ditch having the channel practically covered with vegetation.

All the channels were in alluvial ground and the report states that no noticeable difference was detected in the retarding effect of different kinds of soil. In the study of the ditches, irregularities of sides and bottom were noted separately, as the bottom alone is often the chief cause of retardation during low stages of water. Growth of vegetation checks erosion and promotes silting, but on the other hand active erosion checks and often prevents such growth. It is pointed out that with erosion in a new and well-finished dredged channel the roughness coefficient increases, but that the flow capacity also increases, since the enlarged cross-section more than offsets the retarding effect of the higher coefficient.

On the basis of investigations Mr. Ramser concludes that in designing a dredged channel a value of 0.030 for n should be used if the channel is to be dredged smooth and 0.035 if it is to be dredged roughly. When these values are used the channels should be maintained carefully. If it is known that they will be neglected the value should be selected in accordance with the worst conditions anticipated. When it is known that a soft mud lining will exist and that the channels will be maintained in good condition a somewhat lower value of n may be employed.

Other conclusions as to dredged channels may be summarized as follows: (1) A deposit of slimy silt on the sides and bottom greatly reduces frictional resistance to flow; (2) clearing of perennial growth will increase the flow capacity greatly; (3) summer growth of grass and weeds decreases the capacity greatly, the same being true of accumulation of drift, trees and logs; (4) after a certain amount of erosion further erosion may not increase the roughness; (5) the roughness coefficient is appreciably higher for a roughly dredged channel; (6) the hydraulic efficiency deteriorates quickly unless the channel is maintained systematically; (7) abrupt variations in cross-section reduce the hydraulic efficiency of a channel.

As to the use of photographs and pictures in selecting a value of n for a proposed channel, Mr. Ramser points out that the engineer who has had a wide personal observation of conditions in channels for which values have been determined is generally qualified to select a proper value for a new channel. But the engineer who has not had similar experience may get material assistance from views and descriptions of existing channels for which values have been determined by experiment. For this reason the report is accompanied by numerous views and careful descriptions of the channels in which flow observations have been made. By comparing the relative conditions and values the engineer may guide his judgment in selecting a proper roughness coefficient for the probable or expected condition of a proposed channel.

Montreal Bridge Fire Starts Discussion of Tunnel and Bridge Projects

Following the roadway fire on the Victoria bridge at Montreal on Aug. 21, 1920, the dependence of the city and in fact of the entire north bank of the St. Lawrence River on this single crossing became painfully apparent. The fire, cause unknown, started in the wood flooring of the highway deck and traveled along the bridge quite rapidly. By the efforts of the Fire Department, aided by rain, the flames were kept from the adjacent railway and electric car tracks, but about half a mile of the vehicle roadway was completely destroyed.

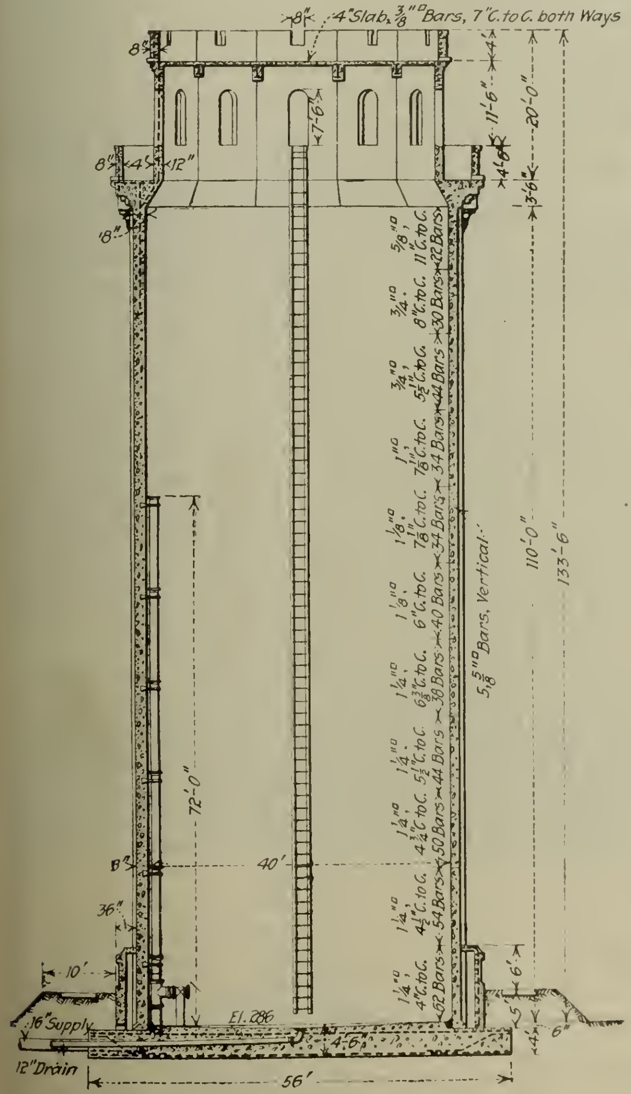
Thousands of motor cars had to seek passage to the city by ferry boat at Longueil, three miles away, during the period that the bridge roadway was interrupted. As this ferry accommodated only a small number of cars, some had to wait as much as ten hours to make the crossing. The prices of garden produce in Montreal increased by about 30 per cent, as most of the produce comes from the other bank of the river. Tourists carried away the bad news of the traffic conditions at the ferry crossing, and in this way Montreal had some gloomy advertising. The isolated position of Canada's metropolitan city was for almost the first time clearly realized. The Victoria bridge is the only highway bridge across the St. Lawrence River. As a result of the accident, already two bridge projects and one tunnel project are under discussion. While the great cost of constructing any such works is likely to make this talk end without results, the present attitude of the Montreal people may be stated as being strongly in favor of improving the highway connection between the two banks of the river.

Concrete Standpipe for 110 Ft. Head at Kansas City

With 40 Ft. Diameter Has a Capacity of 1,000,000 Gallons—Top Is 134 Ft. Above Ground—Has Joint at Base

By T. D. Samuel, Jr.
Chief Draftsman, Kansas City, Mo., Water Department

ONE of the largest reinforced-concrete standpipes ever attempted has just been completed for the Kansas City, Mo., water department in the southwest part of the city. It is 40 ft. in diameter and rises 133 ft. 6 in. above the surface of the ground at its base but it is designed to take water up to the 110 ft. elevation. This gives a capacity of 1,000,000 gal. The distinguishing features of the structure are that there is a joint between shaft and base and the shaft was



VERTICAL SECTION THROUGH KANSAS CITY CONCRETE STANDPIPE

carried up to the top as a continuous concreting operation.

The residential district the standpipe serves is some four to seven miles distant from the Turkey Creek Pumping Station, and comprises approximately seven square miles. Within this district are points whose ground elevations are the highest in the city and which could not be supplied with sufficient water pressure from the Turkey Creek Station during the hours of heavy consumption. In order to relieve this situation, the Board of Fire and Water Commissioners decided to construct a standpipe upon the highest point available. Accordingly the Board asked for and received bids on the design and construction of a reinforced-

NEW CONCRETE STANDPIPE FOR KANSAS CITY WATER WORKS

concrete stand pipe with a capacity of 1,000,000 gal. and a water level of 110 ft. above the ground surface at the site selected.

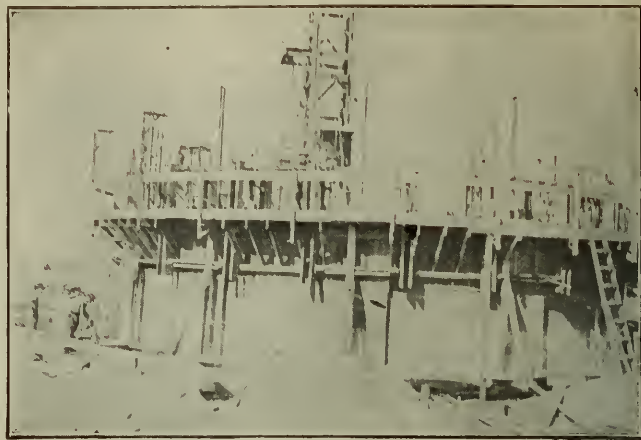
Among the bids received was a general design submitted by the Tifft Construction Co. of Buffalo, N. Y. This design was approved by the Board and the right to use it was purchased from the Tifft company. The Engineering Division of the Water Department completed all detailing of the plans, drew up specifications and advertised for bids. Contract for constructing the stand pipe was awarded to the Finton Construction Company of Kansas City for $50,000.

The district served by the standpipe is regulated by check valves placed on all fed lines running into the district and the height of water within the stand pipe controlled by an altitude valve.

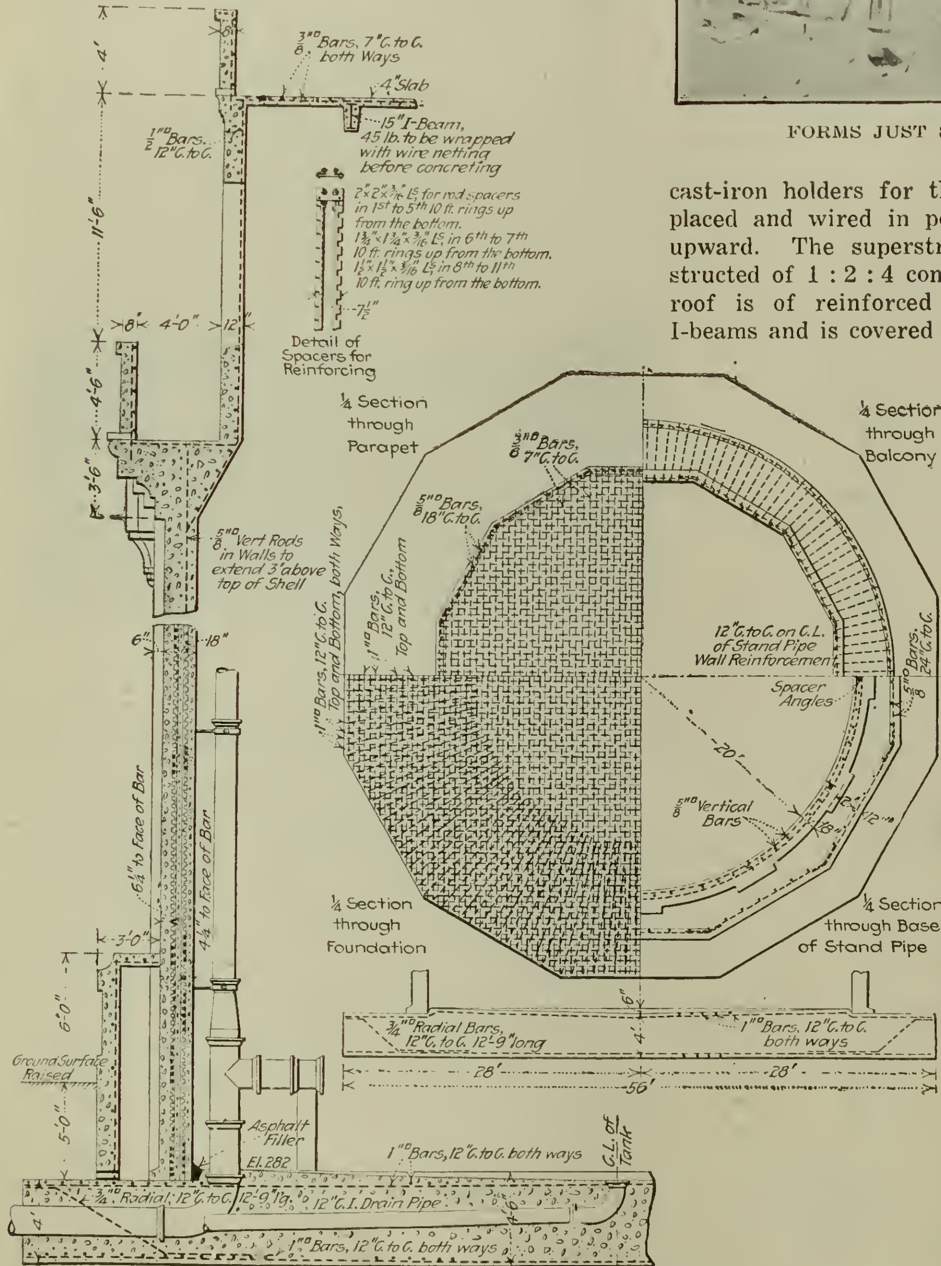
The foundation or base is a 12 sided slab of reinforced concrete 4 ft. thick, with an inscribed diameter of 56 ft. Reinforcement consists of 1-in. square bars in top and bottom running both ways and [illegible] in. square radial bars around the outer portion. Concrete consisted of a 1 : 2 : 4 mixture and was poured in one continuous operation. A recess, whose surface was troweled to a true and smooth finish, was left at the top of the foundation to receive the walls of the stand pipe. A 16 in. cast-iron inlet pipe and a 12 in. cast-iron drain were placed within the foundation. The top of foundation was sloped 6 in. to the center to provide drainage.

The main wall is 18 in. thick throughout its entire height of 110 ft., except for the base which is

flared out. The internal diameter is 40 ft. and there are 12 ribs or pilasters 6 in. thick and 4 ft. wide on the outside of the walls for ornamental purposes. These ribs were poured integral with the wall. Reinforcement within the walls is of circumferential square bars varying in size from 1¼ in., 4 in. c. to c., for the bottom 10 ft. to ⅝ in., 11 in. c. to c. for the top 10 ft. In addition notched angle irons 12 ft. c. to c. are used as guide bars for the horizontal rods and vertical ⅝ in. square bars spaced 2 ft. c. to c. placed between them. A 1 : 1½ : 3 mixture was used in the main wall.



FORMS JUST STARTING FROM BASE



STRUCTURAL DETAILS OF CONCRETE STANDPIPE FOR 110-FT. HEAD AND 40-FT. DIAMETER

Forms for the erection of the walls were built in a ring section, fitted with jacks and jack rods to provide for a continuous sliding form. The operation of pouring was continuous throughout and the pouring was so timed that newly mixed concrete was placed upon concrete which had not yet reached its initial set and yet permitted the forms being moved. Threaded cast-iron holders for the ladders and inlet pipe were placed and wired in position as the work progressed upward. The superstructure and balcony were constructed of 1 : 2 : 4 concrete and were monolithic. The roof is of reinforced concrete with structural steel I-beams and is covered with 5 ply tar and gravel. The ornamental base was poured after the walls of the stand pipe had been completed.

In the concrete, portland cement mixed with clean sharp Kaw River sand and broken limestone of a size that the largest piece would readily pass a 2 in. ring and the smallest a ¼ in. ring were used. Reinforcing bars were of open-hearth high-carbon steel rolled from new stock with a tensile strength of not less than 85,000 lb. per square inch and an elastic limit not less than 52,500 lb. per square inch. A 40-diameter lap on all bars was used.

As the work progressed upward, the walls were cleaned of all water marks and all cavities filled with a 1 : 2 mortar and after the completion of the walls, the entire surface that was exposed to view was finished by rubbing in a thin coat of 1 : 2 cement mortar with carborundum bricks. The recess or groove around the bottom on the inside of the stand pipe was filled with hot asphaltum to act as a filler and keep water from passing through the joint between the walls and the foundation.

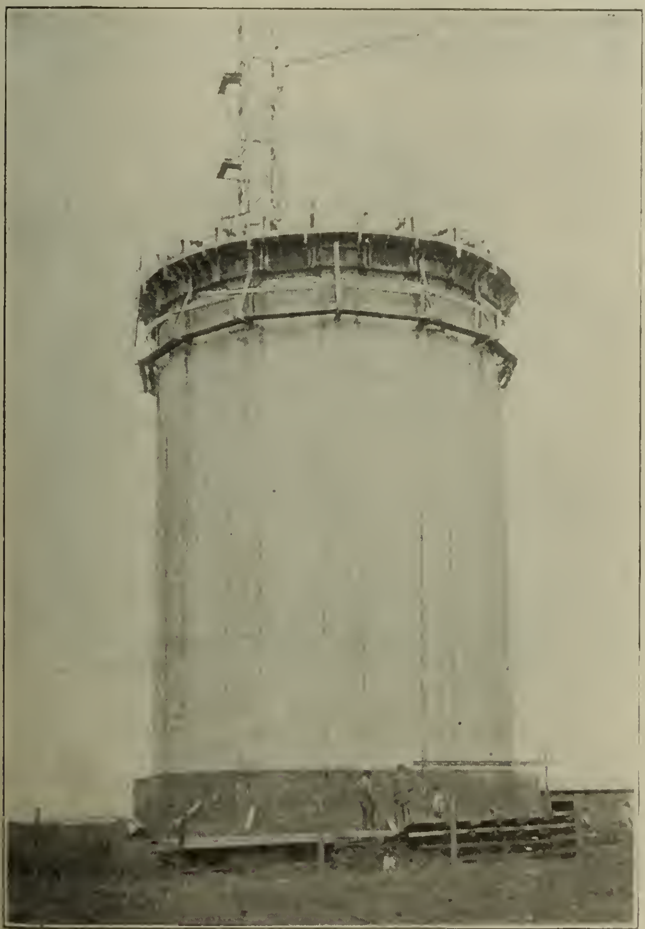
An earthen terrace with concrete walk on the top was built up around the standpipe and ornamental electric light standards set at its four corners.

No outside forms were used for the foundation, the concrete being poured in contact with the clay bank. The foundation was poured in two continuous days of 24 hours each, and the walls in 14 continuous days of 24

hours each. Work began on the excavation in July, 1919, but owing to adverse weather conditions, slowness in getting material and labor troubles, the standpipe was not completed until January, 1920.

In the computations, the tensile stresses allowed for steel were 15,000 lb. per square inch. Tensile stresses and amount of steel required in the walls were figured in the usual manner for water pressures at various depths. Computations for soil pressures were made in the usual manner. Borings at site of standpipe showed a bed of dry yellow clay over 35 ft. thick and tests of bearing power gave results of 4 tons per square foot. Three tons per square foot was allowed in figuring the required area of base.

No waterproofing of any character was used at first on the work, it being thought that the richness of con-



STANDPIPE HALF COMPLETED

crete used and the care taken in its mixing and placing would make it dense enough to be waterproof but after the standpipe had been in service several days and had had a head of water of over 90 ft. in it, several places on the walls developed slight seepage leaks. Examination disclosed that these were probably caused by laitance. The joint at the bottom also leaked and after the standpipe had been emptied this was found to have been caused by the asphaltum filler used in the recess, having hardened and contracted under a water pressure of about 50°.

The leaks in the walls were not serious from the standpoint of water wastage but on account of appearance and possible damage that might be caused this winter by frost and freezing, it was decided to waterproof the entire structure where water came in contact with the surface.

The standpipe was drained, thoroughly cleaned and dried and two coats of "Stark's Waterproof Paint and Cement Putty" applied to the outside and inside surfaces of the shell. The asphaltum filler in the recess was removed and the surface and a short distance up the side walls given a coat of "Johns Manville Concrete Primer." This was allowed to set and then a 32 in. wide 5-ply waterproofing membrane was applied. This extended up the side wall, down over the recess in the base and out over the base the balance of the width. The membrane consisted of No. 14 impregnated asbestos felts mopped in hot self-healing cement in two-ply construction. Over this was applied in one-ply construction a layer of saturated mule hide membrane and following this an additional two plies of impregnated asbestos felts mopped in self-healing cement. In the space left in the recess at the base, self-healing cement was poured while hot.

The standpipe has been in service over three months at this date and has given very satisfactory service. There has been no more leakage.

All construction work was under the direct supervision of Charles S. Foreman, first assistant engineer of the Water Department.

Zinc-Chloride Loss from Treated Ties

IN use of inorganic salts for preservative treatment of wood the effect of the preservative is likely to be reduced by its leaching out of the wood when affected by water or moisture. Experiments on this leaching action and its effect in railway ties treated with zinc-chloride, reported by Ernest Bateman, of the U. S. Forest Products Laboratory, in Bulletin No. 227 of the American Railway Engineering Association, indicates a segregation of the preservative. During wet weather leaching takes place, with the result that basic zinc-chloride is deposited in the tie. During dry weather the moisture is evaporated, thus concentrating the solution, the excess hydrochloric acid being either lost in evaporation or taken up by redissolving any basic chloride which may be present. The conclusions presented by Mr. Bateman are substantially as follows: In the leaching process the chlorine leaches faster than the zinc, part of which is left behind as an insoluble basic chloride. This indicates that the chlorine plays a very important part and that if the zinc does not have its proper amount of acid radical it loses its preserving power. In other words, as long as the zinc remains soluble it is toxic, but as soon as the insoluble basic chlorides are formed, the zinc so combined has little or no toxic action. The presence of comparatively large amounts of zinc does not insure that the wood is protected against rot unless a sufficient amount of acid radical is present. The soluble basic chlorides of zinc have little or no toxic value.

Railway Motor Car Service in Australia

A 5-ton motor truck converted into a motor car for operating the Grafton and Lismore branch of the New South Wales Government Railways has proved so successful, according to the report of the railway commissioners for the year ending June 30, 1920, that other motor cars are to be built for similar service on other branch lines.

Fast Railway Tunneling in France During the War

Single-Track Tunnel in Rock Driven and Lined in 75 Days for War Emergency—Continuous Work in Eight-Hour Shifts

RAPID progress in tunneling was accomplished by the Northern Railway of France in 1918 as part of the work of doubletracking a section of the line between Paris and Treport to form an alternative to a route threatened by the enemy. The progress averaged 16 ft. per day of single-track tunnel, lined and ready for traffic. At Marseille-en-Beauvaisis there were two single-track tunnels 180 and 600 ft. long, separated by an open cut 66 ft. deep and 260 ft. long. Widening these tunnels was out of the question, as the existing line was handling heavy traffic.

The new tunnel for the second track had to be nearly 1,200 ft. long, as the great amount of excavation from a large cut corresponding to that on the old line could have been removed only through the southern section of the new tunnel and would have delayed materially the work whose speedy completion was of the utmost importance. The line is on an ascending grade of 0.6 per cent to the north. About 577 ft. of the southern end of the tunnel is on a curve having a radius of 1,640 ft., with a parabolic transition curve in the track. The tunnel was in a badly fissured chalk formation and was located with its center line about 60 ft. from that of the old tunnel in order that it might be considered in solid ground where it paralleled the open cut and that its construction would not affect the stability of the existing work. The section, shown in the accompanying drawing, is identical with that of the old tunnel, but its lining is of concrete instead of brick. In the curved portion the thickness of lining is 24 in. instead of 14 in. Recesses or refuges for the section men are provided on the west side at intervals of 80 ft.

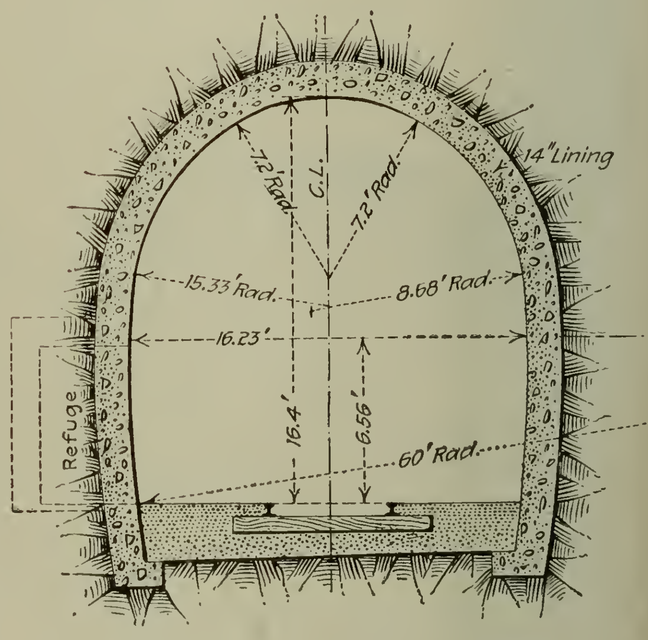
Method of Lining

Work was commenced simultaneously at both ends, the first step being a bottom heading on the center line. As soon as this had advanced about 65 ft. a top center heading was started, holes being broken through its floor to allow of discharging the rock into cars on a portable construction track of 24-in. gage in the bottom heading. This excavated material was used to form the approach fills at the ends of the tunnel. As soon as the top heading had advanced sufficiently a third gang widened the top heading and cut side trenches for the seats of the arch lining. A fourth gang erected the centers and a fifth gang placed the concrete. This lining rested partly upon the rock and partly upon sills to be supported later by heavy posts.

Transverse struts having been placed to brace the arch at the springing line, the widening of the bottom heading was undertaken to place the side walls, the arch being underpinned by heavy inclined posts at 6½-ft. intervals. As soon as these posts were placed excavation was stopped and the footings for the walls were built. Curved ribs for the forms were then spiked to the posts and the concrete for the side walls was placed. The side walls were built in sections separated by piers of solid rock, which were not excavated until the concrete had set. With this arrangement the arch was supported by underpinning for only short lengths, so that there was no fear of settlement and no necessity of taking observations for settlement.

At the north end a main highway crosses the tunnel with very little cover. On account of the traffic of heavy artillery and motor trucks it was necessary to establish a temporary bridge to carry the load over the tunnel roof. At the south end, an aqueduct 5 ft. wide had to be extended and carried on difficult foundations.

The material encountered was such as to permit of rapid progress, but it soon began to disintegrate on exposure to the air, which necessitated heavy timbering and almost continuous sheeting. One of the great difficulties was to procure a sufficient supply of timber in the short time available. From April 20 to May 20, 1918, a force of 240 workmen was engaged on the preliminary work of leveling and locating the line, installing the camp, arranging for the supply and storage of provisions and materials, placing the construction tracks on the approaches and excavating the approach cut.



CROSS-SECTION OF FRENCH TUNNEL

Tunneling was commenced May 21, 1918, and the railway company undertook to have the work completed and the line ready for traffic in 100 days from that date. The bottom headings met on June 28 and the top headings on July 4. All the masonry was completed by Aug. 2, and tracklaying and ballasting by Aug. 4, or only 75 days after the commencement of the work. On Aug. 6 the line was put in operation. Miners from districts invaded by the Germans composed the greater part of the forces, which numbered 520 men from May 21 to July 6, when the number was increased to 630. The work proceeded continuously, the men working in three 8-hr. shifts. A contract was let to Fougerolle Brothers, of Paris, and construction was under the direction of Mr. Aumont and Mr. Candlier, engineers for the Northern Railway, with Mr. Petit as engineer in charge. The above description is from an article in the *Révue Générale des Chemins de Fer* by Mr. Moutier, assistant superintendent.

Standard Method of Recording Construction Accidents

Argument and Instructions for Compiling Accident Statistics Formulated by the Construction Section of the National Safety Council at Recent Annual Congress

THE following data form a report presented by the Statistical and Standardization Committee of the Construction Section, National Safety Council, at the recent annual congress of the Council held in Milwaukee, Wis. The members of the committee are F. C. Davidson, Dwight P. Robinson & Co.; F. S. Robinson, Detroit General Builders' Association; and J. E. Griffith, E. I. Du Pont de Nemours & Co.:

The keeping of systematic records is of the greatest assistance in preventing accidents and is a fundamental factor in effective safety work:

(1) By showing executives the number and the causes of accidents and enabling them to grasp clearly the waste and loss of efficiency which accidents represent. Only when the facts regarding accidents are presented in an exact, concise form instead of in a vague general way, can a busy executive be reasonably expected to realize fully the importance of the accident problem and its bearing upon the well being of his employees and the productiveness of his business.

(2) By showing operating executives and safety men where accidents are occurring and from what causes, so that they may know where to concentrate their efforts for prevention.

(3) By attracting the attention of foremen and workmen, and stimulating rivalry between different organizations or between different divisions or groups in the same organizations, so that superintendents, foremen, and workmen will strive to produce a record with respect to accidents which will compare favorably with other divisions and with their own past record.

Value of Accident Statistics

As a matter of fact in the field of accident prevention as a whole, not much headway was made in reducing the frequency of accident occurence until accident statistics were collected which showed the causes responsible for the greater number of accidents, and directed effective prevention measures. The concerns which have been most successful in securing the interest and co-operation of executives, foremen, and workmen in accident prevention, are practically without exception those which have a satisfactory system of recording accidents and who have devised means for presenting these records in an interesting form.

A uniform method of compiling accident statistics should be adopted by all members of the Construction Section:

(1) It enables members to compare their various accident records and lets each individual member know how his record compares to others.

(2) It stimulates friendly rivalry between different members to achieve good accident records.

(3) Having the accident records of all members on a common basis enables the combined experience of all members to be analyzed in a scientific manner: (a) Thus, in a very much shorter time than if each depended solely on his individual data, the principal hazards in the whole construction field can be fairly definitely determined; (b), this makes it possible for all to devote their energies to the solution of the most urgent accident problems in the construction field, and to exchange ideas and experiences to the most useful advantage; (c), it affords a sound basis for concerted action by the Construction Section in such possible ways; as assisting in the preparation of standard codes or in bringing pressure upon manufacturers of construction equipment to induce them to guard their devices at the source; (d), it makes it possible for valuable special studies to be made in correlating accident statistics with other phases of construction work, such as endeavoring to determine whether or not any definite relation exists between accidents and such other factors as overtime work, night work, labor turnover, labor unrest or special types of construction.

Reporting Accidents

Every accident, large or small, that causes any sort of personal injury, serious or trivial, whether or not it requires any medical expenditure should be reported and made a matter of record on a printed form provided for that purpose. The reason is that in the case of every accident there is a possibility of subsequent complications such as a serious infection. Consequently, it is advisable to have available the essential data relating to the case, such as the name of injured and the time, place, cause and nature of the injury. There are various satisfactory systems for obtaining a formal report of every accident; some of the methods in use are:

(1) The foreman makes out a report of every accident on a prescribed form. One copy of this report is kept on file in the field office and one copy is sent to the home office.

(2) Where there is a medical station or field hospital on the job, a record of every injury is made there.

(3) Where there is a safety department on the job, a report of every accident is made by this department.

(4) One of the most advantageous methods is to use the standard state accident report forms prescribed by the state authority administering the compensation law in any particular state. Since at the present time almost all the states have compensation laws and most of them require a report on all accidents, it saves duplication of effort if the forms of the particular state in which the job is located are used for reporting accidents. A certain individual on the job, a clerk, or a first-aid man can be designated to see that every accident is reported properly and promptly on the state accident blanks. A copy can be kept on file in the job office and a copy can be sent to the home office.

FORM 1 FOR USE BY FOREMEN FOR REPORTING ACCIDENTS

FOREMAN'S REPORT OF ACCIDENT

Name: Check No
Occupation:

Date injured: Hour of Day: A M / P M
Weather conditions at time of accident
Place where accident occurred:

Injured person's immediate superior
Where was he at time of accident?
Had employes been instructed in the work? By whom?
Machinery, tool or appliance (if any) involved?
Is it in good condition? Was safeguard provided?
Describe in full how accident happened:

Nature of injury:
Disposition made of injured:
Witnesses to accident or names of persons with knowledge of accident?
What can be done to prevent a similar accident:

Date 192 Foreman.

(5) Form 1 is for use by foremen in reporting accidents and indicates the type of essential facts which should be made a matter of record in the case of every accident.

For statistical purposes the following have been adopted for standard definitions:

Tabulation Accidents, Diseases and Injuries—All accidents, diseases and injuries arising out of the employment and resulting in death, permanent disability, or in the loss of time other than the remainder of the day, shift or turn on which the injury was incurred should be classified as tabulatable accidents, diseases and injuries. Tabulatable accidents are commonly called "Lost Time" accidents, although

the former term is preferable due to the fact that in the use of the latter term there is danger that the idea might be conveyed that the occasional permanent partial disability with no lost time connected with it is not to be counted. Tabulatable accidents are the only accidents which should be used for comparative or publicity purposes.

Reportable Accidents, Diseases and Injuries—These include all tabulatable or "Lost Time" accidents, diseases and injuries and all non-tabulatable or "No Lost Time" accidents, diseases and injuries.

Compensable Accidents, Diseases and Injuries—These, as used in any report in accordance with the practice in any particular state, should be shown separately and clearly defined.

Permanent Total Disability—To this group should be assigned every accident, disease, or injury which is designated by statute as permanent total disability or which permanently incapacitates the workman from performing any work continuously in any gainful occupation.

Permanent Partial Disability—To this group should be assigned every accident, disease or injury (less than permanent total disability) which results in the loss of, or in the permanent impairment of any function of the body.

Fatal and Non-Fatal—For statistical purposes, all accidents or injuries are to be considered non-fatal which do not terminate in the death of the injured employee within twenty-eight days of the date on which the injury was sustained. No subsequent correction of the original tabulation requires to be made of non-fatal injuries as thus defined which terminate fatally after more than twenty-eight days of the date on which the injury was sustained.

Days Lost Time—Days lost time due to accident should be expressed in terms of working days. Sunday is not to be counted as a working day. Saturday should be counted as a full day, even though only a half day is worked. Calendar days can be converted into working days by multiplying by 6/7.

Accident Rates

The basis of all accident rates is necessarily the number of men exposed to the risk of accident.

It is absolutely necessary to have a common unit for measuring accidents in all occupations, all industries, and all states or countries. Therefore, it is recommended that all members of the Construction Section adopt the unit of 1,000 hr. exposure or 1,000 working man-hours as the basis for calculating all accident rates. This unit has been adopted by the U. S. Dept. of Labor Statistics and endorsed by the International Association of Industrial Accident Boards & Commissions and by many leading members of the National Safety Council.

There are two fundamental kinds of accident rates which it is recommended that all members compute: (a) Accident Frequency Rates. (b) Accident Severity Rates.

An accident frequency rate is an expression stating the number of tabulatable or lost time accidents occurring in a specified period of time per given number of 1,000 man-hour units of exposure. The accident frequency rate is generally stated as the number of tabulatable, or lost time, accidents per hundred 1,000 man-hour units of exposure (per 100,000 man-hours worked) or per thousand 1,000 man-hour units of exposure (per 1,000,000 man-hours worked).

Method of Computation—The number of tabulatable or lost time accidents occurring in any given period are known from the accident reports. The number of man-hours worked during the given period are known from the regular records of any company. Hence, the accident frequency rate for the given period is obtained by dividing the number of tabulatable or lost time accidents by the actual number of 1,000 man-hour units of exposure. The quotient represents the number of lost time accidents per 1,000 man-hour units of exposure or per each 1,000 man-hours worked. The accident frequency rate for the period is stated either as the number of tabulatable or lost time accidents per 100,000 man-hours worked or per 1,000,000 man-hours worked.

FIG. 1—FORM FOR COMPILING ACCIDENT FREQUENCY RATES

Jobs or Depts.	No. of Man-Hours Worked	No. of Tabulatable or Lost Time Accidents				Temporary Disabilities			Frequency Rate Accidents per 1,000,000 Man-Hours Worked
		Total	Deaths	Permanent Total Disabilities	Permanent Partial Disabilities	Over Two Weeks	Over One to Two Weeks	One Week and Under	
Total									

A concrete example to illustrate the method of computing the accident frequency rate is as follows: The Atlantic Construction Co. in the month of May had occur on their construction jobs a total of 10 tabulatable or lost time accidents. The total number of man-hours worked on the jobs of the Atlantic Construction Co. during the month of May was 179,880, which is equivalent to 179 1,000 man-hour units of exposure. Therefore divided 10 $\times$ 179.88; the quotient is 0.056 which represents the number of lost time accidents per each 1,000 man-hour units of exposure, or per each 1,000 man-hours worked. The accident frequency rate of the Atlantic Construction Co. for the month of May is, therefore, stated either as 5.6 tabulatable or lost time accidents per 100,000 man-hours worked, or as 56 tabulatable or lost time accidents per 1,000,000 man-hours worked. A sample form recommended for use in tabulating accident frequency rates is shown by Fig. 1.

The purpose of accident severity rates is to compare the relative seriousness of accidents. The only stable, convenient and satisfactory basis for measuring the relative seriousness of various accidents is by the time lost. An accident severity rate is an attempt to express in a standard way the economic cost of industrial accidents in terms of time lost.

An accident severity rate is an expression stating the number of working days lost per each 1,000 man-hour units of exposure (or 1,000 man-hours worked) due to the tabulatable or lost time accidents occurring in a given period.

Method of Computing—The number of working days lost due to the accidents occurring in the given period are known in the case of all temporary disabilities.

Furthermore, the number of fatalities, permanent total disabilities and also the number and degree of the permanent partial disabilities occurring in the given period are known. In order to derive an expresion in the form of a rate the fatalities and permanent disabilities must be taken into account. Therefore, for statistical purposes, to each fatality and permanent disability must be assigned arbitrary figures representing an equivalent number of days lost. The table of equivalents which is used by the U. S.

FIG. 2—FORM FOR COMPILING ACCIDENT SEVERITY RATES

Jobs or Depts.	No. of Man-Hours Worked	Days Lost Due to: Total Days Lost	Death	Permanent Total Disabilities	Permanent Partial Disabilities	Temporary Disabilities: Over Two Weeks	Over One to Two Weeks	One Week and Less	[illegible] per 1,000 Man-Hours Worked
Total..									

Department of Labor Statistics, the International Association of Industrial Accident Boards and Commissions, the National Safety Council, and others is shown in Table 1.

The number of days lost due to the temporary disabilities is added to the number of days obtained by taking the equivalents of the fatalities and permanent disabilities and thus the total days lost due to the accidents occurring in the given period are known.

TABLE I—SCALE OF TIME LOSSES FOR DEATHS AND PERMANENT DISABILITIES

(Its use is advocated by the International Association of Industrial Accident Boards and Commissions and by the United States Bureau of Labor Statistics)

Nature of Injury	Degree of Disability in Percent of Permanent Total Disability	Days Lost
Death	100	6,000
Permanent total disability	100	6,000
Arm above elbow, dismemberment	75	4,500
Arm at or below elbow, dismemberment	60	3,600
Hand, dismemberment	50	3,000
Thumb, any permanent disability of	10	600
Any one finger, any permanent disability of	5	300
Two fingers, any permanent disability of	12½	750
Three fingers, any permanent disability of	20	1,200
Four fingers, any permanent disability of	30	1,800
Thumb and one finger, any permanent disability of	20	1,200
Thumb and two fingers, any permanent disability of	25	1,500
Thumb and three fingers, any permanent disability of	33⅓	2,000
Thumb and four fingers, any permanent disability of	40	2,400
Leg above knee, dismemberment	75	4,500
Leg at or below knee, dismemberment	50	3,000
Foot dismemberment	40	2,400
Great toe or any two or more toes, any permanent disability of	5	300
One toe, other than great toe, any permanent disability of	00	
One eye, loss of sight	30	1,800
Both eyes, loss of sight	100	6,000
One ear, loss of hearing	10	600
Bonth ears, loss of hearing	50	3,000

Notes. (1) Injuries not involving amputation should be rated as a proportion of the weight assigned to the entire loss of the member involved, in accordance with the degree of impairment. (2) The weighting for impairment of function of any member should be such percentage of the weighting for dismemberment as may be determined by the adjudicating authority in fixing the compensation for such impairment —*i.e.*, if loss of an arm is compensated by 240 weeks indemnity, then an impairment of the arm for which 160 weeks compensation was paid, should rate as two-thirds of the loss of the arm in the above scale. (3 Hernia should be included only as a temporary disability on the basis of the actual time lost.

The number of man-hours worked, or hours of exposure, during the given period are known from the regular records of any company.

Hence the accident severity rate for the given period is obtained by dividing the total days lost by the actual number of 1,000 man-hour units of exposure. The quotient represents the number of days lost per each 1,000 man-hours worked. This figure is stated as the accident severity rate for the given period.

A concrete example to illustrate the method of computing the accident severity rate is as follows:

The Atlantic Construction Co., as cited above, during the month of May had occur on their construction jobs a total of ten tabulatable or lost time accidents; seven of these ten accidents were temporary disabilities, one was fatal, one caused permanent disability and one resulted in the loss of the man's finger, which is a permanent partial disability.

The total number of days lost is determined as follows:

No.	Kind	Days Lost
7	Temporary disabilities	[illegible]
1	Fatal	[illegible]
1	Permanent total disability.	[illegible]
1	Permanent partial disability (one finger lost)	[illegible]
10	Accidents	12,388

* From the actual records of the time lost by the individual [illegible] supplemented possibly in some cases, where an individual has not returned to work at the time of compiling the record by an estimate as to the time [illegible] expert industrial physician.

† From Table I of Equivalents

The total number of man-hours werked on the jobs of the Atlantic Construction Co. during the month of May was 179,880, which is equivalent to 179.88 1,000 man-hour units of exposure.

Therefore, divide 12,388 by 179.88. The quotient is 68.9 which represents the number of days lost per each 1,000 man-hour unit of exposure.

Hence the accident severity rate of the Atlantic Construction Co. for the month of May is stated as 68.9 working days lost per 1,000 man-hours worked. A sample form recommended for use in tabulating accident severity rates is shown in Fig. 2.

Heavy Truck Traffic Under Special Conditions on English Roads

An article on Essex roads and bridges, in *Surveyor and Municipal and County Engineer of* August, 13, 1920, tells of extra-heavy road traffic during or after the railway strike of September, 1919. The following quotations from the article indicate the extent of damage to bridges and of necesasry repairs.

"Statistics taken in November, 1919, show that on one occasion about 2 a.m. a fleet of thirty-nine loaded lorries, representing 585 tons, passed an observation post on the Chelmsford-Colchester road at intervals of 45 seconds; this is mentioned as a sample of what this road was subjected to in the autumn and early winter of 1919. The road is now carrying approximately 2,000 tons per day.

"The strain of heavy motor lorry traffic succeeding the railway strike has been very apparent upon the old county bridges on certain main roads, and Mr. Sheldon predicts a large expenditure in dealing with the damage already done. On the London-Ipswich road an important iron bridge at Widford near Chelmsford gave way at the abutment in March last and a temporary bridge had to be constructed at a cost of approximately £2,000, while the new bridge when built will probably cost £10,000. Upon the section of the same road lying between Chelmsford and Brentwood a careful examination disclosed that three brick bridges, each about 100 years old, had been seriously damaged since August, 1919, and extensive repairs and strengthenings were immediately necessary. Seeing that the great majority of the county bridges are from 100 to 150 years old, brick built, and were designed and built or strengthened to take coach traffic prior to railways, it is regarded as extraordinary that with present-day traffic they are standing as well as they are."

Experimental Sewage Irrigation Plant in Florida

Filter Effluent Pumped to Field — Discharge of Risers on Pipe Laterals Controlled by Automatic Float Valves

By F. E. Staebner
Drainage Engineer, U. S. Bureau of Public Roads, Washington, D. C.

In the spring of 1919, by arrangement with the Bureau of Public Roads and the Florida Agriculture Experimental Station, a plant to utilize the sewage from the University of Florida was built at Gainesville, Fla., under the direction of the writer. The former disposal plant of the university is retained, consisting of a septic tank and broken stone filter bed. The septic tank gives a rather clear effluent and this is discharged onto the filter bed through four aerating sprays, these discharges being controlled by an automatic siphon and occurring at intervals of about 30 minutes during the daylight hours. The layout of the plant is shown by Fig. 1.

In the outlet from the filter bed a diversion box was built to deliver the water to the new irrigation field or to waste it to the small creek as formerly. As it is intended to use the field for the continuous disposal of the sewage as well as for the growing of crops the effluent is sent through the irrigation system all the year, except when the pumping plant requires an occasional shutdown. In normal operation the water runs by gravity from the filter bed to the diversion box and thence through an inverted siphon to a reinforced-concrete collecting tank, from which it is pumped by a motor-driven centrifugal pump to the irrigation field 400 ft. away. The water is discharged successively through any one of eight automatically operated valves to a small head ditch at that valve, from which it flows over wooden weirs into the furrows between the crop rows. Corn, sorghum and Japanese cane form the 1920 crops.

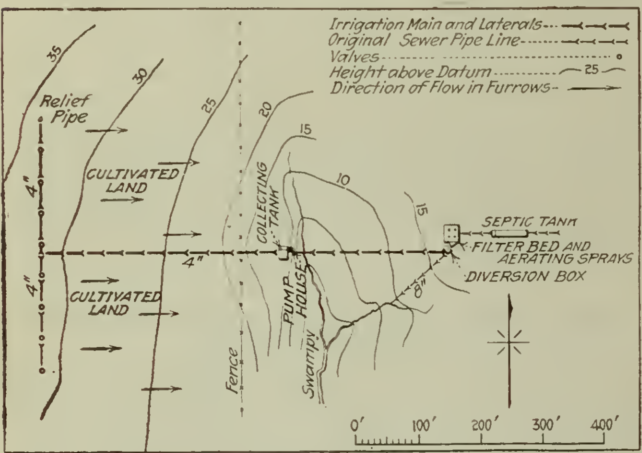


FIG. 1. SEWAGE IRRIGATION ON FLORIDA EXPERIMENTAL FARM

The diversion box, Fig. 2, is 3 ft. square inside, with two diversion walls and an 8-in. irrigating valve, so arranged that with the valve open the sewage discharges through the old 8-in. terra cotta waste line. With the valve closed the sewage rises and flows over

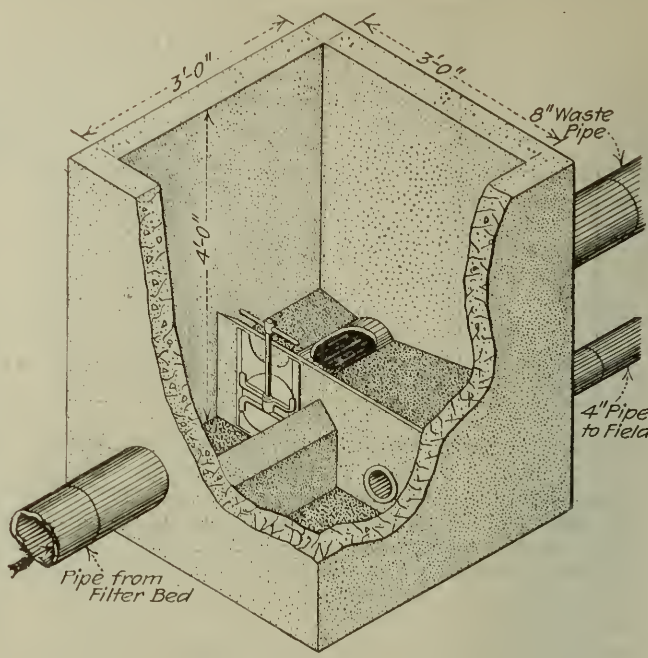


FIG. 2. DIVERSION BOX FOR SEWAGE FLOW

the first diversion wall into a side compartment, from which it flows into the 4-in. terra cotta inverted siphon which takes it to the collecting tank. The second diversion wall serves simply to allow an overflow when the 4-in. line cannot handle the flow, as during heavy storms, the excess passing over the second diversion wall and into the 8-in. waste line. The inverted siphon, 350 ft. long, passes under a small brook and may have a maximum head of about 12 ft. A clean-out plug is located at its lowest point. The concrete collecting tank is 20 x 14½ ft. and 5 ft. deep inside.

An electric control switch automatically operated by a float at selected heights of water starts and stops the 3-hp. motor which is direct connected to a horizontal centrifugal pump. No check valve is used, and at the end of each pumping period the water in the pipes is allowed to run back through the pump into the tank. A 4-in. terra cotta pipe carries the water to the high side of the field to be irrigated. The lowest part of this line is reinforced with concrete and wire up to such a point that the maximum head on the unprotected pipe does not exceed 10 ft. A 4-in. lateral leads to the north and south from the end of the main, along the high side of the field, the surface of which slopes downward in a general easterly direction, as shown in Fig. 1.

In the pipe laterals, which are 50 ft. apart, are placed 8-in. terra cotta riser pipes for the delivery of the water above the ground surface. In each riser is an automatic irrigation valve operated by a float. When the pump starts and water enters the line the float rises and causes a ratchet wheel to revolve. Ordinarily the rising of the float closes the valve and prevents the outlet of water. But after the proper number of closures the ratchet wheel, through an attached crank, draws into position a stop which prevents the closing of the outlet and leaves a free water discharge. It is necessary that the valves in the series be properly synchronized. The valves are designed with a capacity of 100 gal. per minute under normal conditions. Fig. 3 shows one of these valves.

From the valve the water spills over into a head ditch, 50 ft. long, 18 in. wide and 8 in. deep, there being one ditch for each valve. Boards with notches about 2 in. deep and 4 in. wide are placed at each furrow and brought to such position as to give equal flow

FIG. 3. AUTOMATIC SEWAGE IRRIGATION VALVE

in each of the 13 furrows leading away from any one valve. One setting of these weir boards suffices for the season. The water runs a distance of from 175 to 350 ft. down the furrows, according to the dryness of the land. The soil is sandy loam and tends to be very dry.

Four valves are now in use, and it was found that the water available was insufficient to properly irrigate the full field in dry times. During the academic year about 25,000 to 30,000 gal. per day are discharged on the 1.6 acre that have been irrigated, and a thoroughly sanitary disposal has been secured. It requires only the changing of the valve adjustments to bring the other four valves into action and another area of 1.6 acre under irrigation. The plant was not in regular operation until July, 1919, which was too late to show much effect on that season's yield.

Large Area Desirable

For sewage irrigation it is not desirable in general to dispose of the sewage on as small an acreage as possible, but rather on as large an acreage as is available. With this plant it is epected to irrigate the whole 3½ acres available. Other experiments have seemed to indicate that allowing the sewage water to run down every other furrow is as effective agriculturally as allowing it to run down every furrow, so that twice the number of plants may be fertilized and twice the area supplied with a given quantity of sewage.

During the greater part of the past year the pump operated about once every two hours and discharged a little over 2,000 gal. at each pumping period. The valves had been adjusted to discharge three successive times out of a cycle of 12 pumping periods. With this regulation any one plot of ground received what sewage water had been pumped for about six hours per day, and then had about 18 hours in which to dry out before it received any more water. Early in March the operating levels that control the operation of the pump were so charged that the pump should handle about 5,000 gal. at each period. This indicates that there will be about five or six pumpings per day, so that any one plot will take about half the sewage for one day, and be allowed about 2½ days to dry before the next application of sewage.

Cost of Maintenance of Rails

ANNUAL COST of maintenance of rail per mile of track for rails of 85 lb., 100 lb. and 103 lb. per yard is shown in the accompanying table, which is calculated on the basis of the following figures: cost of new rail, $41 per ton; cost of installation, including delivery and taking up and disposing of old rail, $20; salvage value of rail removed, $18 per ton; net cost in track, $43 per ton.

Column A gives the first cost of rail in terms of annual charge at 6 per cent compound interest which will yield the original cost of rail in track ($43) at the expiration of the life of the rail. Column B is the total annual charge including the figure in Column A plus interest and taxes as follows. (1) interest at 6 per cent and tax at 1 per cent on $43, or the annual interest and taxes on the value of rail in track; (2) interest and taxes at the same rates on $18, or the annual carrying charge to the railway at scrap value of rail in track. These two items are $3.01 and $1.26 respectively, or a total of $4.27.

Columns C, E and G give the total annual charges per mile of track for the three weights of rail. Columns D, F, and H are the same figures plus the annual cost of rail maintenance per mile of track, this cost being $135 for the 85-lb. rail, $114 for the 100-lb. and $86 for the 103-lb. rail, under the same conditions of traffic and track.

ANNUAL COST OF MAINTENANCE OF RAIL PER MILE OF TRACK

			85-lb. Rail 133 57 Tons per Mile		100-lb. Rail 157 14 Tons per Mile		130-lb. Rail 204 29 Tons per Mile	
Life of Rail Years	First Cost A	Annual Charge Per Ton B	Annual Charge C	Annual Maintenance D	Annual Charge E	Annual Maintenance F	Annual Charge G	Annual Maintenance H
1	$40 566	$44.836	$5,989	$6,124	$7,046	$7,160	$9,160	$9,246
2	19.629	23.899	3,192	3,327	3,755	3,869	4,882	4,968
3	12.743	17 013	2,272	2,407	2,673	2,787	3,476	3,562
4	9.255	13.525	1,807	1,942	2,125	2,239	2,763	2,849
5	7.202	11.472	1,532	1,667	1.803	1,917	2,344	2,430
10	3.077	7.347	981	1,116	1,115	1,269	1,501	1,587
15	1 743	6.013	803	938	945	1,059	1,228	1,314
20	1.102	5.372	718	853	844	958	1,097	1,183
25	0 739	5.009	669	804	787	901	1,023	1,109
30	0.513	4 783	639	774	737	866	977	1,063

This table is condensed from a tabulation accompanying a paper on "Economic Weights of Rail for Various Classes of Traffic," read at the annual meeting of the Roadmasters and Maintenance of Way Association by J. B. Baker, engineer of maintenance of way, Pennsylvania System (see *Engineering News-Record* of Oct. 7, 1920, p. 715).

Topographers Use Fire Lookout Towers

Topographic engineers of the U. S. Geological Survey, while working on triangulation in the heavily timbered area of northern Maine, saved great expense by making observations from the numerous steel lookout towers erected by the Maine Forestry Commission to aid in protecting the timber from fire. These lookout towers range in height from about 40 to 70 ft. and in each of them a watchman is stationed day and night during the summer and fall. The Government surveyors found that these towers make admirable observing stations, and by using them they were able to do work in five weeks which would otherwise have consumed four or five months. In this way they saved several thousand dollars and were able to cover a larger area than they could otherwise have covered with the funds available.

What the Government is Doing To Help Port Layout

Details of Information So Far Collected by Shipping Board and War Department and Prospects for Future

BY VIRTUE of the recent Shipping Act the United States Shipping Board and the Secretary of War are jointly loaded with the responsibility of promoting port development and the transportation facilities in connection therewith. The extent to which this instruction has been carried out was well outlined by Capt. F. T. Chambers, C. E. C., U. S. N., at the recent meeting of the American Association of Port Authorities. Capt. Chambers was chief engineer of the Port Facilities Commission on the Shipping Board and is now working with the Chief of Engineers of the Army in port work. He is therefore particularly well qualified to speak on the subject.

He said in part:

As the Shipping Board is required by law to sell the ships built during the war it is plain that it cannot be expected to go extensively into the provision of port facilities by the expenditure of government funds. It did find it very necessary before it could build ships to erect shipyard plants in which to build them. But this was war emergency. It furthermore found itself in an insecure position with regard to dry-dock business during the war, first with the Division of Shipyard Plants of the Emergency Fleet Corporation, and afterward as chief engineer of the Port Facilities Commission of the Shipping Board. It was our endeavor to place the necessary dry-docking facilities in "going" ship repair yards so they would be available in peace times as well as for the war emergency. As time was the chief consideration we adopted timber constructed floating dry-docks and marine railways as our program. The marine railways were designed primarily for the wooden ships, and a haul-out capacity of 2,500 tons was adopted for the earliest, changed afterward to 3,200 tons for later designs. The floating dry-docks ranged in capacity from 5,000 to 20,000 tons lift. They were intended for more general use than the marine railway and their capacities were determined in each case, first by the apparent requirement of the particular harbor in question, but also to some extent by the commercial concern which was to own and operate the dock. We then placed dry-docks, or marine railways, or both, in many harbors inclusive of Portland, Maine; Boston, Somerset, Providence, New York, Philadelphia, Baltimore, Norfolk, Charleston, Savannah, Jacksonville, Tampa, Pensacola, Mobile, New Orleans, Beaumont, Galveston, Los Angeles and San Francisco. We also advised the authorities at Portland, Ore., with reference to the design of the new floating dry-dock for that port, and by general agitation of the subject we believe we have been instrumental in starting other dry-dock projects in various ports, so that, except for extremely large ships, the situation as to dry-docking and repairs has been fairly well covered.

The Port Facilities Commission also did some work to relieve the coaling and bunkering situation. Among other items we equipped ten barges with mechanical elevators for bunkering ships in the stream or alongside commercial piers, thus relieving commercial coal piers for the larger operation of supplying cargo coal.

As time went on we were able to devote attention to terminal design, and while we were not justified in spending Shipping Board money for the construction of such facilities, we made many commmercial studies and general engineering layouts, and advised local authorities both as to prospects of business and upon terminal design. We did not hesitate to say to some authorities that their local prospects did not promise hope of a successful overseas business. For instance, at one New England port we stated that the situation of the city with reference to the railroads would not justify the construction of wharfage for foreign trade. At a Southern city we advised a detailed study of the hinterland by the local board of trade before constructing an addition to the municipal terminal, rather than building a pier on the chance that it would bring business to the city. We also made studies of river terminals for large variations of water level under flood and drouth conditions. We started a collection of statistics upon foreign ports but, upon the close of the war and the curtailment of personnel in general, found ourselves under a new administration which did not consider expenditures for the collection of trade statistics for the promotion of port facilities justified. When about to lose practically the entire port facilities force, the Board of Engineers for Rivers and Harbors offered to take over all that part of the personnel engaged upon United States port work. I transferred with this force, taking with me the valuable port facilities files, so that the work is now continuing.

We are still advising local port authorities and to do so we must necessarily have the facts, not only as to local port facilities but as to prospective and actual trade, upon which alone good design can be based. It is a remarkable fact that many boards of trade and chambers of commerce have little thought of investigation along the lines of character and quantity, origin and destination of cargo. If any one of the individuals were contemplating the expenditure of his own funds upon a new merchandising business, he would, beyond a doubt, make very sure of the source of his supplies and the market for them, but the same mode of procedure does not seem to apply when a municipal trade body contemplates an overseas business for its port. I was asked recently by the Mayor of a large river city to tell him off-hand the cost of a terminal for his river front. He quite lost patience with me when I insisted upon a quantitative analysis of the cargo he hoped to handle. Nor did he authorize the officials under him to make the necessary study. Much of an educational nature is necessary to be done if we are to encourage the construction of efficient terminals.

Cities Must Share Port Cost

No port should be given Government aid as to channels and anchorage ground until it can convince the Chief of Engineers that it will do its share with regard to terminals. States with only one first class harbor should be brought to look upon that harbor as the property of the state to be properly developed along modern scientific lines. For we may here assert that only the very largest cities can possibly afford the necessary expenditures for a properly coordinated terminal. Then, too, the waterfront of our principal harbors where no state or municipal control exists is being more and more occupied by industrial plants, in most cases requiring little or no actual berthing space for ships.

We think that in the central nucleus collected in Washington, under the Board of Engineers for Rivers and Harbors, and in the field offices of the division and district engineers at our ports and river terminals, we have the means at hand for the proper investigation and for sound, well based advice to ports. But we do not expect to depend upon this organization alone. In the other departments of the Government we have important sources of information in the Shipping Board, the Bureau of Customs, the Bureau of Foreign and Domestic Commerce, the Interstate Commerce Commission, the Office of Naval Intelligence, etc Without utilizing them to their fullest extent we would not only lose available data, but would invite duplication of effort, with consequent lack of economy and the loss of temper on the part of those commercial concerns otherwise called upon more than once for the same information by the various Government agencies.

We propose, therefore, to form an advisory commission or board, composed of representatives of the interested departments, to meet from time to time as required to co-ordinate the statistical effort and discuss new points. It is

anticipated that such procedure will prove most economical. For instance, too much attention has in the past been devoted to values in dollars at the expense of losing sight of quantities and tonnage. Doubtless many of you have tried to find in commercial statistics the increase or decrease in shipments for the past fiscal year. You have always found a statement in money but, except for a few special commodities, such as coal, ore and grain, the quantity or weight is missing. Exports and imports are, at present, usually given by customs districts. They would be much more valuable by ports. Changes of method, often slight, will increase the usefulness of the data collected, without large additional expense.

Statistics Needed

We propose to gather together both the trade statistics upon which all port business should properly base, and which is so necessary to economic port design, and the port statistics of all classes to show the shipmaster what he may expect at each individual port, and the port authority what is the present status of the port, in order that future improvements may follow a well preconceived plan which will keep pace with the growth of business in the most modern and efficient way. By studying the data upon the advanced port, the backward port will learn its own need.

We have prepared a comprehensive questionnaire, with elaborate supporting tables, which we will shortly send to all our districts. This, when completed, will show, for each port and upon the same basis, all that goes to make its port facilities, or which is useful in the design of such facilities. From time to time, as the information is completed, separate pamphlets will be published. Port facilities data for each large port will be contained in a single publication. Small ports in district groups will be treated separately, but in one pamphlet.

About a year ago the Port Facilities Commission of the Shipping Board published a pamphlet entitled "Twenty-seven Ports of the United States." The information contained was not so comprehensive as that now proposed, but the demand for copies was such that the edition was soon exhausted. The new publication will have a port facilities map for each port, showing by symbol the exact location of each facility, such as overseas piers, coastwise piers, cargo coal, coal and oil bunkers, shipyards, dry docks, etc. There should be a great demand for these pamphlets. With their help and with the commercial statistics grouped in a separate volume, the producer should be able to select the economic port, the port merchant may determine the location of available cargo and the placement of imports, the shipper can judge whether it is best to ship by rail or by inland waterway. If carried to the extent proposed, a basis will be had for separate and combined rail and barge rates. Full knowledge of the facts will enable the Chief of Engineers to base his recommendations for channel and harbor improvements upon the real merits of each individual case. Above all, the very best information will be in available form for advice to ports.

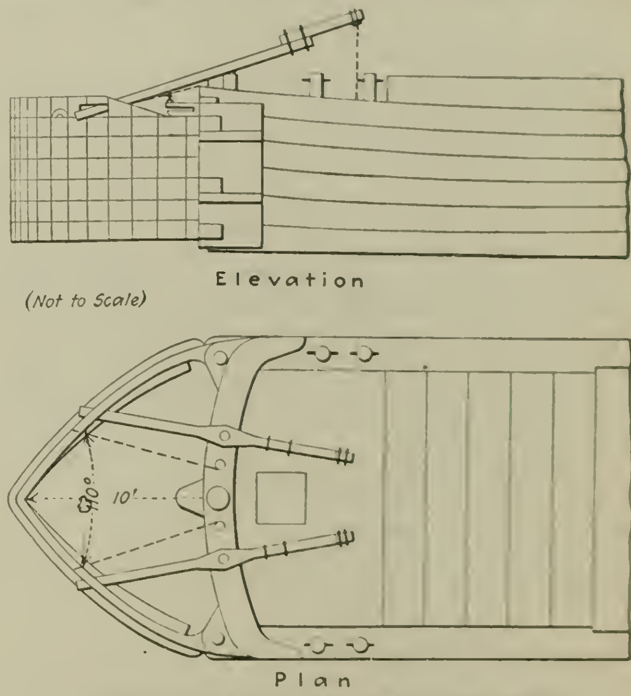
In designing port facilities there has been too little consideration given to the business to be handled. Many individuals in promising ports are anxious to see the home town acquire a shipping business, but they have, in most instances, little idea how to start. From our experience, much education is necessary and this we hope to supply. We have, in fact, had considerable experience in this work already, and in this connection I desire to say here that in our advice to ports we have not in the past, and do not in the future expect to lose sight of the fact that there is a limit to our mission, beyond which we should not go. The information which we collect and the advice which we give is just as available to you as it is to state or city authorities. We naturally do some designing in detail for the Government, but we set a limit with port authorities, advising them that they must employ their own engineers for the details of design and construction. I hope that we may be of assistance to you, and that in turn you will all spread the news that the Chief of Engineers and Board of Engineers for Rivers and Harbors form an agency in co-ordination with the United States Shipping Board for Government co-operation in port development.

French Devise Adjustable Prow to Increase Speed of Barges

Resistance Lowered Twenty-Three Per Cent in Tests Made With Folding Panels That Sharpen Barge's Flat Bow

BECAUSE of the immense impetus given to traffic upon the Seine River during the war and because of the possibilities present of materially increasing that traffic, various methods have recently been tried for increasing the speed and decreasing the resistance to navigation of the many types of barges and canal boats operating on the Seine. Among such means is a device proposed by M. Brisset, described in a recent issue of *Annales des Ponts et Chaussées*, and with which recent experiments have been made, resulting in the lowering of resistance to navigation of barges of 23.5 per cent.

The device designed by M. Brisset consists mainly of two of slightly curvilinear movable wings, each one of



ELEVATION AND PLAN OF FOLDING PROW FIXED TO BARGE

which is supported by three hinges fixed at the extremities and in advance of the vertical walls of the barge. When in use these two wings, extended, just come together, designing a simple form of prow. When docked or in passing through locks the wings are released and spread back against the prow of the barge. When in the latter position the length of the barge is increased only by a very small quantity—in the neighborhood of 1½ ft. when the wings are made entirely of wood. This length, it appears, can be shortened to an excess length of 0.3 of a meter, or approximately 1 ft., in case correctly designed metal wings can be secured. When extended the apex of the angle formed

by the two wings is 10 ft. in advance of the tangent to the prow of the barge and its center line, and the interior angle of the two wings at the point of joining is approximately 110 deg.

Manipulation of Wings

Various systems were devised by which to manipulate the wings. One method is illustrated in the accompanying sketch. Two levers, pivoted and inclined, permit the wings to be moved much in the same manner as the rudder of a boat, at the same time furnishing supports to the upper cross-beams of the wings. This arrangement is considered the most practical.

The important point in the investigation was to determine if it were possible to lower the resistance to navigation of the barge, in spite of the fact that this cut-water had no bottom, permitting eddies to be formed between the wings. In order to clear up these points a series of trials was held. Trials were first made with an ordinary barge completely loaded, then upon the same barge towed exactly along the same course after having been furnished with the device mentioned above. The course picked out for the trials was approximately rectilinear in shape and situated in a section of the Seine River where the currents are regular and where the channel is large enough to permit the passage of other river traffic without alterations in the course of the trial boat.

In order to secure best results several precautions were taken. Only a certain number of selected trips, out of many trial trips made, were used as a basis for computation of resistances, and a mean of these was taken. Two sets of tests each were made with the speed of the engine in the propelling tug geared at 150, 170, and 200 r.p.m. The number of revolutions were recorded at two-minute intervals by tachymeters, and in addition the total number of revolutions were also recorded by another speed-recording machine. For the trips finally selected as test trips there was never a greater variation than two revolutions from the maximum and minimum, and never more than one revolution from the mean.

The mean speed was developed from the following formula, after a series of tests had been made in which V_1, V_3, and V_5 represented speeds in one direction (with or against the current) and V_2 and V_4 speeds in the opposite direction:

$$V = \frac{1}{2}\left[\frac{V_1 + 2V_2 + V_3}{4} + \frac{V_3 2V_4 V_5}{4}\right]$$

Tractive effort was measured by means of an hydraulic dynamometer and a speed recorder of the Richard type. Though the curve plotted by the dynamometer was of such a small scale that it could not be used as an absolute check against the two-minute interval speed recordings, nevertheless the curve checked up any irregularities which the other system failed to reveal. Because of the dynamometer a number of tests that might have been used were discarded.

For half of the tests the barge was attached to a tug by a towline 120 m., or 393.6 ft., long, and in the other half by a line 80 m., or 262.4 ft., long. The variance in length of towline was to determine if navigation was impeded by the presence of the barge close to the backwater from the tug propeller. The tug used in the tests was of 366.3 tons displacement and drew 7 ft. of water.

According to an established formula, based upon use of tugs of 100 tons displacement and of standard design, the resistance offered by the type of barge with which tests were made would be expressed by the formula:

$$R = 78V^{2.25} \tag{1}$$

where R is the resistance and V velocity in meters per second. The accompanying table shows that the discrepancy between measured and calculated resistance, with the barge not using the false prow, is approximately 16 per cent. The regularity of the occurence of this percentage led to a revision of the formula, which for a 120-m. towline would be:

$$R = 67V^{2.25} \tag{2}$$

Resistances observed for the tests made with a towline of 80 m. were also lower than calculated resistances. It was therefore proven that the resistance was greater with an 80-m. towline, and revision of the general formula was made to apply in the instance when an 80-m. towline was used. This revised formula is

$$R = 69V^{2.25} \tag{3}$$

The second series of tests in which the prow was used showed that the calculated resistances were nearest the measured resistances when the formula

$$R = 52V^{2.25} \tag{5}$$

was used. Comparing this equation with (2) an economy of effort of 23.5 per cent is noted.

The use of these wings, which do not add any appreciable weight to the boat nor encumber it in any way, and which have adaptation for use upon canal boats, will, it is stated, considerably reduce towage costs. It will also allow more prompt transportation of materials and lead to a consequent increase in amount of tonnage handled.

TABLE I. MEASURED AND CALCULATED RESISTANCES

	Speeds		Resistance in Kilograms to 100 Tons Displacement		
	Meters per Second	Kilometers per Hour	Test Measurements	Formula Computations	Per Cent of Error between Measured and Calculated Resistance
Tests with Tow Line of 120 meters	1.67	6.012	214	247	15
	1.87	6.732	274	319	16
	2.14	7.704	373	432	16
Tests with Tow Line of 80 meters	1.64	5.904	213	237	11
	1.84	6.624	264	307	16
	2.13	7.668	380	427	12

The tests were made under the direction of Major of Engineers Dugardin, engineer of roads and bridges, temporarily attached to the military exploitation of navigation upon the Seine River.

Power Commission Issues Rules

Under date of Sept. 3, 1920, the Federal Power Commission issued its rules and regulations under which applications for licenses to use Federal water power must be made. These rules lay down all of the forms which must be followed in dealing with the office of the commission, which is in Washington, D. C. Copies of the rules may be obtained by writing to the Federal Power Commission, O. C. Merrill, Executive Secretary, Washington, D. C.

Comparisons of Modern Steam and Electric Locomotives

Extracts from the three principal papers presented before the joint meeting of the Metropolitan Section of the American Society of Mechanical Engineers, the Railroad Section of the American Society of Mechanical Engineers, and the New York Section of the American Institute of Electrical Engineers, held at New York, Oct. 22, 1920.

The Steam Locomotive

By John E. Muhlfeld
Railway & Industrial Engineers, Inc., New York

TO REFLECT initial and operating costs from a credit or an investment standpoint and to interpret faithfully on the basis of expert judgment, backed by practical experience, the probable effect on the annual balance sheet, any investigation for the purpose of determining upon the advisability of electrical or steam operation for an existing or new line of railway should be made, preferably by a committee consisting of experts in railway, mechanical, electrical, and civil engineering, transportation, and accounting, without any endeavor to modify the best steam railroading methods to suit the requirements of electric traction, and by keeping clearly in mind the fundamental fact that where anything within reason is possible, provided enough money can be spent, if the auditors' annual statement cannot show the balance on the right side of the ledger, the project will have failed from the most important point of view.

Comparisons have been made between the operation of new, up-to-date electric and of obsolete steam installations, and assumptions have been made of extraordinary steam locomotive standby fuel losses. It is just as misleading to compare the most efficient electric locomotive operation on the St. Paul with that of its saturated steam locomotives of 1910 as it would be to compare the most efficient superheated steam locomotive performance on the Baltimore & Ohio with that of its electric locomotives.

Several years ago a report was made on the advisability of electrifying about 275 miles, or a division, of one of the more prominent western lines. When all involved factors were properly adjusted the net capital expenditure of $4,000,000 required for electrification compared with $1,000,000 as needed for modernizing the steam equipment, and the estimated annual operating saving of approximately $750,000 from electrification was wiped out and replaced by a saving of $250,000 from a continuation of the improved steam operation.

When engineers and politicians propose reckless superpower plans for the electrifying even of such belts of steam roads as lie in the densely populated district between Washington, D. C., and Boston, at a new capital cost aproximating a billion of dollars, and in addition mark off the books the principal value of existing steam locomotives, passenger cars, shops, and terminal and intermediate facilities that would be unsuitable for electrified service, they are planning either a new road to railroad bankruptcy, or a further burden in traveling and shipping cost, or in taxes.

Before the electric locomotive can be made permissible for general application the electrical engineer must reduce first costs; promote interchangeability; provide a motor which will efficiently, economically and flexibly cover a wide range of speeds and loadings, and substantially reduce current losses. Likewise the steam railway mechanical engineers must become more active in modernization and bring about improvements that will substantially increase the capacity and thermal efficiency of the steam locomotive by the use of higher steam pressures and superheat.

Electrification increases the capacity of a terminal, but an analysis of the situation of the New York Central shows that this is not due to decreasing locomotive requirements through the use of multiple units as is usually stated. . . In the handling of heavy tonnage trains by the unlimited combining of electric locomotive units, the factors of peak load, transmission lines, and power plant capacity must all be considered with the probability that permissible modern steam locomotive train units can be more economically handled over dense traffic lines than the electric multiple unit super-trains. The tonnage to be handled without rear end or intermediate helpers is limited by the ability of the draft rigging on the cars to withstand the pull and shock, and this limitation can be readily met and exceeded in steam locomotive design and operation, as may be noted from the following comparison of the St. Paul electric freight and the Virginian steam freight articulated types of locomotives:

	St. Paul Electric Articulated, Lb.	Virginian Steam Articulated, Lb.
Tractive power, in simple gear, maximum	132,500	176,600
Tractive power, in compound gear, maximum		147,200
Tractive power, at 15 miles per hour	71,000	[illegible]
Total weight on driving wheels	448,000	617,000
Total weight of locomotive	564,000	832,000
Factor of adhesion—maximum tractive effort	3.38	3.49

The average freight car is in main line movement only about 10 per cent of its life. Therefore, increasing train speeds beyond established economic limits at the sacrifice of tonnage, with an increase in fuel, track and equipment upkeep and danger of operation is not the solution of the freight traffic problem. The electric locomotive is a constant speed proposition. The steam locomotive can be more efficiently operated over the continually changing up and down grades and curves.

Fuel Consumption

Great economy in fuel consumption and cost is the principal claim for electrification. Recent tests of a hand-fired locomotive on the Santa Fe show an average coal consumption for gross 1,000-ton miles of 114.8 lb. From the foregoing it can be assumed that the average yearly performance will approximate 100 lb. of 12,000 B.t.u. coal per 1,000 gross ton-miles, or equivalent to what we are promised for the expenditure of billions of dollars of new capital and the loss of billions of dollars worth of investment in existing plant and equipment to inaugurate the comforts of electrification.

The offsetting fuel and energy losses, due to standby in steam operation, and decrease in efficiency on account of fluctuating loads in the electrical operation must not be lost sight of, as well as those incident to the transforming, transmission and conversion of electric current. It is unquestionably true that when operating under ideal fixed load conditions, the central power station, either hydro-electric or steam, can produce a horsepower with less initial energy input than is possible on a steam locomotive. It is also true that the standby losses on existing steam locomotives are, in ordinary practice, a serious proportion of the total fuel consumption, but it is likewise a fact that the majority of these can be substantially reduced if not entirely overcome by modernizing the present equipment and improving maintenance and operation which would then rob the advocates of electrification of their main arguments.

Thermal Efficiency

Furthermore, the production of electric current involves expensive lines, plants and equipment, as well as tremendous losses from the generator at central power stations to the bus bar on the direct-current side of the transformer where the current is usually metered for billing. Also the secondary system (rail bonding and feeder lines) is responsible for further losses in current, all of which, after allowing say 10 per cent regeneration not only limit the capacity of the electric zone but also materially increase the arbitrary

electric costs usually considered, so that it is safe to say that the actual dead loss in power from the central power station to the electric locomotive drawbar will be not less than 50 per cent.

Comparing the electric and steam locomotive figures, the relative percentage of power delivered at the track rails to 100 per cent B.t.u. in the coal would be:

Kind of Locomotive	Net Thermal Efficiency at Load Ratings of 100 Per Cent	75 Per Cent	50 Per Cent
Electric	5.79	5.95	4.54
Steam, superheated	3.85	4.83	5.88
Steam, saturated	2.70	3.86	4.47

As 100 per cent load rating conditions would, in practice, occur only momentarily and as the majority of the drawbar load represents from 30 to 60 per cent of the locomotive maximum drawbar capacity, comparison should properly be made only of the net thermal efficiencies at 50 per cent load ratings. At speeds of from 15 to 75 miles per hour the existing superheated steam locomotive thermal efficiency actually ranges from 5.3 to 8.1 per cent as compared with the calculated figures of from 4.83 and 5.88 per cent for 75 and 50 per cent load ratings, respectively. Adding to this an increase of from 15 to 50 per cent in net thermal efficiency that may be produced from developments now under way and the steam locomotive of the future will be quite a respectable assembly of engineering efficiency.

Maintenance and Repair Costs

In determining the maintenance cost of the electric locomotive the popular error is to take into account the locomotive proper, where as true comparison can only be made by including all corresponding elements as found in the self-contained steam locomotive which goes back to the upkeep of all facilities having to do with the utilization of the fuel or water power, including the central power station buildings and transmission line equipment. Until a true reflection of the upkeep cost per electric locomotive, or per 1,000 gross ton miles hauled, can be given by including all the facts and elements of age and mechanism embodied in the steam locomotive, comparisons will all be worthless.

In order to meet the ideal conditions for electrification, the traffic should be uniformly spread or scattered over the 24-hr. period. With the steam locomotive the traffic requirements are met by the distribution and utilization of the necessary number of self-contained motive power units as required, regardless of the capacity of one or more central power stations or of any limitation in quantity, or in price, of the total available power output.

Since the development of regenerative braking with the electric locomotive, great emphasis has been laid on increased security of operation by holding the trains and motors temporarily converted into generators to produce electricity returned to the line for use by some other locomotive in pulling a train. When the power so generated cannot be directly used by another pulling locomotive on the line, it must be otherwise absorbed, and it remains for the electrical engineers to prove just how much of it is lost in conversion or by absorption.

In steam locomotive practice there are factors of radiation and freezing to be reckoned with, which gives the electric locomotive the advantage in winter, but this is largely overbalanced during the summer when the main motors heat, and require cooling at terminals.

While the electric locomotive has the advantage of not being required to take on fuel and water, delays in steam locomotive practice in taking water have been entirely eliminated through the use of track troughs, and with modern fueling facilities either coal or oil can be quickly supplied, where necessary, between terminals.

While there is much existing steam road trackage that can and should receive first consideration as regards electrification for the purpose of eliminating gases from underground terminals and tunnels, to give relief to terminals or line traffic congestion by combined rapidity and frequency of train movements in the vicinity of large commercial and industrial centers, or where transportation and operation are auxiliary to mining or other industries requiring the extensive use of electricity, it would be financial suicide to electrify immediately adjacent connecting and intermediate longhaul mileage, particularly in view of the improvements that can be made in both existing and new steam locomotives in the matter of reducing smoke, sparks, cinders and noise, and in increasing general capacity, efficiency and economy in operation and maintenance.

The Electric Locomotive

By F. H. Shepard
Director of Heavy Traction,
Westinghouse Electric & Manufacturing Co.

THE LIMIT to physical expansion of railroad line and of terminals has been just about reached in many cases, on account of both the prohibitive cost and the inefficiency of terminals of unworkable size. A large measure of relief can still be secured by line and terminal revisions and improvements; but when the inevitable increase in the demand for traffic movement of the future is considered, these improvements savor, more or less, of expedients to secure relief which can only be temporary and very limited in degree. The solution lies, to a large extent, in railroad electrification.

With the present standards of train make-up, classification and terminal handling, electrification will double the capacity of any railroad. With the better equipment we can expect in the future, together with the evolution of improved methods of operation contingent on electric power, this capacity should be doubled again, thus securing four times the present capacity. Two conspicuous cases of this have been the Norfolk & Western and the Chicago, Milwaukee & St. Paul. In the case of the Norfolk & Western, two electrics handle the same train as was formerly handled by three Mallet engines, but at twice the speed.

Flexibility in Design and Operation

The advantage of electric power is its great flexibility and mobility. The difference between locomotives, steam and electric, is fundamental. The steam locomotive carries its own power plant, while the electric locomotive, on the other hand, is simply a transformer of power. The design of the steam locomotive is circumscribed utterly by the necessity of tying up the rest of the machine to a steam boiler. On the other hand, the electric locomotive assembly can differ amazingly as to type, length, axle loading and driving connections. A group of small motors does not differ materially from a single large motor in efficiency. The speed and power, therefore, of an electric locomotive is limited only by conditions of track and construction and condition of car equipment. It thus becomes entirely practicable to build an electric locomotive to take any train which will hold together, over any profile whatever, and at any desired speed. Therefore, it should easily be practical to very greatly increase the speed of our freight trains so that they could all run at a common speed not very different from that at which the superior trains are operated.

Without the limitation in train speed commonly accepted as a handicap to operation of tonnage trains, who can say what the limit to train load will be with electric power? Our present methods have been built up entirely under the necessities and limitations of the steam locomotive. This is evidenced by the existence of intermediate terminals at the ends of all the so-called engine districts, where all traffic halts. Again, the steam locomotive requires attention en route, needs supplies of water and coal, and, because of its slow movement when hauling our present tonnage trains, it is frequently sidetracked for superior trains, and thus there are more and still more halts to traffic.

Coming now to the comparative performance of steam and electric locomotives, it is important to bear in mind their fundamental difference to the one, a generator of power, and the other a transformer of power. The generation of power in central stations is surrounded with many refinements, and in the consumption of coal, there is every opportunity for skillful handling and supervision, so

that the thermal efficiency of a modern central station is relatively high and is also continuously maintained. With the steam locomotive, on the other hand, the thermal efficiency is dependent not alone upon the design of the locomotive, but the manner in which it is worked, its condition, which differs widely from the best, and finally by the skill in firing. The electric locomotive, on the other hand, consumes power only when in service, and works at any load at its designed efficiency. The average performance, in the case of the electric, approximates the maximum in efficiency, while the steam, on average performance, will differ widely therefrom.

There are a considerable number of different designs of electric locomotives all in successful operation, and each possessing certain advantageous features. Further experience will, undoubtedly, result in the survival of common types for the different classes of service. The great latitude with which electric locomotives can be designed, while fundamentally most desirable, is in itself at the present time, somewhat of a handicap. This is now the subject of intensive analysis and this study is undoubtedly developing as well, a better knowledge of the running characteristics of the steam locomotive.

The Electric Locomotive

By A. H. Armstrong

Chairman Electrification Committee, General Electric Co.

OWING TO handicap of precedent and prejudice, electricity must take up the railway problem where steam leaves off. In other words the proof is up to the electrical engineer proposing any marked departure from commonly accepted standards as established by long years of steam engine railroading. Thus while a maximum standing load of 60,000 lb. per axle has been generally accepted for steam engines, it is well known that an impact of at least 30 per cent in excess of this figure is delivered to rail and bridges due to unbalanced forces at speed. However, owing to the flexibility of electric locomotive design, there is no immediate need of exceeding steam practice in this respect, although this and other reserves may be called upon in the future.

Accepting the Mikado and Mallet as the highest developments of steam road and helper engines for freight service, the following general comparison is drawn with an electric locomotive that it is entirely practicable to build without in any respect going beyond the experience embodied in locomotives now operating successfully.

COMPARISON STEAM AND ELECTRIC LOCOMOTIVES

	Mikado	Mallet	Electric
Type	2-8-2	2-8-8-2	6-8-8-6
Wt. per driving axle	60,000 lb.	60,000 lb.	60,000 lb.
Total wt. on drivers	240,000 lb.	480,000 lb.	720,000 lb.
Total wt. loco. and tender	480,000 lb.	800,000 lb.	780,000 lb.
Trac. eff. at 18% coef	43,200 lb.	86,400 lb.	129,600 lb.
Speed on 2% grade	14 m.p.h.	9 m.p.h.	16 m.p.h

The above analysis brings out the fact that to equal the hourly ton mile performance of one electric locomotive it would require three and four engine crews respectively for the Mallet and Mikado types.

The electric locomotive has demonstrated its very great advantages in relieving congestion on single track mountain grade divisions. In view of the facts, it is a modest claim to make, therefore, that the daily tonnage capacity of single track mountain grade divisions will be increased fully 50 per cent over possible steam engine performance by the adoption of the electric locomotive.

Regenerative Braking

Not only are air brakes entirely relieved and held in reserve by electric regenerative braking but the potential energy in the descending train is actually converted into electricity which is transmitted through the trolley to the aid of the nearest train demanding power. Aside from the power returned from this source (14% of the total on the Chicago, Milwaukee and St. Paul Railway) the chief advantage of electric braking lies in its assurance of greater safety and higher speeds permitted on down grades.

Probably in no one respect does the electric locomotive show greater advantage over the steam engine than in cost of maintenance. Special importance attaches to this item of expense in these days of high labor and material costs. In order to draw a fair comparison, however, there should be added to back shop repairs, all expenses of round house, turn table, ash pit, coal and water stations, in fact the many items contributing to rendering necessary steam engine service, as most of these charges are eliminated by the adoption of the electric locomotive. Including all engine service charges, the facts available give foundation for the claim that electric locomotives of the largest type can be maintained for 25% to 30% of the upkeep cost of steam engines operating in similar service.

To afford a common basis for comparison a single assumption seems permissible and a rate of 2½ lb. of coal per kilowatt-hour is taken as representative of fair electric power station practice. While the electric locomotive demands power only when in motion, the steam engine requires coal at all times during the twenty-four hours, whether doing useful work, standing idle or coasting down grade. In tests made on the C. M. & St. P. Ry. the run of a more modern steam engine would have effected a material reduction in the 23,640 lb. of coal burned in doing useful work, but the amount of coal wasted in standby losses (9,042 lb.) might have been duplicated or even possibly increased with larger grate area. As standby losses constitute so large a proportion of the total coal burned (27¼% in this instance) it is apparent that enormous economies over the simple engine tested must be realized in the modern superheater and other improvement since introduced to offset in part the high inherent efficiency of the electric locomotive.

Except over very long runs with terminals at the same elevation it seems hardly possible therefore accurately to compare engine performance over different profiles by such a variable unit as pounds coal per 1,000 ton-miles.

A truer understanding of what takes place under the engine boiler may be shown by continuous records of coal burned, tons moved, profile, delays, etc., all reduced to pounds of coal burned per useful horsepower-hour work done at the driver rims with segregation of the many standby losses.

ANALYSIS STEAM AND ELECTRIC RUNS
HARLOWTON—THREE FORKS

(Per 1,000 Ton Moved)

	Steam	Electric
Kw.-hrs. at driver rims	2,038	2,038
Hp.-hrs. at driver rims	2,625	2,625
Coal per hp.-hr. driver rims	9.02 lb.	*3.08 lb.
Credit regenerative braking		0.55 lb.
Standby losses 27¼ per cent	2.47 lb.	
Total coal per rim hp.-hr.	11.49 lb.	2.54 lb.

* Measured at power house and includes locomotive losses and 32 per cent transmission and conversion loss.

Under the same conditions a modern engine would undoubtedly have consumed much less than 9.02 lb. coal (11,793 B.t.u.'s) while doing work measured at the driver rim. The addition of superheaters gives greater output and economy while mechanical stokers add output only and it is claimed, at some expense in economy over good hand firing. However efficient the power plant on wheels may reasonably be developed without too seriously interfering with the sole purpose of the steam engine, the hauling of trains, it can never approach the fuel economies of modern turbine generating stations. Whatever transmission and conversion losses are interposed between power house and electric locomotive are more than compensated for by the improvement in the load factor resulting from averaging the very fluctuating demands of many individual locomotives.

Each individual electric locomotive will reproduce almost exactly the record of all others in similar service, little

influenced by either extreme cold or skill of the engineer, while the fireman so called and still retained, has nothing to do with the matter at all. There is no creeping paralysis gradually impairing the efficiency of an electric locomotive until temporary relief is obtained through frequent washing of boiler and round house tinkering inevitably ending up in the major operations annually performed in the back shop hospital on the steam engine to keep it going. It is for such reasons that the electrical engineer is slow to accept general statements of average service operation based on the results of tests usually made on steam engines in excellent condition and skillfully handled.

It is with some knowledge of all these facts that the broad statement is made that the general adoption of the electric locomotive would probably result in saving fully two-thirds the fuel now burned on present steam engines and possibly one-half the amount of fuel necessary to steam engines of the most modern construction.

Comparative Cost

The superior operating advantages of the electric locomotive are admitted by many who believe the first cost to be prohibitive, largely due to the trolley construction, copper feeders, substations, transmission lines, etc., necessary to complete the electrification picture. The steam engine also demands a formidable array of facilities peculiar to itself. Proper facilities for rendering adequate steam engine service apparently adds some 62% to the cost of the latter and no cry of extravagance has ever been raised in this respect.

One advantage of the electric locomotive rests in the longer engine divisions which they make possible. Two of the four steam engine divisions comprised in 440 miles of the St. Paul were wiped out by electrification and certain sidings and yard tracks were dismantled. To the above exclusively steam engine facilities should be added therefore the expense of engine division points not necessary to successful electric railroading.

Summary

Some of the principle advantages claimed for the electric as compared to the steam locomotive may be briefly stated as follows:

1.—No structural limits restricting tractive effort and speed of electric locomotive than can be handled by one operator.
2.—Practical elimination of ruling grades by reason of the enormously powerful electric locomotives available.
3.—Reduction of down grade dangers by using regenerative electric braking.
4.—Very large reduction in cost of locomotive maintenance.
5.—Very large saving of fuel, estimated as two thirds the total now burned on steam engines in operation.
6.—Conservation of our natural resources by utilizing water power where available.
7.—Material reduction in engine and train crew expense by reason of higher speeds and greater hauling capacity.
8.—Increased valuation of terminal real estate following electrification.
9.—Increased reliability of operation.
10.—Material reduction in operating expense due to elimination of steam engine tenders and most of the Company coal movement, the two together expressed in ton miles approximating nearly 20% of present gross revenue ton mileage.
11.—Large reduction in effect of climatic conditions upon train operation.
12.—Postponement of immediate necessity for constructing additional tracks on congested divisions.
13.—Attractive return on cost of electrification by reason of direct and indirect operating savings effected.
14.—Far reaching improvements in operation that may revolutionize present methods of steam railroading.

New York's Freight Handling Problem

Extracts from a paper by Col. Charles D. Hine, special agent, Erie R.R., at New York, presented before New York Section, Am. Soc. C. E., Oct. 20, 1920.

NEARLY fifty terminal plans of more than fifty years since the Civil War have in the Metropolitan District of New York remained in the project stage. Plans and special public commissions are always necessary and sometimes valuable, but plans and special commissions move no freight. The distribution of freight and food products after arrival in the Metropolitan District, it is common knowledge, is crude, unscientific, expensive and wasteful. No satisfactory formula has yet been devised to measure the cost to the carriers and to the public of terminal congestion.

Need for Expansion of Storage Facilities

Distribution in the Metropolitan District is directly concerned with three elements of transportation. First, a relatively long haul or large unit consignments moving by rail or water; second, delivery to or from warehouse, consignee, or connecting carrier by lighter, truck, dray or cart; third, warehousing for incoming or outgoing freight awaiting delivery or shipment. The last named, storage, is the underfed, stunted little brother of the transportation family. Long haul today by rail and water is comparatively easy. The real problem is a terminal one. In many cases it is almost a physical impossibility to enlarge internal freight yards or steamship piers. Relief must come through such terminal handling as will permit quicker movement of equipment. The greatest possibilities lie in expediting the short haul in small workable units, and in prodigious expansion of storage facilities.

Such expansion must take the form of segregated groups of warehouses and market warehouses at numerous suitable points in cities. The temptation to make these groups few in number and unwieldy in size must be resisted. Otherwise the congestion of trucks or lighters will, without attainable reduction, be merely transferred from rail head and pier to warehouse and market. Demountable motor bodies now in successful use in Cincinnati and other proposed devices make it feasible for long haul carriers to have numerous off-line freight station warehouses entirely disconnected except by streets from existing terminal property.

Goods reaching the Metropolitan District must be forthwith moved as far as possible in the direction of ultimate destination. This means numerous market warehouses rather than a few.

The large outlays of capital required for some of the comprehensive plans for local distribution thus far developed must probably wait until financiers and public authorities are convinced that maximum co-ordination of existing facilities has been attained. Much can be accomplished by public authority. For example: The mayors and borough presidents of the Metropolitan District could with the carriers and commercial bodies work out methods by which back haul and street congestion would be minimized. For example: Freight for upper Manhattan comes to lower Manhattan when perhaps it could better be distributed from the Bronx. Freight to and from Newark passes through Manhattan only to add to intolerable congestion.

The question will fail of comprehensive solution until it becomes political in the sense of economics and statesmanship, not in the narrow range of partisanship.

Railroad Water Consumption

The Southern Railway uses, by careful investigation of each station, 45,500,000 gallons of water per day of 24 hours, at a cost of over $1,660,000 per year. This consumption is furnished by 350 pumping plants, 60 gravity stations and 121 city supply stations, making a total of 531 water stations. It has been conservatively estimated that the average railroad wastes 15 per cent of the total amount of water used, that is, 15 per cent more water is used than is actually needed to meet requirements.—A. B. Pierce, engineer water supply, Southern Railway, in *Southern News Bulletin*.

Letters to the Editor

Bureau of Public Roads Will Measure Highway Bridge Impact

Sir—The matter of impact on bridges, discussed in your editorial, "A Field for Experiment," of Sept. 1920, is one which our bridge division has to consider almost daily in connection with the design of highway bridges in the construction of Federal Aid roads. Unfortunately, there is a lack of adequate knowledge on this subject. We have been at work for the past year on a series of impact tests to determine the impact effect of heavy trucks on road surfaces, and our tests indicate that the effect of impact on our highways is very considerable.

It is true that we know little of the stress developed either in the bridge floor on in the bridge members due to impact. Our records as of Jan. 17, 1920, show that 24 states use an impact allowance of variable amounts. Fifteen use no impact allowance, leaving nine states for which we have no records available I am inclined to believe that a study of impact on highway bridges is important from the standpoint that it will lead to more rational design, but from the standpoint of the relative expenditures on roads and bridges we have considered such an investigation in connection with road design to be more urgent. Because of the small number of bridges per mile of road and the relatively small extra cost in their construction, it must be realized that the total increased cost of bridges must be a small item as compared with the increased cost of our roads to withstand the same impact.

For this reason, we have been concentrating our efforts on a solution of the problem of impact effect on road surfaces rather than on bridges. We think it important, however, to undertake impact studies on bridges and have given this subject some attention. Arrangements have now been made to measure impact stresses on bridges, making use of the strainagraph developed during the war for use on reinforced concrete ships, which apparatus has been obtained for this purpose. We plan to make a preliminary investigation on at least one bridge during he coming year.

Washington, D. C. — Thos. H. MacDonald,
Oct. 11. — Chief of Bureau of Public Roads.

Urge Negative Vote on Joining Federation

Sir—Whether the American Society of Civil Engineers shall become a member of The Federated American Engineering Societies is a serious matter in view of its early decision by ballot. It may fairly be presumed that a great majority of the members of that Society would welcome such an affiliation of the four great national engineering organizations as would lead to concert of effort in all matters affecting the interests of the engineering profession, especially in its relations to public affairs. Such an affiliated organization would tend greatly to strengthen the engineering profession in this country and correspondingly advance public interests based upon or affected by engineering activities. Some such effective mode of conserving the fundamental interests of the engineering profession is urgently needed and that need has doubtless prompted the organization of The Federated American Engineering Societies, but the proposed Federation goes much too far.

All members of the four national engineering societies in this country ought to consider critically every provision of the Constitution and By-Laws of The Federated American Engineering Societies. This is no matter of professional courtesy or sentiment; it is simply the cool and impartial determination of a serious question, i.e., whether the interests of the profession will be advanced or retarded or even gravely injured by merging individual organizations in this proposed Federation.

A careful reading of the Constitution of The Federated American Engineering Societies shows that the organization is no mere affiliation designed for the purpose of securing concerted effort among individual organizations for the common good, each preserving vigorously individuality, but rather a strong, rigid organization with a Constitution and By-Laws prescribing completely what functions are to be discharged and the means provided to accomplish their full purpose. There are twelve pages of Articles of the Constitution and Chapters of the By-Laws. The object of the Federation is shown in Article II which reads as follows:

> A.—"The object of this organization shall be to further the public welfare wherever technical knowledge and engineering experience are involved, and to consider and act upon matters of common concern to the engineering and allied technical professions."

Article I, Section III of the Constitution of the American Society of Civil Engineers declares its object to be as follows:

> "Its object shall be the advancement of Engineering knowledge and practice and the maintenance of a high Professional standing among its members."

Manifestly this succinct statement of the object of the American Society of Civil Engineers is substantially identical with the expression " . . . to consider and act upon matters of common concern to the engineering and allied technical professions," each being expressed in general terms. It would be impossible for The Federated American Engineering Societies to discharge its constitutional functions without occupying the field explicitly reserved to the American Society of Civil Engineers by its Constitution, thus leading inevitably to fatal friction and disruption of the amalgamated organization. The same general observation can be made in reference to the three other national engineering societies.

The administration or management of the Federation is to be effected by "The American Engineering Council" consisting of representatives of Member-Societies. As stated in Article IV, Section 2, "This Council shall co-ordinate the activities of State councils and of local and regional affiliations whenever these activities are of national or general importance or may affect the general interests of engineers."

The actual management is carried on by an Executive Board acting under the direction of the Council. If coordination means anything in this connection, it means the regulation of the general affairs of the Member-Societies. In other words, the Member-Societies are to be substantially regulated and controlled in their principal or general activities. There is no escape from this conclusion unless the Federation becomes supine and nerveless in the functions which its Constitution and By-Laws prescribe. These functions are in the main those which the National Engineering Societies are already performing and have been performing for many years, but which the Federation now requires them to assign to it while they in turn are to divest themselves of their original individualities and place themselves under the management of the American Engineering Council acting through its Executive Board.

In Article IV it is prescribed to "be the duty of the American Engineering Council to interest itself in the activities of local and regional organizations and affiliations and state organizations and councils if such activities are of national scope, or affect the general interest of the engineering and allied technical profession." This means that even local affairs as well as those of the state are to come within the consideration of the Council, as it would be difficult to find any engineering matter or activity which could not be so interpreted or shaped as to "affect the general interests of the engineering and allied technical profession."

Article VI provides funds by assessments upon Member-Societies, at the rate of $1.50 per member annually. At the same time there is no provision in the present referendum for obtaining these funds from the membership of our Society. The recent favorable vote on constitutional amendment to increase the dues will furnish only the necessary revenue to meet current expenses of operation and there is no available source of income to meet this proposed additional assessment. One of the most objectionable features

about this whole matter is to be found in Chapter I, Section I of the By-Laws, which reads as follows:

B.—"Qualifications: Any society or organization of the engineering or allied technical professions whose chief object is the advancement of the knowledge and practice of engineering or the application of allied sciences and which is not organized for commercial purposes, is eligible for membership."

This provision expressing the required qualifications of Member-Societies is certainly broad and liberal enough to take in any organization from the four great national engineering societies down to a Carpenters' or Plumbers' Union, as the latter are not organized for commercial purposes and they have for their purpose among other things the advancement of the application of allied sciences. The latter organizations are excellent and accomplish much good when managed in a sane and reasonable way, but they would scarcely make a suitable and harmonious combination with the American Society of Civil Engineers or with the other National Societies. The application of these qualifications for membership would bring together a destructively heterogeneous gathering of a great variety of organizations with a wide range of objects, different ideals and a diversity of interests so intrinsically conflicting as to breed incurable dissension.

These critical considerations could be much extended to cover other objectionable features of the proposed Federation, but enough has been shown to demonstrate conclusively the unwisdom and unworkability of the contemplated organization. The four National Engineering Societies at least should form some effective affiliation for the common good whenever important measures need concerted action without in any way trenching on the individual activity of each. The creation of such an affiliation is perfectly feasible, although requiring the deliberate and careful consideration of each organization. Such an undertaking is worthy of the best efforts of the broad minded, experienced members of each Society.

In the meantime, the proposal to enter The Federated American Engineering Societies should be defeated.

WILLIAM H. BURR, HENRY R. LEONARD,
J. VIPOND DAVIES, SAMUEL REA,
ALLEN HAZEN, J. WALDO SMITH,
ALEXANDER HUMPHREYS, WILLIAM J. WILGUS.

New York, Oct. 25.

Am. Soc. C. E. Should Join Federation, Says G. S. Williams

Sir—A member of the American Society of Civil Engineers has well said: "In order to make most effective the influence of that sound engineering service and guidance to which the public is justly entitled, and to improve the agencies through which the combined intelligence and genius of American engineering may express itself, the outstanding need of our profession today is its unification through a central representative body."

To meet this need the Federated American Engineering Societies has been formed, and in that specification lies the essential and a very distinct difference between it and the American Association of Engineers. The American Association of Engineers has for its primary object service to the individual, its member; the Federated American Engineering Societies has for its primary object service to the nation, the state and the municipality. With these distinct aims there is no reason to anticipate antagonism between the two, but rather, in matters of common interest, co-operation. In this distinction lies the justification, abundant in the writer's opinion, for the two organizations being separate bodies rather than united as one.

It is difficult to understand the opposition to the Federated American Engineering Societies on the part of men who have distinguished themselves in the work of civic betterment in their own communities, unless they have overlooked the underlying purpose of the organization as set forth in the second paragraph of its constitution which reads:

A service to others is the expression of the highest motive to which men respond and as duty to contribute to the public welfare demands the best efforts men can put forth, NOW, THEREFORE, the engineering and allied technical societies of the United States of America, through the formation of the Federated American Engineering Societies, realize a long cherished ideal, a comprehensive organization dedicated to the service of the community, state and nation.

The name and prestige of the American Society of Civil Engineers are dear to all its members, but what is in a name and what is prestige? Many a splendid name has gone to oblivion by the failure of those who bore it to measure up to the standard set before them—and prestige is defined as "an illusion."

There was a time when the American Society of Civil Engineers stood at the head of our engineering organizations and was looked up to by the whole profession in America, but that time has past. The opportunity to continue in that exalted position was thrown away by the provincialism of the governing minority and for ten years the society has done practically nothing for the profession, for its members or for the nation (except as a publication house at an exhorbitant cost), while other societies, both the Mechanical and the Electrical Engineers, if not also the Society for Testing Materials, have far outstripped it in the esteem of the profession and the public. Perhaps as suggested in a recent communication in your journal *"the standing of the American Society of Civil Engineers in the eyes of the world is a valuable professional asset,"* but it is nevertheless a *"standing-still,"* a mausoleum to the shortsightedness of those who have controlled and, in spite of an adverse majority, still seek to control its policies.

The arguments advanced by the committee against joining the Federated Societies are almost all counterparts of those to be found in the speeches of Melancthon Smith in the New York Convention of 1788, against the adoption of the Federal Constitution, but time has shown the fallacy of his reasoning, just as time will show the fallacy of that of the committee.

If the American Society of Civil Engineers is to play its part or any important part in the solution of the great problems today before our nation it must put its shoulder to the wheel of service with its sister organizations, and take its chance of a few blisters and callouses with the rest. If it is not willing to play such a part it has no right to the name it now holds, nor can it expect to retain the respect and support of its public-spirited members.

GARDNER S. WILLIAMS,
Ann Arbor, Mich., Oct. 23. Consulting Engineer.

Edwin Thacher and the Straight-Line Formula

Sir—In your issue of Sept. 30, p. 675, there is a biographical sketch of Edwin Thacher, whose professional services throughout a long life were so eminent as to deserve richly the memorial. I write this after many years of cordial friendship with him, the memory of which I shall always cherish. There is, however, one statement by the writer of the biography which is not in accord with historical accuracy and I doubt much whether Mr. Thacher himself would sanction it.

In speaking of the "notable achievements of his career," it is stated that they include "the deduction of the straight-line formula (in the publication of which, however, he was anticipated by Thomas H. Johnson, who had been independently studying the subject at the same time as Mr. Thacher)." This is a fundamental error in the history of the straight-line formula, as the establishment of that formula was due neither to Mr. Thacher nor to Mr. Johnson, and in all my long acquaintance with the former I never heard him make such claim or even intimate it. Curiously, the straight-line formula has for a considerable number of years been rather often called the "Johnson formula," although not generally.

The circumstances under which the formula originated, as any one can determine for himself, are as follows: At the annual convention of the American Society of Civil Engineers at Washington, D. C., in June, 1881, the old

bridge-building firm of Clark, Reeves & Co., of Phoenixville, Pa., presented a paper on the ultimate resistances of a series of wrought-iron Phoenix columns, the actual tests having been made at the Watertown Arsenal, Watertown, Mass. In the discussion of these tests the straight-line column formula was first set forth independently by each of three members of the American Society of Civil Engineers, Charles E. Emery, Prof. Mansfield Merriman and myself. Mr. Emery's discussion simply called attention to the straight-line character of that portion of the experimental curve of resistances which included the lengths of columns used in ordinary structural design, at the same time exhibiting in his discussion the equation of a straight line, but not in terms for immediate practical application. Prof. Merriman and I set forth rather extended discussions showing over what part of the experimental curve the straight-line formula would find application. He expressed the formula in terms of length over diameter of column, but my discussion presented the formula in terms of length over radius of gyration, the form in which it has ever since been used. My discussion, therefore, gave for the first time the straight-line formula in the form in which it has come into general use.

I am aware that it is not a matter of material consequence who first proposed and used the straight-line formula, but it is worth while in the interests of historical accuracy to record the facts as they are.

The paper to which I have referred above is entitled "Experiments Upon Phoenix Columns" and is found in Vol. XI, 1882, *Transactions* of the American Society of Civil Engineers. The discussions showing the straight-line formula are found on pages 93, 111 and 115.

Mr. Johnson's paper can be found in the *Transactions*, Vol. XV, 1886, p. 517. He, therefore, had before him for a period of four years the establishment of the straight-line formula before the appearance of his paper on the same formula. Although the straight-line formula is purely empirical and not subject to analytic derivation, he attempted to establish it by analytic demonstration, an effort which could not result successfully. An analytic demonstration based even partially upon the common theory of flexure cannot correctly be applied to members like long columns which are tested far beyond the elastic limit, although it may be done as an approximate analysis to which empirical co-efficients may be fitted by tests for ultimate resistance.

WILLIAM H. BURR,
Consulting Engineer.

New York City, Oct. 21.

Simple Formulas for Bond Stress Limits in Concrete Beams

Sir — For figuring bond stress in reinforced-concrete beams of uniform loading the writer suggests the following method as handier than the usual one of solving for u in the formula:

$$u = \frac{V}{\Sigma O.jd}$$

Given an area of steel required for moment, the smaller the individual bar, the greater the total surface for bond. That size which is sufficient for moment and small enough for bond varies directly with the length of span, according to the following relations:

$c = \frac{l}{200}$ = Simple Beam

$c = \frac{l}{100}$ = Cantilever Beam

$c = \frac{l}{250}$ = Continuous Beam of Two Spans

$c = \frac{l}{200}$ = End Supports of Continuous Beam of Many Span.

$c = \frac{l}{300}$ = Elsewhere in Continuous Beam of Many Spans

where c = maximum size of bar—
and l = span in inches.

This may be proved as follows:

Σa_s = steel used for moment.

$$= \frac{M}{f_s . jd}$$

Also, $u = \frac{V}{\Sigma O.jd}$ (where ΣO = total circumference of bars)

or, $\Sigma O = \frac{V}{u.jd}$

But, for either round or square bars,

$\frac{\Sigma a_s}{\Sigma O} = \frac{c}{4}$ (where c = size of average bar).

$$= \frac{M}{f_s . jd} \cdot \frac{u\, jd}{V} = \frac{c}{4}$$

or, $c = \frac{M}{V} \cdot \frac{4u}{f_s}$

Allowing $u = 80$ and f_s = 16,000 lb. per square inch. Then for a simple beam—

$$\frac{M}{V} = \frac{wl^2}{8} \times \frac{b}{\frac{wlb}{2}} = \frac{l}{4}$$

and $c = \frac{l}{200}$

The other derivations are similar:

CHARLES E. SHARP, JR.

St. Louis, Mo., Sept. 30, 1920.

Factors Affecting Use of Water in Irrigation

Sir—In your issue of June 10, 1920, is a valuable article by E. A. Moritz entitled "Factors Affecting the Use of Water in Irrigation." The data furnished by Mr. Moritz do more than what he says that he hopes to do, i. e., "throw an increment of additional light on the subject." The author, however, does not attempt to answer, even in general terms, the question editorially asked, "What is the maximum area which a given water supply will irrigate?", appreciating the fact that volumes written about irrigation engineering could not answer the question completely, for, as he well says, "It is obviously impossible to duplicate any given set of conditions."

However, in view of the fact that "a new irrigation development is nearly upon us," as is suggested, "engineers should have the benefit of the widest available information," from whatever source it may be obtainable, and any engineer of experience should be glad to share with others the conclusions derived through that experience. Therefore, since a study of the subject during a period of over thirty years, in the course of which time reports have been made concerning proposed irrigation projects scattered throughout the entire so-called arid and semi-arid parts of the United States, has led to certain conclusions which may be of interest to others, at least as bases for discussion, the writer ventures to present them herein. It is, of course, impossible to go into the details as to the reasons for these conclusions, or even to state them in full, in a letter of this character, but it is hoped that it may, nevertheless, be worth while to attempt to outline them in brief.

In the past, even under the most favorable conditions as to water supply, irrigation companies, districts, canal owners, etc., have generally been individual entities, fighting all others dependent upon the same source of supply for their "rights" to water, shotgun control being exchanged slowly for regulation by properly constituted legal authority. The coming era may, perhaps, be an era of co-operation in which the general aim will be to utilize to the greatest possible extent all, or as much as it is practicable to use, of the available supply of a given stream system, or even a combination of stream systems, recognizing the fact that, generally speaking, the supply of arid land far exceeds the available supply of water. To illustrate, the writer selected, nearly twenty years ago, two projects for U. S. Reclamation

Service, both of which have since been constructed. One of the primary reasons for selection in each case was the fact that it was believed that the available water supply, with storage as it might be needed, would always be adequate, practically regardless of what those having so-called priorities in the stream system might do. The most recent reports have been designed to make the fullest possible use of all of the practically available supplies, through a consolidation of all the interests in water within the given watershed, regulating the annual flow and conserving the floods through storage, utilizing both the normal underground supplies and the recovered waters originating from the surplus water used in the original distribution and application, so far as such utilization may be found to be practicable, the fact being now generally recognized that apparent losses in greater or less amounts, depending upon existing conditions, are inevitable and may even be necessary to achieve the desired result, i. e., the profitable production of crops.

It is obvious that "a given water supply," when uncontrolled or unregulated by storage, will efficiently irrigate only the minimum area. With storage and regulation, a greater area, and through the addition permitted by the recovery and utilization of the available underground supplies to the fullest extent possible, a still greater area, approaching a maximum, may be irrigated, the results being also modified and limited by the ratio of cost to returns. It is the practice of the writer, when attempting to arrive at a tentative conclusion as to the maximum area that can be effectively supplied with water, in cases where it is planned that the most complete use possible shall be made of the water supply, to follow a method, which, reduced to the form of an equation, is as follows:

$$A = C\frac{S + U + R + P - L}{D}$$

where

A represents the area sought, expressed in acres.

C is a coefficient varying inversely with the completeness of the irrigation of the district, taking into consideration the following factors: (a) The area irrigated the first year will be relatively small; (b) Development of irrigation to the maximum amount will require several years, the length of the term depending upon local conditions; (c) The area actually irrigated will in no given year be more than a certain percentage, also more or less dependent on local conditions, of the entire area within the district—as only a certain percentage of all of the good agricultural lands in any given county or township in humid territory is cultivated in any one given year. In very large projects, generally speaking, from 60 to 80 per cent appears to be about the range of reasonable probability as to the maximum, with smaller amounts in the earlier stages of operation, C being the inverse of this estimated percentage.

S is the measurable (and, for final estimates, at least, reasonably well known, not guessed or estimated from precipitation, drainage area, etc.) dependable surface run-off of the stream system, expressed in acre-feet, modified in accordance with known practicable storage and regulation possibilities. It is obvious that the determination of bases that would warrant final conclusions must involve definite knowledge of actual run-off, availability and efficiency of storage sites, evaporation, seepage and transmission losses, existing rights, etc.

U is the normal underground supply, expressed in acre-feet, that is being or that may be profitably drawn upon and added to the surface supply. This factor would generally have to be estimated after a study of local conditions had been made.

R is the practically recoverable and usable parts of the delivery and application surpluses, expressed in acre-feet. It will vary with many conditions, such as nature of reservoir bottoms and sides, dams, geology, soils, canal surfaces, distance water has to be conveyed, efficiency of application, etc. Mr. Moritz suggests from 25 to 50 per cent of the total entering the headgate as the probable range of gross loss. It will obviously be some derivative of the sum of S, U and itself. In this connection it should, perhaps, be stated with reference to the control of the underground waters that the best modern practice tends to a recognition of the fact that plans for an irrigation system should also include provision for drainage, the details to be worked out as conditions may be evolved. Unless the ground water levels are controlled large tracts of land, perhaps originally considered the best in the district, will become water-logged and perhaps permanently ruined.

P is the amount of precipitation beneficial to agriculture, expressed in acre-feet. It may or may not be important, the conditions varying in different localities.

L is the amount of water, expressed in acre-feet, that is definitely lost beyond recovery or that becomes too alkaline or otherwise bad to be used for irrigation.

D is the ultimate duty of the water, i. e., the number of acre-feet capable, on the average, and considering all the acres irrigated within the district, of producing the most satisfactory results. It must not be confused with the amount from which transmission losses are to be deducted, since such losses are otherwise provided for in the formula, but is simply the amount actually required at the place of application for transpiration and evaporation. Reliable investigations have sometimes shown it to be as low as two, and where the return waters are used over and over, even one acre-foot per acre.

One example of the formula, with estimated values, as used in practice in one instance, is as follows:

$$\underset{(C)}{\frac{4}{3}} \times \frac{\overset{(S)}{825{,}000} + \overset{(U)}{100{,}000} + \overset{(R)}{200{,}000} + \overset{(P)}{0} - \overset{(L)}{125{,}000}}{\underset{(D)}{10/3}} = \overset{(A)}{400{,}000}$$

In this example the estimate for C was based on a study of the history of somewhat similar large projects, for S on authentic records covering a period of 24 years, for U, R and L on studies of local conditions, and for P on U. S. Weather Bureau records. P was ignored as being too small and erratic to be taken into consideration, though in actual practice in that particular region it is usually thought to be at least the equivalent of a winter irrigation. D, based on local requirements, is probably large but the intent was to make the estimate, a preliminary one, very conservative. Due weight, must, of course, be given to uncertainties, irregularities of supply, etc., but generally speaking, where conditions are reasonably well understood, it is a mistake to lean too strongly to the side of conservatism, as the practicability of the undertaking from the standpoint of the ability of the project to repay the cost is likely to depend upon the inclusion of as much new land as can certainly be furnished with enough water. Certainly the aim of the engineer should be to make his preliminary estimate as nearly "right" as possible.

It is obvious that when no storage or use of underground waters is contemplated the formula becomes

$$A = C\frac{S + P - L}{D},$$

S becoming, in this case, that portion of the surface supply practicably and advantageously available, taking the monthly records and requirements into consideration along the lines suggested by Mr. Moritz, the other factors remaining as before. Of course there may also be an infinite number of intermediate situations, a different analysis being required in each case. A will sometimes be limited to the existing area of good land and P may often be eliminated through it should always be studied.

Only the relationship of water supply and land has thus far been considered. Estimates of cost, ability of the land to repay the cost with a good margin of profit, financing, settlement, etc., must follow the original tentative estimate of area. Every experienced engineer will have his own method of going about this. The writer generally uses approximately the following skeleton outline of a plan of investigation and reporting:

Location: availability of labor and labor-saving machinery.
Description: historical statement; general plan.
Climate: its general suitability for human habitation and agriculture.

Lands: geology, topography, altitude, extent, soils, crops, markets, transportation facilities, ownership and other conditions affecting the practicability of the undertaking.

Water Supply: amount and suitability for the irrigation of the lands, including all the factors used in the formula previously described.

Cost: preliminary investigations, surveys, financing, construction, settlement, overhead expense, and everything incidental thereto.

Economic Practicability: the capacity of the lands for paying the charges that must be made to cover maintenance and operation and the repayment of the original cost with interest, and adequate returns with profit to the farmers.

The writer considers the general plan as suggestive rather than otherwise but hopes that its presentation may induce further discussion. It might be stated, further, that detailed, checked, verified and revised estimates should be made before final conclusions, even concerning A, are reached.

A. LINCOLN FELLOWS,
Senior Irrigation Engineer, Division of Irrigation, Bureau of Public Roads, U. S. Department of Agriculture.
Denver, Col., Oct. 15.

Depths of Concrete Footings

Sir—In order that there may be no misunderstanding, it might be well to note that the d in the diagram on formula on p. 464, *Engineering News-Record*, Sept. 2, 1920, in my article entitled "Practical Design of Concrete Cap Footing" should be the effective depth of the footing slab, that is the depth from the top of the slab to the center of the reinforcing steel.

Chicago, Ill., Oct. 9. H. H. FRENZEL.

Takes Exception to Utility of Venturi Flume

Sir—I have read with much interest the article by Messrs. Wilson and Wright on "A Study of the Venturi Flume as a Measuring Device in Open Channels," published in *Engineering News-Record*, Sept. 2, 1920. I do not wish to criticize the experiments as carried out in the Cornell laboratory, which appear to have been conducted in an academic and scientific manner. There are, however, several statements in the text to which, I believe, many hydraulic engineers will take exception.

The authors say of the Venturi flume: "It will combine, under field conditions, accuracy at least equal to that of any other open-channel measuring apparatus, together with reliability and small loss of head in the channel." Usually under field conditions, in the West, the gages are read by ditch riders who are rarely able to read a gage closer than 0.01 ft. In the Venturi flume two readings have to be taken, each of which, under field conditions, are likely to be in error 0.01 ft. Consequently, the Venturi difference h could easily be in error 0.02 ft. Referring to Fig. 5 of the article, it can be seen that an error of 0.02 ft. would cause an error in the discharge of from 25 to 50 per cent. Besides the probable error due to reading the two gages there is a constant error due to the inaccurate coefficient C_f which, according to the authors' statement, is about 5 per cent.

The authors' statement, "The Venturi flume has been demonstrated to be a means of measuring water with an accuracy about equal to that of the ordinary weir in practice" cannot pass unchallenged. The classical experiments of Francis, Bazin, Lyman, Thompson, Barr and others all indicate that with a properly constructed weir the error by formula will be within 2 per cent of the actual discharge. Moreover, the relative error due to field observations of gage height will not be in excess of 0.01 ft. Let us assume that a channel is being measured by a right-angled notch weir, the formula in the case being $Q = 2.52\ H\ 2.47$. With a head of 1.10 ft. the discharge is 3.189 sec.-ft. and with a head of 1.11 ft. it is 3.261 sec.-ft., giving a difference in discharge of 0.072 sec.-ft., or 2.2 per cent, which is a considerably smaller error than could be expected by the Venturi flume.

The writer, sometime manager and engineer for various Western irrigation projects, has had considerable opportunity to test out the accuracy of the ordinary Price current meters. He has found when gaging flumes are rated by means of a current meter, that an accuracy of from 2 to 5 per cent may invariably be obtained. The lost head in a gaging flume is far less than that in a Venturi flume, and also the cost of construction would be considerably less.

It is hardly to be expected that any project engineer would install a Venturi flume and be satisfied to use a laboratory formula in computing the discharge. The friction factor and the coefficient C_f of the field flume would undoubtedly be different from that of the smaller laboratory model. The Venturi flume, to be of practical service, should be rated in the field with a current meter, and since an equally accurate rating curve can be obtained for a rectangular flume of constant cross-section there would be no object in adopting the more expensive and complicated measuring device.

Weirs of all types have been used very successfully on irrigation projects. Over 5,000 small weirs are used on one Western project alone. The lost head resulting from the use of weirs is, in many cases, an actual advantage. A majority of the weirs are placed at the turnouts of the main canals or laterals, at which points there is generally an excess of head to be dissipated.

Even the small lost head of the Venturi flume would hardly be permitted in low-head power projects when the flow could be measured more accurately without obstruction by means of a current meter or by Chemi-Hydrometry. B. F. Groat, in his paper on Chemi-Hydrometry, Vol. LXXX, Trans. Am. Soc. C. E., 1916, claims an accuracy of a fraction of 1 per cent by the chemical method of gaging. In an article on the "Characteristics of Cup and Screw Meters," Vol. LXXVL, Trans. Am. Soc. C. E., 1913, Mr. Groat remarks in regard to current meter gagings: "Good work on the mountain streams of North Carolina and Tennessee has shown that individual discharge determinations based on the foregoing processes will plot within 1 or 2 per cent as extreme errors, of the final discharge curves."

The writer has repeatedly checked current meter discharges against that of a standard weir, the difference being generally under 3 per cent.

I am of the opinion that an effort should be made toward simplicity in the design of all gaging devices. Unfortunately the modern hydraulician is constantly striving for something new and, in doing so, frequently creates a complicated laboratory device, and overlooks the necessity for the practical application of the same.

Anaconda, Mont., Sept. 9. H. L. THACKWELL,
Hydraulic Engineer.

The Spreader Plow for Railroad Embankment

Sir—Referring to the comments of L. C. Scott in *Engineering News-Record*, Sept. 2, p. 473, in connection with the use of a spreader plow in building high banks in railroad construction work, (*Engineering News-Record*, Aug. 12, p. 229), his statement that such a method would interfere with uninterrupted service is true. Where space is limited and service must be maintained this method could not be used to advantage. However, where sufficient space is available the method described has been used and has effected an enormous saving as compared to what trestle work would have cost. Some material will roll down from the high position of the track as suggested by Mr. Scott, but not to so great an extent as to be serious.

South Milwaukee, Wis., Sept. 30. MARK J. WOODHULL.

Large Gas-Welded Tank for Compressed Gas

A tank 22 ft. in diameter by 30 ft. high, for compressed gas, has just been completed at the plant of the Liquid Carbonic Co., Birmingham, Ala. It consists of ¾-in. steel plates joined at the seams by oxyacetylene welding. After completion it withstood the proof test and was found to be gas-tight in all the seams.

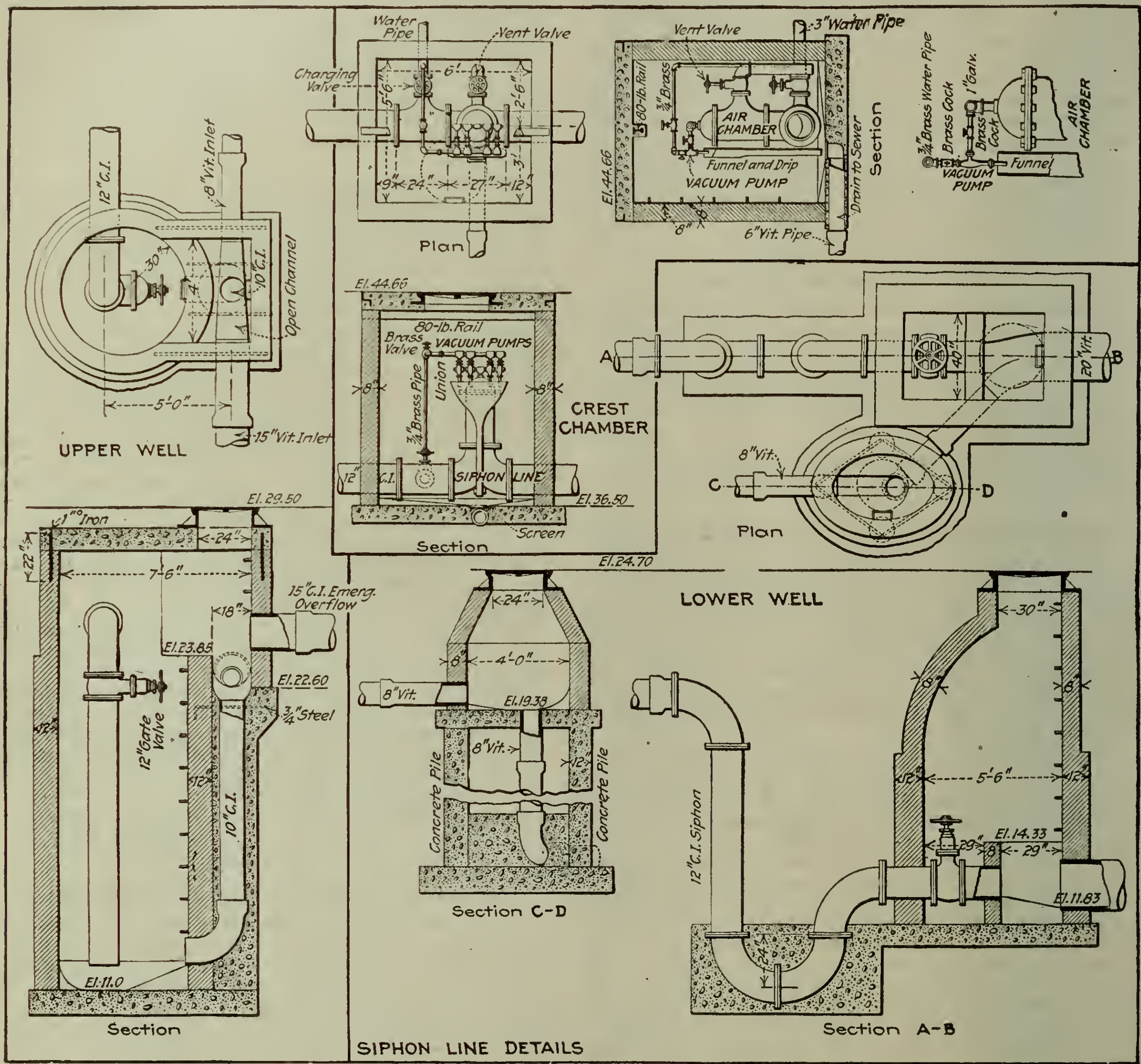
True Sewage Siphon With Water-Jet Ejectors on Air Chamber

Sir—In connection with the article in your issue of Sept. 16, describing the installation of an electrically-operated pump to remove accumulated air from the crest of a true siphon, and a letter published Sept. 30, suggesting the use of a venturi tube for maintaining the requisite vacuum, your readers may be interested in the accompanying plan showing a true siphon which I designed in 1907 to carry clarified sewage from a high but pocketed district of East Providence, R. I., to the main gravity system of the town.

The siphon is of 12-in. cast-iron pipe. Both ends are water-sealed—the intake by submerging the pipe to an elevation lower than the spill of the discharge, the outlet by a return bend. Even when operation ceases entirely, the siphon can draw no air from either end.

At the crest an air-chamber is provided, and to the crown of this is connected a battery of four water-jet ejectors (in multiple merely to guard against obstruction of one or more units between visits of inspection), operated by $\frac{1}{16}$-in. jets from the water main in the street. The operating water and the small amount of sewage entrained when all air has been removed from the chamber are discharged directly into the shallow local sewer which serves the houses on the hill.

The siphon is charged thus: First, the intake well is filled to the level of the valve controlling the intake pipe. This valve and a similar valve at the outlet end are then closed, an air-vent at the crest is opened, and water from a 3-in. connection with the water main is turned into the siphon. When full, the water valve is closed, the outlet valve is opened, the intake valve opened and the battery of ejectors started.



TRUE SEWAGE SIPHON AT EAST PROVIDENCE, R. I.

The velocity of flow is governed entirely by the amount of sewage entering the upper well. No throttling is needed. If a sudden rush of sewage brings a volume greater than that being removed by the siphon at the head momentarily existing, water will rise in the intake well and increase correspondingly the head and the velocity through the pipe.

If it diminish, the discharge will slacken; it may cease altogether without breaking the siphon.

The admitted waste of water is, in the judgment of the writer, much more than offset by the low cost of installation and maintenance and the entire absence of moving parts.

G. EVERETT HILL,
City Wastes Disposal Co.

New York City, Oct. 8.

NEWS OF THE WEEK

New York, October 28, 1920

Federation Endorsed by 455 Am. Soc. C. E. Members

Circular Letter Issued This Week Urges Affirmative Vote on Ballot To Be Canvassed Nov. 8

Carrying the names of 455 corporate members, a circular letter urging an affirmative vote on the proposal to join the Federated American Engineering Societies was sent this week to the membership of the American Society of Civil Engineers, by whom the question will be decided by letter ballot to be canvassed Nov. 8. After recording the endorsement of the federation by Engineering Council and the Washington Organizing Conference the communication presents arguments in favor of charter membership in the federation for the American Society of Civil Engineers.

The letter is reprinted in full below:

We fully endorse the arguments for joining the Federated American Engineering Societies. We are impressed that the unanimous recommendation of the Joint Conference Committee of the four Founder Societies (Sept. 17, 1920) of a comprehensive engineering organization, received the unanimous endorsement of

(a) Engineering Council (October, 1919),
(b) The joint meeting of the governing boards of the Am. Soc. C. E., Am. Inst. M. E., Am. Soc. M. E., Am. Inst. E. E., Am. Soc. T. M., U. E. S., and the members of Engineering Council (Jan. 23, 1920), and
(c) The Washington Organizing Conference (June 3-4, 1920),

and led to the unanimous creation of the Federated American Engineering Societies and American Engineering Council (June 3-4, 1920), which were unanimously endorsed by Engineering Council, June 17, 1920. The Chairman of Engineering Council advised the Joint Conference Committee on July 12, 1920, that it would act for the new Council and do everything in its power to facilitate a smooth transfer of activities from the old to the new Council (Jan. 1, 1921).

This movement does not embark the society either on a "highly questionable" or "dangerous" procedure or "carry it abruptly into untried paths," nor does it mean the "surrender of the society's name and prestige," since it is a continuation, on a more representative and democratic basis, of the work of Engineering Council, in the organization of which the society participated and has fostered and financially supported for over three years.

(*Continued on p. 866*)

Business Stagnation Reduces Steel Prices in Germany

(From Engineering News-Record's Berlin Correspondent)

Business stagnation in Germany has considerably eased the iron and steel markets and has lately resulted in an all-round reduction of iron and steel prices for raw and semi-finished products. Scrap iron, which was at its highest point in March, at 2,100 marks, is now freely offered at 500 marks and still the supply overlaps the demand. Prices for semi-finished products, which were at their highest point in May, 1920, have now returned to the level of February, 1920. The August quotation of structural shapes was 2,740 marks, as against a high quotation of 3,620 marks in May, 1920. Structural shapes were offered at 220 marks in December, 1918. Steel bars were offered in August at 2,840 marks, as against 3,200 marks for June and 3,650 marks for May. Bars were quoted at 135 marks in December, 1915. Price quotations here are per thousand pounds.

As Germany is now mostly dependent on foreign countries for the supply of iron ore, the prices will naturally move in accordance with the fluctuations of the exchange. The only stabilizing factor in this respect is the scrap iron, which still forms a large part of furnace supplies. The supply of scrap is by no means exhausted and is considerably helped now by the scrapping of war material. Lately, over 500 airship sheds and airdromes, estimated to contain more than 300,000 tons of steel, have been designated to be scrapped. Also there are stores of ammunition, rifles and ordnance in the country which the Reparation Commission will soon put on the scrap market.

New Member for Federation

The Washington Society of Engineers has voted to accept the invitation to become charter members of the Federated American Engineering Societies. At a recent meeting R. L. Humphrey explained the advantages offered to members of the federation. A. P. Davis, George R. Putnam and M. O. Leighton urged that the invitation be accepted. While some arguments in opposition were presented sentiment was overwhelmingly in favor of accepting membership.

Federation Opposed

A vote of the executive board of the Illinois Society of Engineers was 9 to 1 against joining the Federated American Engineering Societies, but no definite action has been taken. The matter may be submitted to a vote of the members.

Discuss Steam and Electric Locomotives

Relative Merits Considered at Meeting of Engineering Society Sections Last Week

The relative merits of modern steam and electric locomotives were discussed Oct. 22 at the first joint meeting of the Railroad Section, Am. Soc. M. E., the Metropolitan Section, Am. Soc. M. E., and the New York Section of the Am. Inst. E. E. The principal papers presented were by John E. Muhlfeld, Railway & Industrial Engineers, Inc., New York; F. H. Shepard, director of heavy traction, Westinghouse Electric & Manufacturing Co., and A. H. Armstrong, chairman, electrification committee, General Electric Co. Abstracts of these three paper appear elsewhere in this issue.

The meeting was held in the auditorium of the Engineering Societies Building and the attendance overtaxed its capacity. The program was presented under the direction of E. B. Katté, chairman of the Railroad Section, Am. Soc. M. E., H. W. Buck, chairman of the New York Section, Am. Inst. E. E., and W. S. Finlay, Jr., chairman of the Metropolitan Section of the Am. Soc. M. E.

The discussion was opened by Frank J. Sprague, who was introduced by the chairman as the "father of electric traction." Mr. Sprague briefly reviewed the remarkable development of steam railroad electrification and pointed out that present conditions, for purposes of increasing traffic and power, demanded the concentration of power represented by electrification, together with increased speed. He said that electrification would come gradually and would be governed largely by financial conditions, but that by electrification only will maximum traffic capacity of trackage be secured. Following the papers of Mr. Muhlfeld, Mr. Shepard and Mr. Armstrong, the discussion was continued.

In a paper by F. J. Cole, chief consulting engineer, Locomotive Superheater Co., read by H. B. Oatley, chief engineer of the same company, the statement was made that further refinements of the steam locomotive should be able to equal past performance. In any comparison of maintenance cost the comparative costs of the maintenance of all electrical as well as all steam equipment must be considered. The complete cost of electrification is hard to obtain in full.

A. W. Gibbs, chief mechanical engineer, Pennsylvania System, who has had charge of electrification at New York and Philadelphia, pointed out that

it was desirable to unify speeds of both passenger and freight service in order to increase the traffic capacity of trackage. Mr. Gibbs conceded that standby losses of steam locomotives are considerable. In his opinion it is useless to attempt comparison of relative maintenance costs since the necessary data have not been developed by experience. Local conditions must always determine whether electrification is to be resorted to.

The cost of maintaining electrical equipment is comparatively high according to the statement made by F. H. Hardin, chief engineer of motive power and rolling stock, New York Central R.R., in a paper read by R. M. Brown, engineer of motive power of the same road. While it is stated that there is no need for back shops for electric locomotives, wrote Mr. Hardin, shops whether called back shops or by some other name will be required. On the New York Central R.R., in one estimate, equated costs per mile for repairs to a Mallet locomotive and the electric locomotive showed 37c. for the Mallet and about 60c. for the electric locomotive. It was stated that electrification will be a part of the solution of developing railroad capacity, but is only one factor and perhaps not the greatest involved in accomplishing what Mr. Shepard pointed out for the future.

Range of Operation

That the steam locomotive could be made to do all that had been claimed by Mr. Shepard for the electric locomotive as to range of operation was a statement included in a paper by W. F. Kiesel, Jr., mechanical engineer, Pennsylvania R.R., which was read by title.

W. L. Bean, assistant general mechanical superintendent, New Haven R.R., emphasized the relatively high maintenance cost of electric locomotives; danger from overheating from repeated acceleration, and effects on insulating material.

In behalf of the electric locomotive, C. H. Quinn, chief electrical engineer, Norfolk & Western Ry., said that on that road it had not been necessary to install any system of power limiting by dispatching and that the only signaling that was used to dispatch trains is ordinary block signaling. However, the future possibilities of the steam locomotive to keep up to the demands of power and speed should be looked into with due regard for limits of clearance and wheel loading. He said that the Norfolk & Western over its electrified area was now carrying 100 per cent more tonnage than was previously possible.

A. L. Ralston, mechanical superintendent, New Haven R.R., cited successful experience with electrification on the New Haven. A paper written by Reinier Beeuwkes, electrical engineer, Chicago, Milwaukee & St. Paul R.R., described the successful operation of electric locomotives on that road and stated that as a result definite information and cost data had been established. "In any event," said Mr. Beeuwkes, "actual available operating data will permit of settling the matter one way or the other in the individual case." The case for the electric locomotive was summed up by E. B. Katté, chief electric engineer, New York Central R.R., who said that electric locomotives on that road were ready for service 56.2 per cent of the time and steam locomotives only 24.3 per cent. Mr. Katte pointed out wide difference in fuel consumption on different electrifications.

Building Construction Disclosures at New York

With a view to determining the extent to which the action and practices of building-material interests and contractors have prevented building on a larger scale in the State of New York, an investigation is now under way in New York City by a legislative committee, with Samuel Untermyer acting as its counsel. Specifically the committee was ordered by the legislature to determine whether a "building-materials trust" was putting up the price of materials or otherwise interfering with the volume of construction work.

The disclosures so far made, and to which importance is attached by the counsel of the committee, relate to the activities of an attorney, one John T. Hettrick, in "advising" contractors whether or not to bid on certain jobs; to the simultaneous retainer of Hettrick by the labor unions, and to a bribe alleged to have been given by a contractor in order to have a strike "called off" promptly.

"Advice" Given on Bids

Hettrick, it appears, acted as adviser of a number of plumbing contractors. These contractors sent him copies of bids they proposed to submit, and he, in turn, "advised" them with reference to the client's credit, the conclusion being drawn by the counsel of the committee that that advice was a ruse to control the bidding figure and bring about collusion.

Later in the investigation there was introduced in evidence a letter written by Hettrick to the Mayor of New York, urging him to facilitate the starting of work upon certain contracts for the building of the new Court House. In it was a closing paragraph in which he stated that he represented a number of the unions. Attempt is being made to indicate that Hettrick, counseling both the contractors and labor, was in a position to materially affect the prosecution of building work.

Attempt is being made by Mr. Untermyer, also, to run down the story of the alleged bribe for the cancellation of a strike against a building contractor.

As a result of the disclosures so far made, the Mayor of New York has cancelled the contracts already let upon the new Court House, totaling about $6,000,000.

New York Engineers Consider Civic Subjects

First Meeting of Am. Soc. C. E. Local Section Devoted to Freight-Handling Problem

The first of a series of eight meetings devoted to the discussion of important civic subjects that affect the future well being of the New York Metropolitan district was held by the New York Section of the American Society of Civil Engineers, Oct. 20, and was devoted to a consideration of the subject, "Local Distribution of Freight and Food Products." Colonel Charles D. Hine, special agent, Erie R.R. at New York, who was previously vice-president of the Southern Pacific Railroad Co. of Mexico, was the principal speaker. It is the plan of the local section that the discussion at these meetings will result in recommendations and definite plans for action on the subjects under consideration.

Colonel Hine, in discussing the problem of distribution and freight handling in the port of New York, laid emphasis on the need of providing prodigious expansion of storage facilities and expediting the short haul in small workable units. Extracts from his paper appear elsewhere in this issue. Colonel Hine was followed by Colonel F. A. Molitor, who managed the Citizens Trucking Corporation during the strike of coastwise freight handlers; J. Shirley Eaton, of the Federal Trade Commission; Cyrus C. Miller, formerly president of the Borough of The Bronx; E. C. Church, of the New York Chamber of Commerce; J. J. Hallihan, J. B. Miller, assistant corporation counsel, New York City; B. F. Fitch, president of the Motor Terminals Co., New York and Cleveland, which has the contract with the railroads entering Cincinnati for the handling of transfer freight at that point in demountable motor truck bodies; Fred Lavis, consulting engineer, American International Corporation, New York, and W. C. Brinton, consulting mechanical engineer, New York.

Need for Store Door Delivery

Colonel Molitor said that the Island of Manhattan is already too crowded to contain "one single foot more of standard-gage track," and favored the establishment of a great joint classification and storage yard on the New Jersey meadows between Newark and Jersey City, to be supplemented by an outer belt line extending from Kill van Kull, Staten Island, out to the vicinity of Plainfield, N. J., then northward and eastward to cross the Hudson River at a point between Beacon and Camelot, from there connecting with the New York Central, New Haven, and New York Connecting Line railroads. This plan would permit of the immediate discharge of freight at the yards in the New Jersey meadows into truck bodies to the increase of car mileage. Any comprehensive plan for the distribu-

tion of freight and foodstuffs in Manhattan Island must include provision for store-door delivery, said Colonel Molitor.

Mr. Eaton, of the Federal Trade Commission, said that the subject was a public one, requiring the broadest viewpoint and emphasized the importance of store-door delivery. He said that the present situation was universally bad and that it is "up to engineers to bring forth a solution."

Cyrus C. Miller, who now acts as counsel for the associations of food distributors in New York, pointed out that the problem of food handling must be treated specially, since provision must be made for display and sale, as well as distribution and storage, and in any plan the keynote must be in every movement of commodities to go as far as possible to point of consumption.

It was suggested by Mr. Hallihan that permanent committees be appointed by the New York Section of the American Society, each of which should be devoted to a consideration of the public subjects to be discussed this season. These committees would follow up the recommendations made at the meeting to the end of presenting a final report for practical adoption.

J. B. Miller briefly presented a plan for establishing freight yards, with a capacity of 8,000 cars on the islands in the upper East River to be connected by car-ferry slips. Mr. Miller said that New York City must guard against its "becoming the suburb, and Newark the metropolis," as a result of unloading cars in the New Jersey meadows as had been proposed. In connection wit the plan for developing the East Rive islands freight subways would be provided.

Central Warehouses Proposed

The application to the port of New York of the system of handling transfer freight in demountable motor truck bodies, now in use in Cincinnati, was outlined by Mr. Fitch, of the Motor Terminals Co. As a result of a four-year engineering study, said Mr. Fitch, it is established that 50,000 tons daily in the metropolitan district are available for such service, on which the present cartage cost is $2.50 per ton and the distributing and assembling terminal cost to carriers not less than $3.50 per ton, or a total daily cost of $300,000, which by the service proposed could be reduced to $100,000, representing an annual saving of approximately $60,000,000. This plan would ultimately provide for store-door delivery through the medium of demountable motor truck bodies handled between rail and pier heads and a number of centrally located off-track or inland zone station warehouses.

Mr. Lavis presented a plan for a large warehouse and manufacturing plant terminal in Jersey City, with rail and deep water connections as a central point of distribution. The meeting was presided over by R. S. Parsons, general manager of the Erie system.

The New York Section will hold monthly meetings devoted to other civic subjects, extending until next May. The present program is as follows: Nov. 17, "Urban and Suburban Passenger Transportation"; Dec. 15, "The Port of New York"; Jan. 12, "Water Supply and Sanitation"; Feb. 16, "Light, Heat and Power"; Mar. 16, "Streets and Parks"; April 20, "Military Features," and May 11, "Bridges and Tunnels." These meetings will be held at the Engineering Societies Building, 29 West 39th St., New York City, opening at 8 p.m. The first speaker will be limited to a period of twenty minutes and will be followed by several invited speakers, to each of whom will be allotted ten minutes for discussion of special phases of the subject under consideration.

Water and Light Bond Election at Topeka, Kan.

A bond issue of $535,000 for the consolidation of the water and electric light plants and for a water filtration plant will be voted on at Topeka, Kan., on Nov. 2. Herbert J. Corwine is mayor.

Trial Lettings Proposed by New York Highway Commission

In order to determine if contractors are in a position to submit favorable proposals for highway construction, Frederick Stuart Greene, Commissioner of Highways, State of New York, has announced a trial letting for Oct. 29, when proposals for the construction of twelve highways will be received. Should this letting prove favorable, a second letting is contemplated in November for roads upon which winter work may be carried on advantageously. This intention of the highway commissioner is contained in a recent letter to the Governor and the people of the state.

Commissioner Greene considered that contracting conditions have considerably improved over those existing last April, when the highway commission announced the suspension of further letting for new highway construction. The decision to hold a trial letting was strengthened by requests from leading contractors who will shortly complete all work ahead and who are now preparing for their 1921 activities. It is the assertion of Commissioner Greene that if the state does not continue road construction many of the most reliable road contractors will be forced to seek employment elsewhere.

The 1921 program of the New York Highway Commission for new construction will be published in November and if conditions warrant, proposals will be received during February, March and April for highway construction in order that new work may be underway throughout the state early in the spring.

At the time the 1920 construction program was suspended, there were 183 roads under contract. Of these, 25 have been completed and 78 are now more than 50 per cent complete.

Water-Works Improvements Urgently Needed at Kansas City

Water works improvement urgently needed by Kansas City, Mo., within the next six to eight years would cost from $14,000,000 to $18,000,000 at present prices, according to a report to the Board of Fire and Water Commissioners submitted on Oct. 6 by George W. Fuller in behalf of Fuller & McClintock, consulting engineers, New York City.

The improvements include a filtration plant, a high level pumping station, an equalizing reservoir at the East Bottoms and necessary discharge lines to connect with the distribution system. Under existing statutory authority the city could now issue some $3,000,000 of bonds.

Mr. Fuller's report, which is a preliminary one, was made to bring to the attention of the Mayor and Council and taxpayers the "seriousness of the local water-works situation in order that the program of financing can be arranged without delay." To give added force to the urgency of the Kansas City water supply needs Mr. Fuller recommended the "calling in of several experienced local engineers as a Board of Review" to pass upon his report. This board was composed of Wynkoop Kiersted, chairman; Clinton S. Burns, of Burns & McDonnell; George A. Johnson, of Johnson & Benham; Alexander Maitland, Jr., and John Prince. Under date of Oct. 11 the Board of Review endorsed the conclusions reached by Fuller & McClintock.

Water Shortage Imminent

In their report Fuller & McClintock state that unless the recent rate of increase of water consumption is reduced "a serious water shortage is imminent by 1924." Recent water-waste reductions efforts have diminished the consumption by from 6,000,000 to 8,000,000 gal. a day. The engineers consider that it is imperative that this water waste work be prosecuted without interruption and state that "even with this being done water shortage is threatened by 1926-28." Besides the danger of a shortage the present supply is "objectionably muddy much of the time, and at intervals the sterilization process in use is seriously interfered with by the sediment in the water."

The engineers' investigation showed that the cost of the water supply from the Ozarks, the St. Joseph's district or the upper valley of the Kansas River would cost from $25,000,000 to $65,000,000 in excess of filtered water from the Missouri River. The best source of the city's supply, the report states, "is undoubtedly the Missouri River, with the water taken either from the existing site at Quindaro, or from a new site on the north branch of the river just west of the Platte-Clay County line.

Federation Endorsed

(*Continued from p. 863*)

The Federated American Engineering Societies is a going concern, and in aggregate membership represented is the largest engineering organization in the world. It has seventeen charter members; six national societies, including the Am. Inst. M. E., Am. Soc. M. E., and Am. Inst. E. E., and eleven local, state and regional engineering organizations. The Federated American Engineering Societies is based upon the principle of non-interference with the autonomy, functions and operations of its Member-Societies. Therefore, the technical activities, requirements for membership, and other functions of the society are unchanged by membership in the federation. It is not an organization of individual members. An individual can only be associated with its work through his membership in an organization holding membership in the federation.

We direct attention to the favorable legal opinion of Am. Soc. C. E.'s counsel, pages 3 and 4 of the pamphlet issued by the Board of Direction, which removes all argument as to whether the society can legally become a member of the federation.

The adoption of the amendment, increasing the dues of Non-Resident Corporate Members, provides the funds for the contributions of the society as a member of the federation. The organization will have at least four times the funds that were provided for the operation of Engineering Council, of which this society is a member.

We do not agree with the arguments against joining the federation, since a careful study of its constitution and by-laws shows that

(a) Its purpose is definite and comprehensive.

(b) It is truly representative and democratic.

(c) Its governing body, American Engineering Council, is truly representative.

(d) The requirements for membership are under the control of the Council. The American Society of Civil Engineers should, therefore, be represented on that Council.

(e) It is adequately financed.

(f) The provisions for non-technical work cover local, state, regional and national problems.

We believe that the greatest need of the engineering profession is its unification through a central representative body which will enable the profession to take its part in public affairs. The plan of organization is such as to provide the most feasible means yet proposed for bringing about a solidarity in the engineering and allied technical professions so that their united voice may be heard in matters affecting public welfare, and of common interest to members of these professions. Public opinion is influenced by numbers and in the bulk of the members of this representative organization lies its strength with the public.

If you have already voted you may withdraw your vote by dating, and endorsing over your own signature (handwritten not typewritten or printed) on the outer envelope in which you mail your ballot, "Destroy previous ballot"; the ballot should be mailed not later than Nov. 1, 1920.

VOTE *YES*
ON THE QUESTIONNAIRE BALLOT

A. H. Abel, E. L. Adams, F. H. Adams, R. W. Adams, W. H. Adams, Louis J. Affelder, Frederick W. Albert, Eugene Y. Allen, Thomas D. Allin, George G. Anderson, C. W. Anschuetz, H. F. Anthony, Richard I. D. Ashbridge, A. B. Atwater, Murray C. Ayers, Louis E. Ayres.

Edgar A: Bailey, F. S. Baillie, H. S. Baker, Percival S. Baker, Sheldon K. Baker, William D. Baker, Walter F. Ballinger, J. E. Banks, A. F. Barnard, E. C. Barnard, W. K. Barnard, John H. Bateman, George S. Beal, Willard Beahan, George L. Bean, Orville Benson, Thomas Berry, F. Phillips Best, Arthur H. Blanchard, C. K. Bowen, Edgar R. Bowen, C. P. Bower, James A. Boyle, J. S. Bright, Jacob H. Brillhart, Howard F. Bronson, Baxter L. Brown, J. L. Brownlee, John A. Bruce, L. S. Bruner, Morton Burdon, J. L. Burkholder, C. A. Burnette, W. J. Burton, A. D. Butler.

Charles C. Campbell, G. E. Campbell, J. T. Campbell, C. M. Canady, A. A. Casani, S. N. Castle, L. O. Chambers, E. Ross Chamblin, J. N. Chester, William H. Chorlton, F. D. Christhilf, H. L. Christie, George L. Christy, J. H. Cissel, Edwin Clark, Arthur L. Collins, John S. Conway, William H. Connell, M. E. Cooley, Earl L. Cope, L. F. Copeland, Dudley T. Corning, S. V. Cortelyou, William H. Courtenay, C. C. Covert, John J. Cox, C. Coykendall, William H. Crawford, Edward W. Crellin, O. W. Crowley, R. W. Crum, James F. Cullen, A. O. Cunningham.

Charles H. Dading, C. M. Daily A. M. Danzilli, R. W. Davenport, A. L. Davis, Arthur P. Davis, Chandler Davis, Charles E. Davis, D. E. Davis, W. S. Dawley, Edwin F. Dawson, Arthur J. Decker, H. W. Dennis, F. G. Dessery, James L. De Vou, Richard G. Develin, R. G. Dieck, Clark Dillenbeck, E. C. Dilworth, Charles Y. Dixon, H. J. Doolittle, W. L. Drager, H. P. Drake, W. R. Drury, J. H. Dunlap, Edwin Duryea.

William Easby, Jr., G. S. Edmondstone, J. H. Elder, W. M. Eliot, J. A. Elliott, H. C. Ellis, C. A. Emerson, Jr., Mordecai T. Endicott, J. H. Ensey, H. H. Esselstyn, E. Evers.

E. B. Fay, George H. Fenkell, Lewis R. Ferguson, F. H. Finch, Wager Fisher, Gerald C. Fitzgerald, Edwin J. Fitzmaurice, E. T. Flaherty, R. Follansbe, James W. Follin, F. H. Fowler, James D. Fowler, J. C. Fowler, Charles Kirby Fox, Benjamin Franklin, Owen B. French, Charles Frommer, George S. Frost, Almon H. Fuller, William Copeland Furber.

B. J. Garnett, John T. Garrett, R. P. Garrett, Homer F. Gault, Joseph B. Gemberling, O. H. Gentner, Jr., Elbert A. Gibbs, W. Herbert Gibson, Frank W. Gilcreast, Frank Gillelen, C. E. Gilman, Maurice Goldenburg, Irving D. Goodwin, L. M. Gram, William H. Gravell, W. J. Graves, F. W. Green, A. E. Greene, William B. Gregory, John O Greenway, W. G. Grove, N. C. Grover.

E. A. Hadley, H. L. Haehl, Albert B. Hager, J. C. Hain, L. S. Hall, John P. H. Hallahan, J. P. Hallihan, Milo C. Halsey, Charles Hansel, Andrew B. Hargis, Eugene L. Harman, A. F. Harter, Stephen Harris, O. F. Harting, O. W. Hartwell, T. R. Hasley, F. A. Hastings, Harry Hawgood, Charles Haydock, W. A. Heimbuecher, Francis Henderson, V. K. Hendricks, D. C. Henny, F. W. Henrici, Milton Hesselberger, Louis C. Hill, W. N. Hill, A. Hirst, F. S. Hitchcock, W. C. Hoad, L. R. Hoffman, Howard K. Holland, Ray K. Holland, S. C. Hollister, W. W. Horner, Ralph H. Hosmer, U. B. Hough, John J. L. Houston, Otis E. Hovey, R. H. Howard, C. H. Howell, John C. Hoyt, J. T. N. Hoyt, C. W. Hubbell, Richard L. Humphrey, A. M. Hunt, C. B. Hunt.

William Jackson, Reginald H. James, E. C. Jansen, Walter E. Jessup, A. N. Johnston, H. S. Johnson, Clarence T. Johnson, Alfred Jones, Benjamin E. Jones, George W. Jones, W. D. Jones, S. A. Jubb.

C. P. Keyser, Richard Khuen, Jr., Stephen E. Kieffer, Horace W. King, H. A. Klugel, Morris Knowles, R. E. Koon, O. H. Koch, Homer V. Krouse.

John F. Laboon, J. A. Lahmer, Frank R. Lanagan, Horace G. Lang, Harrison W. Latta, Fred Lavis, Ralph J. Lawrence, Augustine L. Lee, Charles T. Leeds, Theodore A. Leisen, S. H. Leister, J. H. Lewis, W. I. Lex, A. R. Lindsey, J. B. Lippincott, Eugene Logan.

Morton Macartney, J. O. MacFeeters, Thomas Maddock, L. T. Maenner, John M. Mahon, Jr., R. G. Manning, Charles W. Martin, James W. Martin, George C. Mason, Donald C. May, H. P. McKean, Thomas H. Means, Charles F. Mebus, John Meigs, F. N. Menefee, O. C. Merrill, William W. Michael, A. A. Miller, Walter S. Miller, W. M. Mitchell, David A. Molitor, Frederic A. Molitor, Carl de Moll, Charles E. Mollard, S. B. Morris, Howard E. Moses, Harrison C. Mower, Hans Mumm, Jr., J. F. Murray, E. L. Myers, R. A. McMenimen, William V. McMenimen, S. A. McWilliams.

W. H. Nalder, C. S. Nichols, W. S. Nichols, Blaine Noice, Edward N. Noyes, Robert Norris, Emil L. Nuebling.

C. W. Ogden, Frank H. Olmsted, Roger W. Olmsted, M. J. Orbeck, N. H. Orr, Samuel J. Ott, E. H. Owen.

A.E. Palen, S. R. Parke, John C. Parker, William P. Parker, J. H. Payne, Walter Pearl, Emile G. Perrott, C. H. Pierce, John G. Pitney, H. E. Plummer, W. S. Post, B. B. Priest, R. F. Proctor, Charles H. Purcell, C. D. Purdon, George R. Putnam, Clyde B. Pyle.

Earl Querbach, Henry H. Quimby, J. C. Ralston.

Ralph R. Randall, H. A. Rands, Howard S. Reed, M. E. Reed, Ralph J. Reed, O. T. Reedy, Edwin R. Renz, Charles M. Reppert, G. J. Requardt, George H. Reussner, John M. Rice, H. Ridgway, H. E. Riggs, George S. Robertson, John E. Rockhold, W. E. Rolfe, W. H. Root, E. A. Rowe, J. W. Rowland, E. J. Ruff, Richard L. Russell, S. Bent Russell.

C. W. S. Sammelman, Edmond H. Sargent, J. Q. Savage, W. C. Sawyer, William R. Scanlin, Frederick E. Schall, Maurice R. Scharff, Nathan Schein, W. W. Schlecht, W. J. Schlick, H. A. Schofield, Karl D. Schwenbener, G. M. Scofield, Reginald C. Scott, H. T. Shelley, L. V. Sheridan, E. G. Shibley, E. H. Shipman, L. H. Shoemaker, J. G. Shryock, Joseph W. Silliman, J. W. Skelly, S. A. Sloan, J. W. Small, Benjamin L. Smith, C. E. Smith, Edward U. Smith, Henry C. Smith, H. S. Smith, J. Rhodes Smith, Stanley Smith, Vernon H. Smith, Walter D. Smith, George D. Snyder, A. L. Sonderegger, Harrison Souder, T. Nelson Spencer, Herman Stabler, Norman L. Stamm, O. E. Stanley, Edward B. Stearns, Felix C. Stehle, F. H. Stephenson, Eugene W. Stern, Charles H. Stevens, F. S. Stevens, J. C. Stevens, John D. Steveson, W. L. Stevenson Harrison Stidham, Lewis B. Stillwell, H. R. Stocker, H. Struckmann, Russell Suter, S. M. Swaab, R. S. Swinton.

E. G. Taber, Arthur N. Talbot, G. Lewis Taylor, E. B. Temple, J. Hermon Terry, Neil Thom, Franklin Thomas, Carroll R. Thompson, C. W. Thorn, Albert E. Timmons, F. E. Trask, John C. Trautwine, 3rd., James C. Travilla, A. L. Trout, A. J. Turner, W. S. Turner.

J. A. Van den Broek, James H. Van Wagenen, Paul Voorhees, C. B. Voynow.

Joseph C. Wagner, Samuel T. Wagner, O. A. Wait, E. M. Walker, Edward E. Wall, O. L. Waller, R. F. Walter, W. R. Warman, Albert K. Warren, C. L. Warwick, Leonard C. Wason, David L. F. Watson, George S. Webster, Maurice A. Webster, D. R. Wells, A. J. Wenzell, F. E. Weymouth, R. C. White, W. M. White, F. W. Whiteside, Ezra B. Whitman, George F Wieghardt, F. L. Wilcox, T. J. Wilkerson, Thomas L. Wilkinson, Charles P. Williams, Gardner S. Williams, Marshall Williams, A. R. Wilson, Lef Winship, C. O. Wisler, Francis P. Witmer, F. C. Woermann, J. W. Woermann, W. F. Wolfe, C. H. Wondries, S. L. Wonson, Glenn B. Woodruff, Irving Worthington, R. B. Wright, Stanley S. Wright, A. M. Wyman. A. S. Zinn.

Baltimore Votes on Over $50,000,000 Loans Next Week

Probably the largest total of municipal loans to go to popular vote Nov. 2 is the $51,750,000 at Baltimore. This includes $15,000,000 for water supply, $10,000,000 for harbor improvement, $750,000 for an isolation hospital and $26,000,000 for "general development." The latter contains $8,000,000 for sewerage, $6,500,000 for streets and bridges, $2,500,000 for harbor improvements other than docks, $1,150,000 for electric conduits, $850,000 for station houses and fire engine houses, $6,000,000 for new school buildings and $1,000,000 for repairs to old school buildings.

Council Approves Model License Law

Meeting at Chicago Urges Renewed Activity in Support of National Public Works Department

Approval of a model engineer license law, support for the original status of the Nolan patent office bill, authorization of a letter to various societies to revive interest in the movement for a National Department of Public Works, endorsement of a bill to put engineers in the Public Health Service on an equal footing with the medical officers and assistance in the securing of an appropriation to permit the Federal Power Commission to function formed the main business transacted at Chicago Oct. 21 by Engineering Council at a meeting in the rooms of the Western Society of Engineers, where 18 months ago the movement for a public works department was started by the representatives of more than 70 societies. Though the outcome has been successful beyond the expectations of its most ardent supporters, the report of M. O. Leighton, national service representative, who has had the matter in charge, indicated an apathy at present on the part of the various societies and many individuals to whom definite duties have been assigned. The report in full is printed on page 834.

Although its activities will soon be terminated, Engineering Council authorized a letter to the various societies calling on them for renewed support of the public works department movement. Influence needs to be exerted now, it was explained, because the committee of the next Congress will prepare the bill which may be passed at the succeeding Congress, both major parties having given approval of the principles involved. A bill of some kind will be passed, but if civilian engineers do not act quickly, it is pointed out, control will rest with the Corps of Engineers, U. S. Army.

Provisions of License Law

The model license law, as finally adopted, is essentially that which has been before Council for a year. It is a joint architects, engineers and land surveyors registration law in which an engineer is defined simply as a professional engineer. An optional exemption was added to exclude various individuals from the provisions of the law provided they did not pose as registered architects or engineers. This is an expedient to exempt the residual portion of practitioners in the profession, who are too strong to permit the bill to pass. Several of the members expressed themselves as against the principle of licensing but recognized that license laws would surely be enacted; hence the promulgation of the results of the committee's work was believed a proper procedure. L. K. Sherman, president American Association of Engineers, the *liaison* representative of A.A.E., invited to attend the meetings of Council, confirmed the views of J. Parke Channing, chairman, that the majority of engineers were in favor of licensing.

E. J. Prindle, chairman of the committee handling the matter of legislation, increasing the number and pay of the patent office employees, reported that the bill was passed as submitted by the House, but was amended in the Senate so as to reduce the force and pay. Council passed one resolution calling on Congress for a restoration of the bill to its original status and another calling on the engineers for support similar to that originally rendered in the way of acquainting their congressmen with the desirability and urgency of the measure.

Power Commission Needs Funds

The Federal Power Commission finds that the $100,000 appropriated for expenses is not available through a decision of the Controller of the Treasury. Only $5,000, the salary of the secretary, can be used. Sixty-nine applications for permits aggregating 2,000,000 hp. have been filed but the commission is unable to function in a satisfactory way. The support of Engineering Council was authorized toward getting an adequate appropriation.

The Chamberlain road bill was referred to the committee on public affairs for report.

Names which will be suggested to President Wilson as suitable candidates for members of the U. S. Shipping Board are Prof. H. E. Riggs, University of Michigan, Ann Arbor, and W. H. Adams, consulting engineer, Detroit, Mich.

The next meeting will be held Dec. 16 in Washington.

Contractors' Convention Jan. 25-27

The annual convention of the Associated General Contractors of America will be held in New Orleans Jan. 25, 26 and 27.

Illinois Section, Am. Soc. C. E. Against Federation

The Illinois Section of the American Society of Civil Engineers has passed a resolution to the effect that the society should not join the Federation of Engineering Societies. All the opinions expressed at the meeting were unfavorable, and when a request was made for a presentation of arguments in favor of joining the federation no member responded.

Highway Officials Change Convention Date

The convention of the American Association of State Highway Officials, which was scheduled to convene in Washington Dec. 8, has been postponed and will be held Dec. 13, 14, 15 and 16. The change of date was made necessary because it was found that the requisite number of hotel accommodations could not be furnished during the week first selected.

Signers of "Appeal" Suggest New Amendments

Proposals Cover Local Sections, Election of Directors, Welfare and Board of Direction

In accordance with their pledge to work for the adoption of certain changes in the constitution of the Am. Soc. C. E., in case amendments A, B, F and G were defeated in the recent ballot, a group of signers of the "Appeal for a Progressive as Against a Radical Policy" met recently and as a result of their discussion have through a committee consisting of George W. Fuller, W. T. Chevalier and J. J. Yates sent to their fellow signers of the appeal a letter setting forth the substance of the amendments which they feel are desirable and accord with their pledge. The other signers of the "Appeal" are asked to consider the letter to the end that the proposals may be urged upon the constitutional amendment committee. Copies of the letter have also been sent to this committee.

The letter covers, principally, local sections and the nomination of directors by districts, but space is given to welfare work and to the makeup of the board of direction.

Local sections, it is proposed, shall be organized under a form of charter laid down in the constitution. Membership in them shall be voluntary. Their activities and status in society administration shall not be such as to infringe the interests of society members who are not members of sections. A portion of the dues shall be remitted to them. Their functions shall be "the encouragement of members to prepare or discuss papers, to advise as to matters of policy, to study local engineering problems, to co-operate with other local sections in matters of common interest and to bring about closer personal acquaintance between the Am. Soc. C. E. members in the community."

Regarding election of directors by districts, it is proposed that the local sections shall take the initiative in nominating candidates for director. The suggested name or names would go on a ballot to be sent to every member of the district whether a member of a section or not. To be legal, the directors should finally be elected by the entire membership of the society.

For nomination of the other officers, the nominating committee would be retained but its members would be chosen by the districts themselves after the fashion indicated above for directors. It is suggested that the past presidents be removed from the nominating committee.

Opportunity for nomination by declaration would be afforded in selection both of directors and of members of the nominating committee.

Though not covered by the pledge, it is proposed that there be a standing committee on welfare, which would advise the board of direction on matters involving the material and professional interests of the members and the re-

lation of the profession to the public. It would also act under the board's direction on co-operative movements.

Regarding the makeup of the board, it is proposed that the secretary and the five past presidents be eliminated and in their place five "regional" directors be chosen, the latter to make up for the loss of representation due to the removal of the past presidents from the board. A two-year term, instead of three, is proposed for directors.

Recipients of the letter are urged to report to the committee on amendments their views on these proposals.

Civil Service Examination
United States

For the United States Civil Service examination listed below apply to the United States Civil Service Commission, Washington, D. C.

Safety Engineer. $8 per diem plus increase of $20 a month after one month's service. Applications received until Nov. 30.

Engineering Societies

Calendar

Annual Meetings

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. 25-27.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Washington, D. C., Dec. 13-16.

FEDERATED AMERICAN ENGINEERING SOCIETIES, New York; Washington, D. C., Nov. 18-19.

NATIONAL DRAINAGE CONGRESS, Chicago; Atlanta, Ga., Nov. 10-12.

The Kansas Engineering Society will hold its annual meeting at Topeka, Kans., Dec. 16 and 17.

The Southern California Section, Am. Soc. C. E., at its Oct. 13 meeting was addressed by H. W. Dennis on "A Study of Stream Flow or the Kearn River." The members voted unanimously to join in the formation of the California Engineering Council.

Personal Notes

F. P. DILLON, first assistant superintendent of the 5th Lighthouse District with office at Baltimore, Md., has been made superintendent of lighthouses of the 9th District with headquarters at San Juan, P. R., and leaves the United States this week to take charge of his new duties.

E. W. ENGLEBRIGHT, engineer, Union Pacific R.R., New York City, with his entire staff, has been transferred to Omaha, where his office will be consolidated with that of E. E. Adams, assistant to the president.

J. W. FOX, valuation engineer of the Central of Georgia R.R., has resigned to become affiliated with the Lawrence Construction Co., Augusta, Ga.

G. R. SMILEY has been appointed chief engineer of construction of the Louisville & Nashville R.R. with headquarters at Louisville, Ky., succeeding H. C. Williams, resigned.

W. C. ALLEN has been appointed assistant valuation engineer of the Fort Worth & Denver City R.R. and the Wichita Valley R.R. with headquarters at Fort Worth, Tex.

SAMUEL P. COFFIN, supervisor of bridges and buildings of the Boston & Maine R.R., has been transferred from Boston to Salem, Mass.

J. B. CROCKETT, for some time engineer of Collin County, Tex., has resigned to enter the contracting business.

LEE RILEY, hydraulic engineer, has been appointed engineer for the Leavenworth and Fort Leavenworth Water Co., Leavenworth, Kan.

E. P. ASBURY has been appointed engineer of Collin County, Tex., to succeed J. B. Crockett, resigned.

THE J. N. CHESTER ENGINEERS, formerly Chester & Fleming, announce the admittance of E. E. Bankson as a partner. The firm now consists of J. N. Chester, D. E. Davis, J. F. Laboon, J. T. Campbell and E. E. Bankson.

A. T. DICE, JR., a civil engineer recently with the Reading Iron Co., has been appointed assistant superintendent of the Reading and Harrisburg divisions of the Reading Railway with an office at Reading, Pa.

W. D. KINSEY, formerly division engineer, Reading division, Reading Ry., has been transferred to the Shamokin division as assistant superintendent, located at Tamaqua, Pa.

WALTER F. WHITTEMORE, engineer and member of the New Jersey State Highway Commission, has been appointed by Governor Edwards to serve on the State Board of Public Utility Commissioners of New Jersey.

Obituary

GEORGE E. DATESMAN, for 30 years in the service of the city of Philadelphia and, prior to his retirement in January, director of public works, died Oct. 18, at Germantown, Pa. He was born in West Milton, Pa., 1863 and was graduated from Lafayette College as civil engineer in 1883. He entered the employ of the city of Philadelphia in 1885, serving as draftsman until 1889, when he entered private practice. He returned to the Bureau of Surveys in 1891 and in 1893 became principal assistant engineer. In this capacity he was engaged in the design and supervision of various public works, including about 600 miles of sewers, 5 steel piers, the Aramingo Canal Improvement, dredging operations in Delaware and Schuylkill Rivers, consultations upon subway construction and the elimination of grade crossings on the Philadelphia & Reading Ry. The latter involved street alterations, sewer reconstruction, and building steel bridges. In 1913 Mr. Datesman was commissioned by the mayor of Philadelphia to represent the city at the International Building Trades and Scientific Accessories Exposition at Leipzig, Germany, and to make an investigation of public works and modern methods of sewage disposal in European cities. He acted as consulting engineer on sewage disposal to the Metropolitan Sewerage Commission of New York City. He was appointed director of the Department of Public Works at Philadelphia in December, 1915.

CHARLES N. CHADWICK, commissioner of the Board of Water Supply, City of New York, died Oct. 23 at Lyme, Conn., his summer home. Mr. Chadwick was 73 years old and a resident of Brooklyn. He was a charter member and for 16 years a director of the Manufacturers' Association of New York. He was chairman of the Brooklyn Committee on Bridges and Tunnels. With the New York City Board of Water Supply his duties related to the general administrative and legal matters involved in the construction of the Catskill aqueduct.

RICHARD LAMB, consulting and construction engineer, New York City, died Oct. 18 at Brooklyn, N. Y. He was born in Norfolk, Va., Sept. 15, 1859, and was graduated from Brown University in 1883. In 1884 he acted as assistant engineer of construction, Norfolk Terminal Company's railroad from Norfolk to Lamberts Point, Va., and also supervised the building of the extensive coal pier at Lamberts Point. He made plans for the drainage of the Great Dismal Swamp, laid out in the northern section of Norfolk and also (1886) was engaged in construction of a sewer system for the University of Virginia. As chief engineer of the Wilmington, Onslow & East Carolina R.R. and of the East Carolina Land & R.R. Co. (1887-1888), he laid out routes, designed all structures and had entire charge of the construction of the roads from Wilmington to Newbern, N. C. (84 miles). In 1890 he was appointed chief engineer in charge of the Lamberts Point Co. and the Lynn Haven Syndicate, during which time he laid out and constructed streets, water and sewer work. He designed and constructed the electric cableway for towing canal boats at Tonawanda, N. Y. As engineer for the Brooklyn Dock & Terminal Co., Brooklyn, N. Y., the Navesink Improvement Co., Highlands, N. J., and the Chauncey Realty Co., Chauncey, N. Y., he was engaged in designing roads, bridges, sewers and water-works.

A Consolidation of Engineering News and Engineering Record

McGraw-Hill Company, Inc.—James H. McGraw, President

Engineering News-Record

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. Mehren Editor

Volume 85 NEW YORK, THURSDAY, NOVEMBER 4, 1920 Number 19

The Federation's Meeting

WITH the date only two weeks away it becomes more and more apparent that the first meeting of the American Engineering Council will be a very important gathering, even though the civil engineers should refrain from entering the organization. To date (this is written Nov. 1) the names of sixteen member bodies have been announced, including, as the great nucleus, those of the national societies of mechanical, electrical and mining engineers. The membership now represented is 40,000 and the organizing committee expects that when the meeting comes to order Nov. 18 not less than 60,000 engineers will be represented. This is a formidable showing. What action the council takes cannot be a matter of indifference to any engineer. It will stand in the eyes of the public as representative of the engineers of this country. What it does, then, on Nov. 18 and 19, will have the deepest interest.

Water-Supply Needs

INTIMATE studies of water-works consumption and pressure in total and by districts and of corresponding population growths are essential to such forecasts of water-works enlargements as are required from time to time in any growing city. The larger the city and the more diverse its topography and industries, the more complex will be the problem of planning the water-works to meet future needs. Such studies demand a competent permanent engineering staff, some member of which has ample time to devote to the subject. The article on p. 886 details some of the work done at Cleveland, Ohio, in making ready to forecast the water-works needs of that city. The part played by pitometer surveys and by recording pressure gages is worth noting. The need for a reliable population count oftener than the national decennial census is illustrated anew by the various estimates of population to which Mr. Ruggles felt it necessary to resort.

Magnificent Isolation

FREIGHT distribution at New York was commented upon in these columns last week, following a discussion of the subject by the New York Section of the American Society of Civil Engineers. Engineers were in apparent agreement as to fundamentals, but it is indeed unfortunate that a city official should have voiced such antedated opinion as that the City of New York must guard against losing commercial prestige through the establishment, for instance, of classification and unloading points in New Jersey. The possibilities seem great for distribution from New Jersey points in units smaller than the present standard-gage box car. Petty local jealousy cannot stand against public necessity. By the most effective co-ordination of all facilities at the Port of New York, the whole country will benefit, since here is the greatest shipping center. The future of the City of New York is certainly not dependent upon its "magnificent isolation." That belief in such bald fallacies still exists only indicates the need for combating them with expert engineering opinion through the broadest publicity. So long as such beliefs prevail, conditions at the Port of New York will continue to be bad.

Car-Loading Results

WEEKLY car loadings have passed the million mark and, according to reports made at the meeting of the Association of Railway Executives in New York, Oct. 29, the railroads are carrying a traffic volume heavier even than during the height of the war movement in 1918. T. De Witt Cuyler, chairman of the association said, "The railroads have been confronted with the task of moving this traffic with facilities and equipment admittedly inadequate, but the traffic has been moved. This has been made possible by the hearty co-operation of the shipping public, a very considerable gain in labor efficiency, and an intensive drive by the railroad managers to get the utmost out of existing facilities." In eight months the average car movement per day has increased from 22.3 miles to 27.4 miles, and loading from 28.3 to 29.6 tons. Further co-operative effort by the shipping public will go far toward early attainment of the 30-ton, 30-mile-per-day goal of the railroads.

British Miners' Settlement

SETTLEMENT of the British miners' strike is apparently in sight. The leaders have agreed with the Government on terms, and the ballot on acceptance will probably be canvassed and the results announced before this issue reaches our readers. The full details of the settlement are not clear from reports so far received. The proposal refused by the men before the strike provided that the miners would get an advance of 1 shilling per shift for the maintenance of the rate of production of the first quarter of this year (240,000,000 long tons per annum), and 6 pence per shift for each addition of 4,000,000 tons beyond that figure. Apparently, though, the wages determined in the settlement are to be based not upon the rate of production, but upon the "surplus profits accruing from the export of coal." Not only that, but the mine owners are to be penalized by the loss of a certain percentage of profits if the production falls below predetermined figures—thus making the owners' interest identical with the miners'. Even the introduction in a whole industry of a wage dependent on the yearly production rate would have been a momentous step, but a wage dependent on profits applied to an entire industry, pushes the whole matter of industrial relations forward a tremendous stride. There is such uncertainty in the cabled reports that a final judgment cannot be formed, but the outstanding feature is so clearly a wage variation dependent on profits that the significance of the step deserves to be immediately pointed out. We expect shortly to have in hand the full terms.

Rational Street Planning

OUTSIDE of the more progressive municipal engineering departments few people realize that from 25 to 40 per cent of the area of the built-up portions of our cities is devoted to public streets. These streets have been laid out—one can rarely say planned—to suit the momentary interest or caprice of landowners. And yet when built they become part of the city plan, or lack of plan, to serve as such for decades unless changed, perhaps at great cost. It is one of the functions of the city-planning departments now happily being created all over the country to see that new streets are laid out to meet the needs of the future and of the whole city, instead of to serve the momentary caprice of speculative landowners. Until recently, municipal engineers have done very little to direct public opinion in this respect. The time for alert and intelligent activity on their part has come.

Is It Significant?

HAS the turn come in highway building? The question is prompted by the results of the trial letting by the New York State Highway Commission, Oct. 29. Bids were received on every one of the twelve projects advertised. All the forty-one bids were below the engineer's estimate and though six bids were received on each of two projects, five on three others, etc., there was never a greater variation than 9 per cent between the high and the low bid. There are two features of this experience that warrant attention: first, the number of contractors bidding, and, second, the fact that all bids were below the engineer's estimate. For the first, the explanation evidently is that contractors are finishing their work and want to get ready early for next year's business. The mere submission of bids, however, is gratifying, while the fact that they are below the engineer's estimate is very encouraging. We may safely assume that the engineer's estimate was a reasonable one, since the commission has sources of information regarding prices and conditions and the trends equal to those of the contractors. New York contractors apparently have confidence that the conditions next year are going to be better than those of the immediate past. All indications are that their judgment is a sound one. Transportation is improving steadily, labor is more efficient and not so scarce, price tendencies, generally, are downward. On account of these favorable conditions and the New York experience other States will be encouraged to proceed at once to test conditions by similar lettings.

Business Enterprise

SAMUEL M. VAUCLAIN recently made a remark in addressing some of his fellow-Philadelphians that constitutes a plain challenge to organizations of business men on the score of enterprise, and, though Mr. Vauclain does not go into this phase of the matter, suggests that engineers might profitably think of the same thing. Mr. Vauclain was discussing one of the long-standing problems of Philadelphia, a street bridge across the Delaware, and remarked that in planning large enterprises of the kind nowadays we depend upon the government to build them. In protest against this supine attitude he shot out the pointed question, "Why do not the business men of this city organize a stock company and build a bridge across the Delaware River?" The obvious answer, though Mr. Vauclain did not give it, is that business men's organizations are wanting in enterprise and the vision from which enterprise springs. And a contributory reason is that business men lack contact with engineering thought and opinion.

Until Philadelphia gets the bridge to Camden, the business interests of the city are going to suffer, said Mr. Vauclain. Very true, indeed; and there are many other large communities that are suffering and will suffer similarly from failure to provide adequately for communication, or housing, or other public needs. But the suffering apparently is not sufficiently acute, or the consciousness of the business interests is too callous, for response in the form of action.

Individual business men cannot be charged with unprogressiveness or lack of energy. Business facts speak plainly to them and find response. Perhaps the merchant of our grandfathers' day was more boldly adventurous, but the change is surely not such as to account for the collective lethargy of business men toward public improvements that Mr. Vauclain deplores. Yet any one who has had opportunity to observe the manner in which commercial bodies deal with questions of public improvements will be able to support the implied charge that business men taken collectively do lack enterprise.

Why this is so may be an interesting matter for speculation; but the chief present concern of the case for us is that the engineer's position in the community has a direct relation to the matter. Were business men in the habit of seeking the counsel of engineers where public improvements are at issue, and were they inclined to cultivate contact with them and value their opinions, they would be impelled most strongly toward the solution of large community problems which engineering analysis shows to be necessary and profitable. Lacking such contact and counsel, business men remain alien to these problems until their urgency becomes overwhelming and a hurried emergency solution must be sought.

Considerations of this kind merely add to proof already available that the engineer's efforts to gain larger influence in the community are necessary in the interests of the community itself. They suggest further that where we now fall short is in individual weight of influence, not merely in organized effort. Collective action through federations or associations of engineers is not likely to constitute vitalizing influence on business enterprise of the kind Mr. Vauclain suggested.

Rapid-Transit Station Design

IN THIS issue appears the second and concluding part of Mr. Nilsson's study of rapid-transit station design. It is not so long ago that the problem of urban transportation, especially by subways, was regarded as one applying to only a few of the largest cities in this country and abroad. Today, however, a list of municipalities which have built or are planning to build rapid-transit facilities is lengthy and to it the future will bring many additions. The rapid-transit problem, therefore, has passed from the stage of narrowly restricted interest. For this reason Mr. Nilsson's discussion is both timely and valuable and will appeal to a large group of technical readers who, if they are not immediately concerned in the details of the subject, may soon be called upon to study it.

The basis of rapid-transit station design may be

simply stated as ability to handle passenger-traffic flow without impeding train movements. It is clear, therefore, that the planning of stations, far from being a detached problem in the general transit scheme, is a vital feature in the operation of the lines. The station is not an "auxiliary" structure, but an integral part of the system. Only a few seconds eliminated from the time of loading and unloading passengers at each station means much, in the aggregate, in the headway which it is possible to maintain between trains and, of course, in the total number of train movements. The well-designed station, therefore, exerts a decided influence on the operating finances of the rapid-transit routes. This fact is not always fully appreciated.

Many features of station design are discussed in the article on p. 894, including platform lengths and widths, stairways, and arrangements of exits and entrances. Each case must be governed by local conditions, especially since cities are laid out before rapid transit is proposed. Mr. Nilsson, however, neglects one feature of station layout which is almost universally ignored in this country. We refer to the use of direction signs, maps, and other aids for guiding passengers. People generally lose all sense of direction when they get underground, and, especially at transfer points confusion will be caused unless directions be clearly indicated. In the Paris subways this is done very well. Even the stranger unable to speak French has no occasion to ask his way about in the "Metro."

The engineer's job is not, or should not be, finished when the structure he designs is completed. His is the responsibility of providing something that will operate smoothly and efficiently. This obligation requires not only a knowledge of the strength and disposition of materials in a structure but, in transit design, a study of crowds and how they may be moved quickly and without discomfort.

New York's Building Industry in the Mire

NEW YORK is being treated to a series of disclosures that makes every one allied with construction hang his head, even though he may have no connection with the building industry in New York. It is our industry, and the men, both employers and employees, who are implicated in the scandal are part of the organization by which the work of engineers and architects is consummated. The whole industry suffers when the confidence of the public is shaken.

Unfortunately, too, it is not the first time that the industry has been besmudged by a scandal in building work. Both New York and Chicago have had similar experiences before, while other cities have had "disclosures," if not upheavals. As a rule, though, the scandals touched only one of the large factors; at New York both the employers and the employees are involved. Both had their rings. The plumbing contractors were "advised" on their bids by a lawyer who had all the proposed bids in his hands. The unions paid tribute to a leader whose business was to get their pay increased, and who, at the same time, exacted tribute from contractors in return for his permission to allow them to take contracts and get the necessary labor therefor. Even big contractors—some with national reputations—bowed to the power of the boss, by hiring only such subcontractors had his sanction.

Rumor and the promises of the counsel of the investigating committee, Samuel Untermyer, indicate that the disclosures are not even yet at an end. Mr. Untermyer apparently has a lot of trails, and he is not likely to be thrown off the scent by fear or cajolery. Engineers and contractors, generally, will be glad to see the investigation and the resulting criminal prosecution pushed to the sternest limit, no matter what names go down in the mire. In fact, they are in the mire now—of their own volition—and Mr. Untermyer's job is merely to tear away the curtain that has hitherto hid the situation. What they went into voluntarily, to the detriment of the public, the public should now know.

When the investigating committee was authorized by the New York Legislature the ostensible motive was to discover whether or not there was collusion on the part of manufacturers or dealers in building materials, and whether such collusion, if existing, was interfering with the progress of building construction. So far, it is interesting to note, evidence has not been adduced as to restraining measures on the part of the building-material interests. On the other hand, there has been no statement by the counsel or the committee that evidence of such restraining combination was lacking. For the time being, however, the disclosures relate only to the contractors and to labor.

One properly inquires as to the cause of this sort of a situation. It is, however, so fundamental that any statement of it appears both unnecessary and futile. It is, in brief, due to the low standards which obtain in both the labor and the contracting ends of the building industry. With profit the sole ideal on both sides, all efforts are directed toward squeezing out the greatest net return. Such a thing as creating a great permanent industry has never caught hold in a large way. We like to sneer at anything called medieval, yet in the Middle Ages there was a concept of a building industry devoted to service, in which ideals of craftsmanship pervaded all parties to the organization, and which made for peaceful relations, contented workers, skilled artisans, and left us a heritage in Europe of a group of buildings unsurpassed in architectural beauty—monuments produced by a co-ordinated building industry.

Until some conception of this sort comes, we can expect at fairly regular intervals disclosures of corrupt practices such as are being brought to light at New York. The present scandals will conclude, let us hope, with criminal prosecution. They will be forgotten in a few years and some other crooks will then proceed to do the job over again. It is so much easier, you know, to pay a scoundrel a thousand dollars and be allowed to go ahead with your contract, than go to the trouble, and the very great expense, of putting him out of business. Individuals, of course, cannot accomplish the end alone, except with severe loss. Were the ideals of the industry sufficiently developed, there would be a quick banding together as soon as a scoundrel began operations, and, through private means or the agency of the public's legal machinery, an early end put to his efforts.

Do we hope for any early change of conditions? Emphatically, *no*. We are too prone to follow the easiest way. A quick recovery is impossible. Organization of the building-contracting interests with high-minded leadership—after the manner in which the general contractors have been brought together in the Associated General Contractors—would be a good start. In every group there are strong men who are willing to lead a fight for the right, provided the whole organization is attuned to a high purpose.

Sewage Pumping Plants for Chicago Suburban Districts

Electric Centrifugal Pumps with Diesel Engine Stand-By Service—Large Sluice Gates and Automatic Rack Cleaner

By Langdon Pearse
Sanitary Engineer, Sanitary District of Chicago

THREE electrically-operated sewage pumping stations equipped with centrifugal pumps and having many novel features are under construction by the Sanitary District of Chicago. In the largest of these stations extremely large sluice gates, under a high head of back pressure, control the outlets of the discharge chambers; automatic traveling rakes clean the bar screens; practically the entire basement serves as a suction chamber; some of the larger pumps have motors of different size on each side, and a second source of power from generators driven by Diesel engines is installed for emergency use. In the smaller stations the pumps handle the sewage without the use of screens.

An essential point in the design of all the pumping stations is the provision of large waterways. Electric pumps are run at constant speed, but the variation in sewage flow is compensated by the storage afforded by

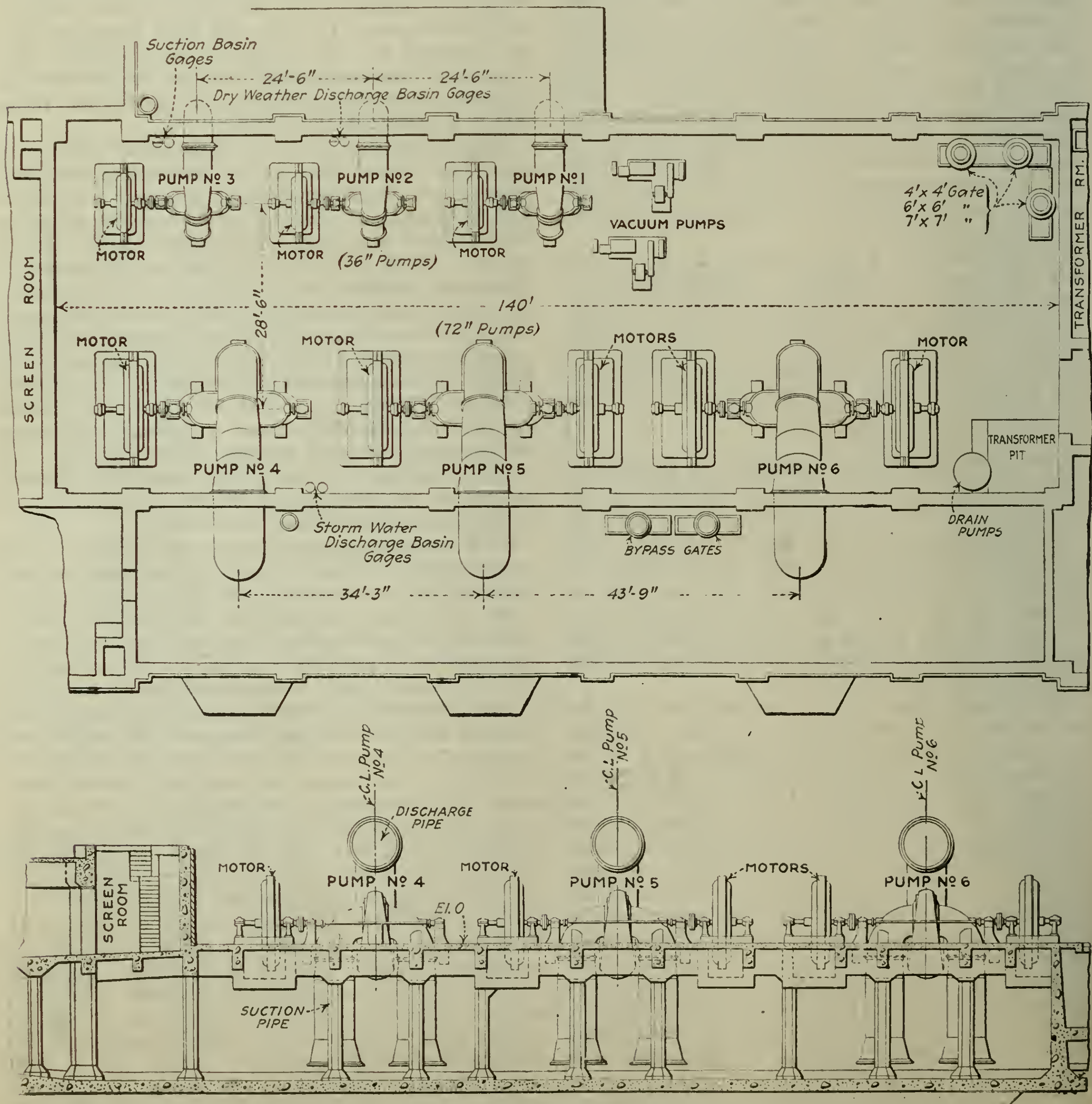


FIG. 1. PLAN AND SECTION OF CALUMET SEWAGE PUMPING STATION

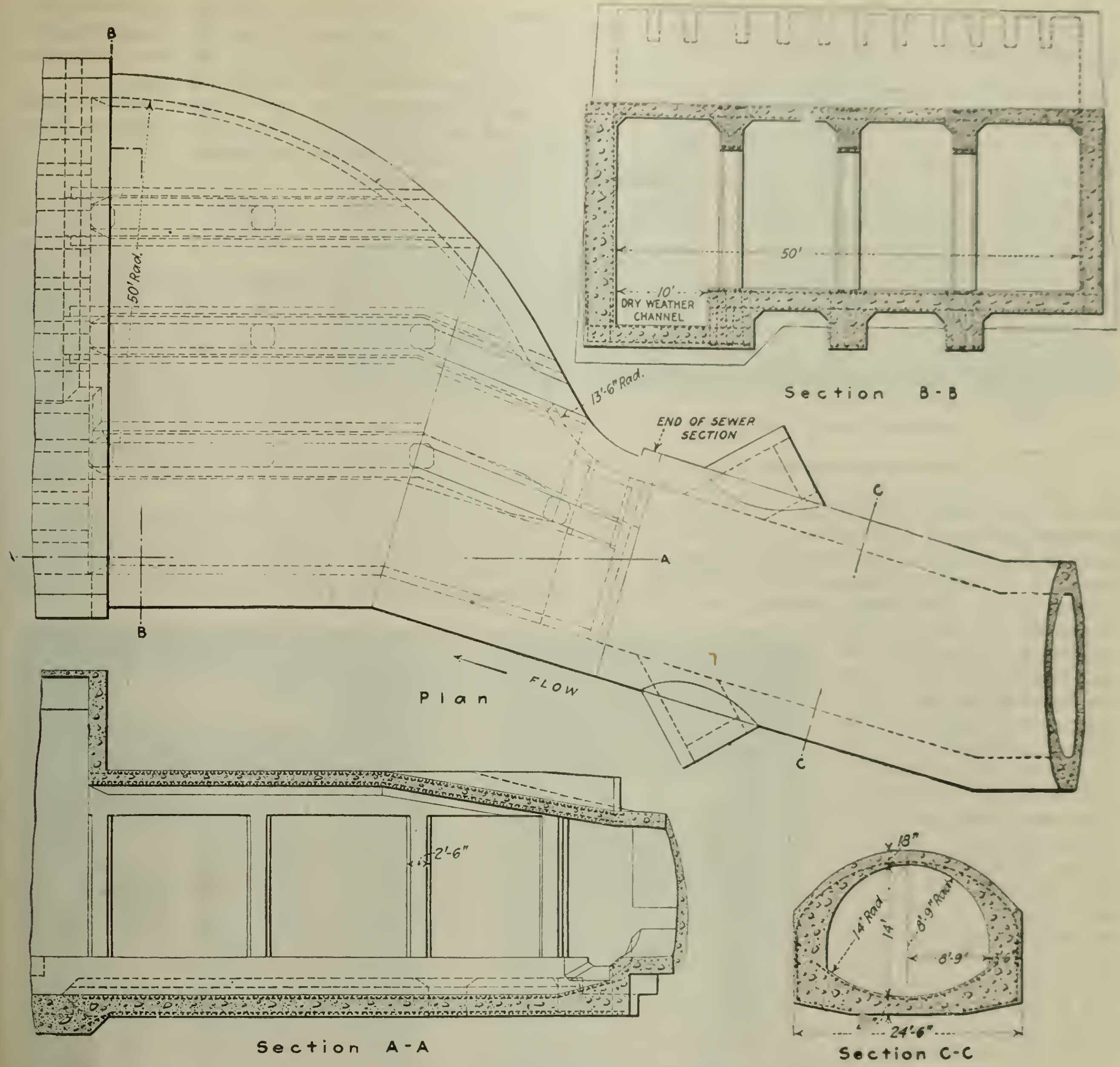


FIG. 2. SEWER CONNECTIONS TO PUMPING STATION

the liberal waterways and by the depth of suction below the flow line. Experience at New Orleans has led to the use of large open basins as far as practicable for both suction and discharge in these stations of the Chicago Sanitary District.

Calumet Pumping Station.—This is the largest plant, including three units handling from 50 to 75 sec.-ft. each and three units handling from 200 to 275 sec.-ft. each. These are all centrifugal pumps with horizontal shafts direct connected to synchronous motors, arranged as shown in Fig. 1. The center of the smaller pumps is set about 18 ft. above low water. The lower ends of the pump suctions and discharge are submerged in the suction and discharge basins, with the highest point of the invert of the discharge above the high water elevation in the discharge basin. This arrangement has the marked advantage of obviating the use of check valves, as large valves of this kind are difficult to design and build. On the smaller pumps, for throttling purposes, gate valves are provided.

At the pumping station, the sewer is of horseshoe shape, 17½ ft. wide by 14 ft. high (see Fig. 2). It drains 12,000 acres, much of which is unimproved low land. The dry weather flow is expected to average from 50 to 75 sec.-ft. with storm flows up to 700 sec.-ft. At the upper end of the sewer, in South Chicago, is the 95th Street sewage pumping station, handling at present a maximum of 250 sec.-ft. During extreme storms, the discharge of this station can be diverted directly to the Calumet River.

Rack Cleaners.—The sewer expands with an easy curve into a screen chamber, 50 ft. wide (see Fig. 2), in which is a rack screen inclined at 37½ deg. to the horizontal, with 4 x ½-in. bars set to give 5 in. in the clear. This screen will be cleaned automatically during storms by a traveling rake (Fig. 3), which moves up the screen and dumps at the platform. The rake remains in a tripped position while lowering, and is rotated at the bottom so that the teeth again enter between the rack bars. The device is counterweighted.

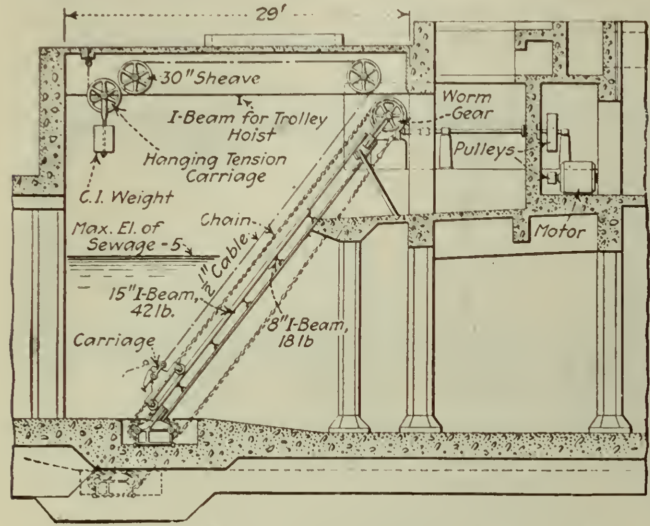


FIG. 3. AUTOMATIC CLEANER FOR TRASH RACK

and will be driven by a reversing motor, with gearing to reduce the speed of rotation. The lineal rate of travel of the rakes is about 35 ft. per minute and the total cycle of cleaning will be about two minutes. Experience at the 39th Street pumping station demonstrates that in dry weather cleaning will be required not more than once a day. The entire basement of the station forms a suction chamber with flat floor. Along the east wall is a channel 10 ft. wide x 3 ft. deep for the dry weather flow. The screen is designed to care for this flow also. In Fig. 4 the main part of the chamber is at the right and the men are standing in the dry-weather channel, with the incoming sewer behind them. On the east side of the suction well is the dry weather discharge basin, receiving the discharge from the three 75-sec.-ft. pumps. On the west side of the suction well lies the storm water discharge basin receiving the discharge from the three 275-sec.-ft. pumps. Ordinarily the latter basin will be kept drained. Each of the two basins is provided with outlet sluice gates so that the discharge may be passed either to the high-level outfall, flowing west to the Calumet-Sag channel behind the controlling works, or south to the low-level emergency outfall direct to the Calumet River. These outlets are shown in Fig. 5. Provision is also made for diverting the dry weather discharge flow to treatment works, plans for which are now being prepared.

The controlling sluice gates include four 96 x 96-in., six 84 x 84-in., one 72 x 72-in. and one 48 x 48-in. gates. They are all hydraulically operated and are designed to stand a backwater pressure of 25 ft. The cylinders are designed to operate normally with a head of 10 ft. on either side of the gate with the city water pressure of 30 lb. per sq. in. in the cylinder. To operate at low city pressure or with high heads, pressure pumps are provided to furnish each gate 150 gal. per minute against 175 ft. head. For emergencies six 2-in. hand pumps are provided for operating the large sluice gates.

The characteristics of the pumps, which were designed by A. B. Wood, consulting engineer, New Orleans, are approximately as follows:

Nominal Size, In.	Normal Capacity, Sec.-ft.	Speed, R.p.m.	Motor, Hp.
36	75	257	106
72	190	106	450
72	275	150	1,100

The motors are of the synchronous type, and are built to start with the pump casings empty. For standby service at time of emergency and to reduce the current required to a minimum, two of the 275-sec.-ft. units are arranged with two motors, one on each side. When delivering to the high level outfall the 1,100-hp. 150-r.p.m. motor will be coupled up. In an emergency this can be discontinued and the 450-hp. 106-r.p.m. motor connected, so that 380 sec. ft. can be pumped with only 900 hp. of current required.

As the Calumet pumping station has to operate at all times to prevent flooding of Pullman and Kensington, two sources of power are to be provided. One is the hydro-electric current from Lockport. For the other installation it is proposed to install in an adjoining building two 500-kw. generators driven by Diesel engines. Oil engines of this type seem admirably fitted for such a stand-by intermittent service. The oil can be stored in underground concrete tanks.

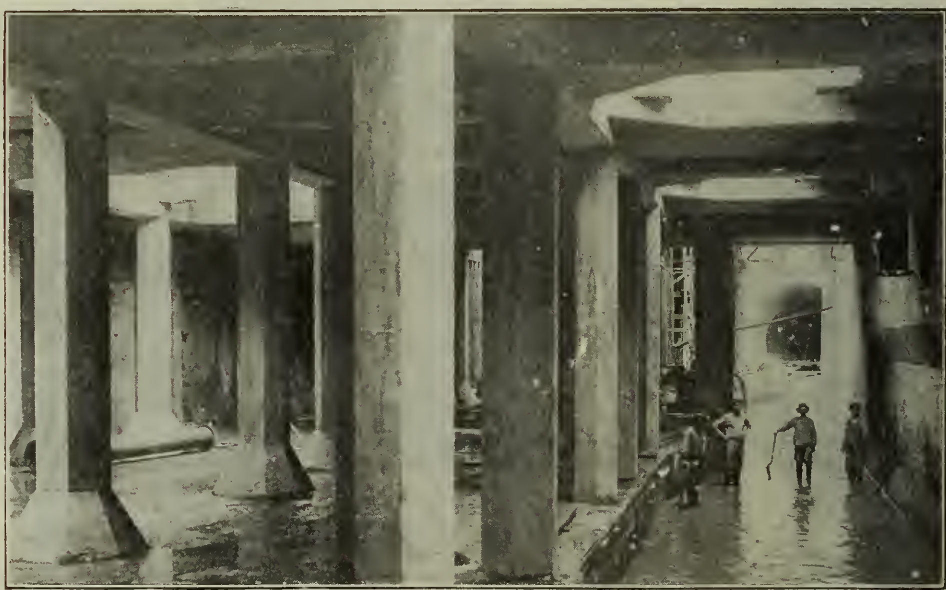


FIG. 4. SUCTION CHAMBER IN BASEMENT

As the pumps will operate normally under 12 to 18-ft. suction lift, priming is secured by a vacuum system. Encircling the pump room is a set of vacuum pipes, to which each pump is connected. At each pump is an automatic vacuum breaker of special design to break the vacuum on the pump when the current to the motor is cut off for any reason. The vacuum will be secured by two hydro-turbine vacuum pumps, each having a displacement of approximately 450 cu.ft. per minute, and capable of holding a vacuum necessary for a maximum lift of 22 ft. Each pump is operated by silent chain drive from a 25-hp. motor.

FIG. 5. CALUMET SEWAGE PUMPING STATION, CHICAGO

The suction and discharge tubes are built up of wrought-iron sheets, riveted up in complete sections for bolting in place. To prevent sweating it is proposed to cover these tubes inside the pump room with a double layer of felt. The foundations and substructure of the building are of reinforced concrete, mostly of a 1:2:4 mix. Where water may stand to a head of 10 to 12 ft. on one side, as in the wall between the pump room and discharge basins, a 1:1½:3 mix was used. In the columns and walls, 5 per cent of hydrated lime was added to the cement. As it is possible that in an emergency the suction level might rise to the elevation of the pump room floor, no openings are left from the pump room to the suction chamber. The only access is through the screen chamber. The basins have been tested and found thoroughly tight.

The building shown in Fig. 6 has a steel frame, with columns carrying the roof girders and runways for a 20-ton crane. The roof is a 3-in. reinforced concrete slab, covered with 2-in. gypsum blocks for insulation, and a waterproof roofing. For the erection of the machinery a trestle has been built in the building, so that a railroad car can be run directly in and machinery unloaded under cover by the crane. For the Calumet station the T. J. Forschner Contracting Co. is the general contractor.

Evanston Pumping Station.—The Evanston and Des Plaines pumping stations are much smaller than the Calumet station, and differ from it in having submerged vertical shaft pumps. As the two stations are very similar in type, only the Evanston station will be described in detail. It serves about 400 acres of low-level sewered area. The station pumps into a gravity outfall sewer through a normal lift of 10-ft. suction-to-discharge water elevations. The total capacity is 133 sec.-ft. In such a small station, it was thought best to avoid the use of screens. Hence the pumps used are of the Wood trash pump type, having a solid runner through which are two curved passages practically the same size as the suction and discharge openings. This type of pump is used in the hydraulic dredges of the New Orleans Canal, as described in *Engineering News-Record* of July 22, 1920, p. 166.

The general plan comprises a dry pump well of rectangular shape, flanked on one side by the suction chamber and on the other by the discharge, as shown in Fig. 6. At one end is placed an emergency overflow or by-pass; at the other end a coal pocket. The 6-ft. incoming sewer enters a suction chamber, 4 ft. wide, running the entire length of the building. The suctions of the pumps, each equipped with a hand-operated sluice gate, draw from this chamber.

Between the suction and discharge chamber is the pump pit, a dry well, 26½ ft. x 72 ft. in plan, in which are set six motor-driven vertical-shaft centrifugal pumps. Three pumps have a capacity of 35 sec.-ft. each at 200 r.p.m. and are driven by 100-hp. motors. The others have a capacity of 9.6 sec.-ft. each at 257 r.p.m. and are driven by 25-hp. motors. In the suction and discharge line of each pump are hand-operated gate valves and in the discharge is a check valve. To provide for the fluctuation in flow and to operate the pumps continuously, particularly on dry weather flows, a by-pass is provided from the discharge of a small pump to

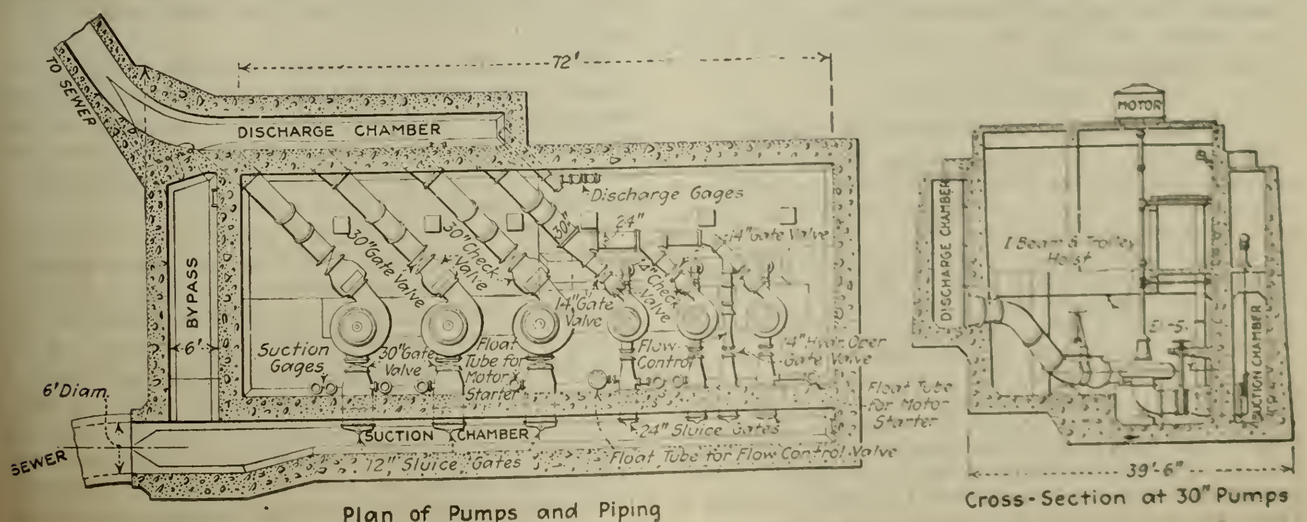


FIG. 6. PLANT ARRANGEMENT AT EVANSTON PUMPING STATION

the suction well, with float control connected to a hydraulic gate valve. This will automatically by-pass sufficient sewage from the discharge end to maintain a fairly uniform elevation in the suction chamber. The motors are arranged to operate automatically by a float switch control.

Owing to the soft and wet nature of the subsoil and foundations, the substructure is reinforced for water pressure on the outside, all over the sides and on the bottom. As the Evanston station is in a residential district, the surrounding land will be grassed and planted with shrubs. For this pumping station, the Nash-Dowdle Co. is the general contractor.

Des Plaines Pumping Station.—This station is located in Broadview, and receives the dry weather flow from a residential district including the villages of Melrose Park, Maywood, River Forest, Forest Park and a part of Oak Park. This sewage from the outlet of the Des Plaines river intercepting sewer is lifted into the sewage treatment plant. Station capacity is provided for three present pumps at 6.5 sec.-ft. each and two future pumps of 20 sec.-ft. each. All of these are of the Wood trash pump type, already mentioned. The nominal head will vary from 25 to 32 ft. total lift. The present pumps discharge into a 24-in. cast iron force main which passes through a Venturi meter to the grit chamber. The future pumps will discharge through a second force main.

The general plan of the station is slightly different from that at Evanston, not only hydraulically, but also because it is combined with the blower house for the sewage treatment works. The 5½-ft. incoming sewer feeds a suction well, tapering in plan, along one side of the basement. One main sluice gate is provided to shut off the entire suction well, instead of individual sluice gates as at Evanston. Each suction is provided with a flange with tapped holes and bronze bolts for securing a blank flange in an emergency. The Leyden-Ortseifen Co. has the general contract.

All these pumping stations have been designed for the Sanitary District of Chicago under the direction of George M. Wisner, chief engineer, until his resignation in May, when E. J. Kelly, then assistant chief engineer, assumed Mr. Wisner's duties. The engineering staff comprises C. R. Dart, bridge engineer; Langdon Pearse, sanitary engineer; F. L. Barrett, architect and H. I. Steffa, mechanical engineer. R. H. Burke, division engineer, is in charge of the construction. A. B. Wood, New Orleans, La., has been consulting engineer on the three pumping plants.

Engineering in the Life of the People

We must see to it that engineering is democratized in the sense that art has been. It must be brought to or within reach or control of the people—to quote the dictionary. We must seek out all the ways in which the man on the street with a thousand interests can be made to feel a sense of satisfaction—even proprietorship—in engineering advance. We, engineers, must avoid building up a cult and looking upon ourselves as a class apart. On the contrary, we must individually more and more seek to widen our contacts with all the pulsating life of our times. Let us study the technique of reaching the people through non-technical publications and throw open our engineering laboratories, libraries and halls to the widest possible public use. Let us seek to have engineering grow up as it were out of the necessities and desires and life of the people.—*Morris L. Cooke, before Philadelphia Engineers' Club.*

Industrial Situation in France

Conditions Improving, but Employers Backward in Labor Policies—Tariff Discrimination Against American Goods

(By an American, resident in Paris)

INDUSTRIAL conditions in France, while still leaving much to be desired, are rapidly improving and, with the exception of Belgium, internal conditions are better than in any of her European neighbors.

During last winter and spring, interested observers were very skeptical of there being a decided increase in French industrial production during 1920. Coal was very scarce, labor uneasy and near-revolutionary in spirit and, worst of all, railway and water transportation were badly demoralized. But we are glad to feel that we were mistaken, for it is believed that from February to October these conditions have improved at least 50 per cent.

The supply of German coal has relieved the lack of fuel enormously and if their shipments continue as during August and September, France can count on 80 per cent of her pre-war requirements for the coming winter. That is sufficient for the time being—sufficient, because her industries have not the labor nor the prime materials with which to work on a 100 per cent basis, nor will they have for a long time to come.

Labor Situation

When one considers that France lost almost two millions of her producing labor during the war—two million young men in the prime of life, who cannot be replaced for at least a generation, if ever—one realizes that it is impossible for her to produce as before the war.

The labor that remains is not more than 75 per cent as efficient and is badly affected by Bolshevist propaganda, although not so badly as in most of the surrounding countries. The solid front displayed by the Government on May 1 last, together with the lack of support from the peasantry and, in many instances, from the union men in the Provinces, put a sad crimp in the extremists and averted a revolution for this year at least. Yet the danger is not completely eliminated, for the successes of the Italian workmen in occupying the metallurgic factories and in forcing the Italian Government and their employers to a compromise which was a virtual victory, has greatly encouraged the French radicals.

This was instanced last week when one of the largest French automobile factories was occupied by the employees, who tried to force the same condition as that obtaining in Italy, where the employees have now just as much (if not a stronger) voice in the management than the owners.

As I write, the "C. G. T.," which, in a syndicalist form, corresponds to our A. F. L., is holding its congress at Orleans, and a warm time they are having, for they are fighting over the fiasco of the May-day Strike and calling each other names. The heads of the C. G. T. fought to their utmost against that strike, realizing that it was foredoomed to failure and only gave it a half-hearted support when they were forced into it by the radicals. Consequently, they are in a position to say "I told you so," which makes the sore-heads still sorer.

But just as all the world was astounded by the sturdy, steadfast resistance offered the German by the French

army during the long war, so are we all gratified by the solidity of the large majority of the working class in France and the lack of progress made by Bolshevist propaganda. For one hot-head who preaches communism there are twenty who reject it.

ATTITUDE OF EMPLOYERS

The worst feature of the situation is that the French employer, as a rule, has no foresight in dealing with his employees. He gives them better wages today simply because he must, but outside his purely business relation with his employee he has no further interest in him as a human being. There are a few, notable exceptions, but this is true as a rule.

The day is close at hand when in all countries the employer must be willing to treat with labor as a partner and to divide his profits with his workmen. He must go further and see that his employees shall have the proper facilities for spending their earnings and for *saving* them as well as look after their physical and moral welfare. To an American reader this may seem axiomatic and hardly worth mentioning, for it is generally accepted in the United States; but we must realize that it is but a recent step even with us and that the European employer has not yet reached this point of view nor will he until he is forced to it as an individual.

For the Frenchman is decidedly individualistic and this individualism is at once the balance wheel of the French industrial machine and an impediment to its advance; for the French are not at all disposed to combine and act in unison for the good of all. No such combined effort as that of the American woman last spring, when they forced a reduction in meat prices by refusing to buy, or of the country as a whole in wearing their old clothes—no such unity of action would obtain in France. If proposed to a Frenchman, he would at once see the logic and agree that it was a mighty good thing to do and that everyone should do it; but to himself and his wife he says, "Let George do it," and goes on in his own individual and selfish way, as his father and father's father did before him.

Something of this same spirit makes the French resent the idea that American engineers or contractors should have any part in the reconstruction program. They invited our engineering societies to come over and advise with them, but I will wager that back in their heads was not so much the thought that they would get sound engineering counsel and advice as that the visit might impress us with the need of financial help and lead to aid from America in that way.

No matter what he may say, the average Frenchman firmly believes that the rest of the world owes France all that she has suffered financially from the war and that the United States, in particular, should pay the greatest part of her loss. And if she is really grateful to the United States for our part in the war, she has a very queer way of showing it. She cannot be blamed for wanting to do her own rebuilding with her own men and in her own way, but before she asks us for help she should put her own house in order: decree and enforce the payment of taxes in such proportion as has Great Britain and the United States.

Moreover, if she wishes us to believe that she appreciates what we have already done, she should put American commerce on a parity with that of the most favored nations. Take up a copy of the French tariff as applied before the war and see on what proportion of the items the American products got the minimum rate. Not 10 per cent. You doubtless think that that has been changed since the war, that Mr. Wilson saw to it that in the future our country would be on a par with Great Britain and Germany. But he did not. France has passed so many decrees affecting the customs since the Armistice that one never knows from today to tomorrow what the duty may be on any given item; but of one thing he may be certain—that goods coming from the United States (prime materials excepted) will pay from 50 to 100 per cent more duty than the same goods from England *or from Germany*.

Take anilines for an example: American anilines are much asked for here, but, whereas the English *or German* dyes pay but 3 francs the kilo, the American goods pay *six* francs. The same thing applies to many other products.

Gratitude? We don't ask that,—but we ask a square deal and we don't get it.

Paris, Oct. 1, 1920.

Lack of Cement Results in New Pavement Base for City of Providence

BECAUSE cement shipments were so uncertain and because the time factor was so important, J. H. Johnson, superintendent of highways, Providence, R. I., decided upon the use of a penetration base upon which to place sheet asphalt on some of the numerous reconstruction jobs being done under his supervision. In several instances where he is using his new "black base" cement concrete had been specified. The result of his experiment, Mr. Johnson believes, will be just as good a street in the least time possible for construction, and at a considerable saving in cost over cement concrete.

The longest job of this character is on Charles St. where approximately a mile of sheet asphalt on a penetration base is being laid. Upon the graded and compacted subgrade are placed 6 in. of 2-in. trap rock, sand-filled and rolled to a compact thickness of 4 in. After being rolled excess sand is swept away and a 2-in. course of 2-in. trap rock is laid and rolled. The whole is then penetrated with asphalt of 95 penetration, 1½ gal. of asphalt to the square yard being used. The surface is then spread with ¾-in. stone. The whole is rolled thoroughly, excess stone then being removed.

The sheet asphalt is laid in two courses. First is laid a binder course of 1½ in., compact thickness, another course being added to bring the topping thickness to 3 in.

The work on Charles St. is made more difficult by the presence of a street railway track through its center. New rails were placed by the railway company when the street work was done, and stone blocks, cement grouted, were laid between rails on an existing cement concrete base.

Mr. Johnson is using the penetration base for the reconstruction of another street where stone blocks are being laid. A sand cushion is spread on the penetration base, the blocks then laid and grouted with cement.

Though Mr. Johnson has not been able to determine how the cost of an asphalt surface on a penetration base will compare with the cost of that laid on a cement concrete foundation, the cost so far for the penetration base has been $1.32 per square yard, a price which includes the preparation of the subgrade after the necessary excavation has been done.

Dam Contract Has Special Cost-Plus Feature

Provision Made for Sliding Scale of Payments Depending on Actual Cost of Wanaque Water Supply Project in New Jersey

PAYMENT on a cost-plus basis, involving a sliding scale depending upon whether the actual cost of construction exceeds or is less than the base price estimated, is the feature of the contract for a portion of the Wanaque earth dam for the North Jersey District Water Supply Commission, bids for which were opened Oct. 28. This feature of the contract was commented upon editorially in this journal, Oct. 21, p. 773.

The work involves the creation of an impounding reservoir of 11,000,000,000 gal. capacity on the Wanaque River. For the earth dam a concrete and puddle core wall, 970 ft. long, will be excavated from the ground surface to bed rock by means of a sheeted trench 100 ft. or more in depth. In the present contract the construction of the concrete and clay puddle core-wall from bed rock to the surface of the ground, excavation of a channel in rock, removal of existing mill buildings, and erection of miscellaneous structures are the main features. The work will require 83,500 cu.yd. of earth excavation, 16,000 cu.yd. of rock excavation, 8,000 cu.yd. of clay puddle 28,500 cu.yd. of concrete, and 1,000 tons of steel sheetpiling.

Alternative forms of contract are offered to contractors, one designated as Proposal A, providing for the cost-plus-a-percentage fee, and the other, Proposal B, being on a straight unit-price basis. The following excerpts from the contract explain the cost-plus feature:

The form of contract under Proposal A provides that the Commission shall pay the actual cost of the work plus a percentage fee. This fee is increased or decreased according as the cost of the work is less or greater than the established price. The work is divided into various items and a price has been set for which it is estimated that unit quantities of the respective items may be constructed or furnished. Most of these so-called base unit prices are estimated upon a definite wage rate for common labor and are subject to adjustment in proportion to any fluctuations which may occur in this common labor base wage rate during the life of the contract.

The sum of the base unit prices times the estimated approximate quantities for the respective items, gives an estimated price upon which the contractor will bid his percentage compensation fee. The sum of the adjusted base unit prices times the respective quantities actually constructed gives the established base price which is used in connection with the actual cost to determine the compensation fee to be finally paid.

The cost of the work is divided into classes, viz.:

(1) Construction cost to include in general elements over which the contractor has a large measure of control by virtue of his experience, organizing ability, and efficiency, and briefly, comprises expenditures for labor, rental of plant, power, fuel, and the basic materials.

(2) Construction cost to include minor elements or elements the cost of which are largely beyond the control of the contractor, and, briefly, comprises expenditures for freight, traveling expenses for employees, miscellaneous materials, tools and supplies, and buildings.

(3) Construction cost to include expenses entirely within the control of the contractor and, briefly, comprises salary and personal expenses of the contractor, executive officers and officials, and general overhead charges.

The Commission will pay all legitimate charges against the actual construction cost of the work as outlined in (1) and (2), but expenses outlined in (3) will be paid by the contractor out of his fee.

The contractor's compensation fee is also divided into classes, viz.:

(1) The fee bid by the contractor which will be paid at the bid percentage rate against the Class 1 Construction Cost, should the latter be equal to the Base Price, but will be increased or decreased according as the Class 1 Construction Cost be less or more than the Base Price. The contractor's fee will not be reduced below 4 per cent for reason of any such increased cost.

(2) A flat 4 per cent on all expenditures for Class 2 construction cost.

SCHEDULE OF BASE UNIT PRICES

Item No.	Description	Base Unit Price
1	Earth excavation with sloped sides for core-wall (cu.yd.)	$1.10
2	Earth excavation for core-wall trench, above elevation 150 (cu.yd.)	5.75
3	Earth excavation for core-wall trench, below elevation 150 (cu.yd.)	10.00
4	Earth excavation, general (cu.yd.)	2.00
5	Rock excavation by specific methods	8.00
6	Rock excavation, general (cu yd.)	5.00
7	Special preparation of rock surface (sq.ft.)	.10
8	Clay puddle (cu.yd.)	6.00
9	Refill and embankment, impervious earth (cu.yd.)	2.00
10	Refill and embankment, general (cu.yd.)	1.00
11	Cement (bbl.)	2.50
12	Concrete (cu.yd.)	7.50
13	Paving (cu.yd.)	6.00
14	Grout (cu.yd.)	20.00
15	Drilling small holes in rock or masonry (lin. ft.)	.50
16	Furnishing steel sheet piling (ton)	85.00
17	Driving steel sheet piling (sq.ft.)	.60
18	Vitrified pipe (lin.ft.)	.50
19	Furnishing timber and lumber (M ft.b.m.)	50.00
20	Placing timber and lumber (M ft.b.m.)	50.00
21	Guard rail (lin.ft.)	.50
22	Gravel road surfacing (cu.yd.)	3.00
23	Fence (lin.ft.)	.50
24	Pumping (mil ft.gal.)	.80
25	Moving buildings (lump sum)	3,000.00
26	Water supply and sewerage for Commission's buildings (lump)	2,500.00

It is agreed that the estimated unit prices given [in the table] are based on labor conditions and market prices at the mill for cement, steel sheet piling and lumber 30 days prior to the date of the advertisement of this contract and on a wage rate for common labor of fifty-seven (57) cents per hour, the rate being paid on that date for the best grade of common labor on trench work by the Bureau of Water, Department of Streets and Public Improvements of the City of Newark, N. J., and that they are subject to adjustment as provided [later].

(2) The sum of the amounts obtained by multiplying each item quantity in the final estimate by the corresponding base unit price as named in the schedule or adjusted base unit price established as herein provided will be termed the base price.

(3) Should the actual Class 1 construction cost be equal to the base price, the Class 1 compensation fee shall be the percentage of such construction cost bid by the contractor for that item.

(4) Should such actual Class 1 construction cost exceed the base price, the Class 1 compensation fee shall be reduced by 25 per cent of the excess cost up to an excess of 10 per cent and by 50 per cent of all additional excess cost above 10 per cent, provided, however, that the Class I compensation fee shall not in any case be reduced to less than 4 per cent of the base price, excepting for such payment for liquidated damages and other deductions as are provided for.

(5) Should the actual Class 1 construction cost be less than the said base price, the Class 1 compensation fee shall be increased by 25 per cent of the saving in cost below the base price up to a saving of 10 per cent of said base price and by 50 per cent of all additional saving above 10 per cent of said base price.

(6) Should the Commission grant additional time for any delay beyond the control of the contractor the minimum Class 1 compensation fee shall be increased by the sum of $2,000 per month for extended time granted.

(7) For Class 2 construction, the contractor shall receive a compensation of 4 per cent computed thereon, which shall be paid him monthly as it shall be determined to be done by the Commission.

(8) The compensation fee covers and is in payment for all and any cost and expense not included in payments for construction cost.

The base unit prices for all items except cement, lumber and steel shall be adjusted by increasing or decreasing the

same in the ratio that the final average wage rate, computed as herein provided, bears to the rate of fifty-seven (57) cents per hour provided. The final average wage rate shall be computed as the sum of the products of the percentage of the total Class 1 construction cost included in each monthly estimate multiplied by the average wage rate for the best grade of common labor prevailing in the Bureau of Water, Department of Streets and Public Improvements, of the City of Newark, during the same estimate period. For the purpose of computing the final average wage rate, the cost of cement, steel sheet piling and lumber shall be omitted from the Class 1 construction cost.

The base price for reckoning the contractor's compensation fee for Class 1 construction as provided shall be calculated by multiplying the quantity of each item by its respective base unit price or adjusted base unit price and adding the products. The contractor's compensation fee shall be reckoned in accordance with the provisions herein contained and when added to the construction cost and other moneys due the contractor as herein provided for, shall constitute the final estimate.

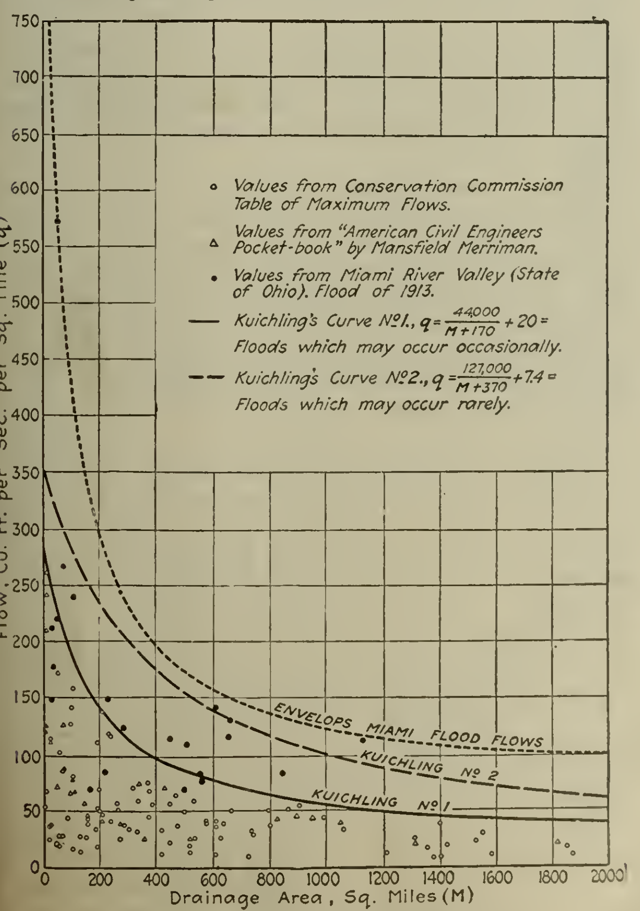
Maximum Flow of Streams in the State of New York

By E. H. Sargent

Senior Assistant Engineer, New York State Conservation Commission, Albany, N. Y.

THE results of a study, made by the writer, of the maximum flow of streams in New York State are shown on the accompanying diagram.

A search was made of all known authentic records of flood flows of streams in this state, and these are shown by the circles on the diagram. These values are not all strictly comparable, for the reason that some of them are actual maxima, while others are the flows corresponding to the highest reading of gages



FLOOD FLOWS IN NEW YORK STATE

that are read twice a day. In addition, there have been plotted, using the triangles as a legend, values of flood flows of New York State streams given in Merriman's "American Civil Engineer's Hand Book." There is also shown, by the squares, the values of flood flows of streams in the Miami River valley in the State of Ohio during the extraordinary flood of March, 1913. These latter values were taken from tables in Part IV of the Technical Reports of the Miami Conservancy District. An inspection of this district made by the writer shows that its topography is not dissimilar from that of many of the streams in New York State and that, although the flood flows which obtained in this flood greatly exceeded any known value of floods in New York State, it is entirely within the realm of possibility that such flows might occur on some New York streams.

In making an investigation, in 1901, of the water supply of the new Barge Canal, the late Emil Kuichling made an exhaustive study of the maximum flood discharge of certain American and European rivers under conditions comparable to those in the Mohawk Valley. As the result of these studies he plotted two curves which are shown on the diagram. Curve 1, for occasional floods, just envelops all the values of flood flows in New York State; curve 2, for rare floods, envelopes most of the flood flows of the famous Miami River flood. There has also been drawn on this diagram a curve just enveloping these latter flows.

Contract for South American Railway

RECENTLY a contract was signed between the Bolivian Government and a firm in Buenos Aires for the construction of the railway between La Quiaca in Argentina and Tupiza in Bolivia, a distance of 57 miles. According to the terms of this contract, construction is to proceed at once with the materials now in possession of the Government, and the line is to be finished as far as the Yaruma station within four months from the signing of the contract. The entire line must be completed within 24 months. As fast as the rails are laid the line is to be opened to traffic and the contracting company is to be responsible for the maintenance of the line for a year after its opening. At the expiration of that time it is to be delivered to the Government for operation as a State line. The company has deposited a guaranty of 200,000 bolivianos (1 boliviano = \$0.3893) with the Government, which will, moreover, withhold 5 per cent of the monthly payments to the contractors until the completion of the line. The plans of Vezin et Cie, former contractors, whose contract was annulled in 1919, have been incorporated in the new contract except for certain modifications in the specifications.—*Commerce Reports.*

Abandoned Canals Made Into Fish Hatching Ponds

Portions of the old Erie and Champlain canals have been transformed "into ponds for the propagation of some of the warm water food and game fishes," according to the 1918 report (just published) of the Conservation Commission of the State of New York. By this means a small expenditure has provided a "pond cultural area" which is more than fifteen times as great as all of the area at the State hatcheries and in excess of the pond cultural area of all the hatcheries of the U. S. Bureau of Fisheries.

A Self-Checking String Polygon

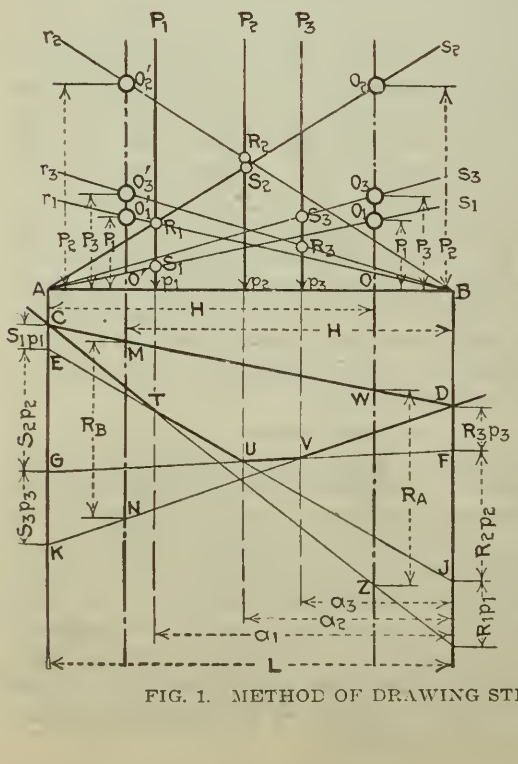
New Graphical Method in Which Paralleling Is Replaced by Measurement Gives Increased Accuracy

By Theodore Bleckmann
Cleveland

THEORETICALLY, the graphical method of determining the reactions and bending moments in a horizontal beam on two supports under a stationary or moving system of vertical loads, has some marked advantages over the analytical one. Most conspicuous among these is the direct and positive manner in which the finished string polygon locates the critical forces and moments, as compared with the slow experimental process by which this location is determined in the analytical method. In actual practice, however, the unquestionable theoretical advantages of the method are partly neutralized by certain practical difficulties in constructing the string polygon, which may be summarized as follows:

1. It is not possible to predict closely the shape of the string polygon corresponding to a given force diagram, and therefore it is difficult to assign a desirable shape and location to a string polygon to be constructed, by the judicious choice of the force diagram.
2. Cumulative inaccuracies are not easily avoided in the unwieldy process of paralleling strings and rays by means of the standard drawing triangles.
3. A simple visual check on the correctness and the accuracy of the results is absent; this is a specially undesirable feature.

By slightly modified application of the well known geometrical properties of the string polygon, however, a method is produced in which these undesirable features are practically eliminated. From Fig. 1, which shows a string polygon constructed in the customary manner by means of a force diagram there follows:



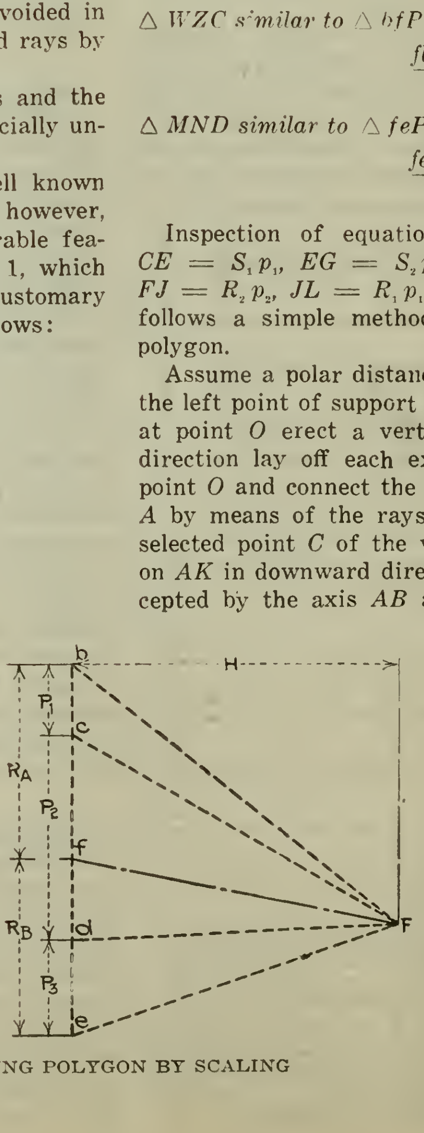


FIG. 1. METHOD OF DRAWING STRING POLYGON BY SCALING

$$\left.\begin{aligned}
&\triangle\, CET \text{ similar to } \triangle\, bcP,\ \therefore\ CE = \frac{bc \times Ap_1}{H} = \frac{P_1(L-a_1)}{H}\\
&\triangle\, DFV \text{ similar to } \triangle\, deP,\ \therefore\ DF = \frac{de \times Bp_3}{H} = \frac{P_3\,a_3}{H}\\
&\text{By like reasoning, } EG = \frac{P_2\,(L-a_2)}{H};\\
&GK = \frac{P_3(L-a_3)}{H};\quad JL = \frac{P_1\,a_1}{H};\quad JF = \frac{P_2\,a_2}{H}
\end{aligned}\right\}\ (1)$$

Further,

$$\left.\begin{aligned}
&\triangle\, AS_1p_1 \text{ similar to } \triangle\, AO_1O,\ \therefore\ S_1p_1 = \frac{O_1O \times Ap_1}{AO} = \frac{P_1(L-a_1)}{H}\\
&\triangle\, BR_3\,p_3 \text{ similar to } \triangle\, BO'_3O',\ \therefore\ R_3\,p_3 = \frac{O'_3\,O' \times Bp_3}{BO'} = \frac{P_3\,a_3}{H}\\
&\text{By like reasoning, } S_2\,p_2 = \frac{P_2(L-a_2)}{H};\\
&S_3\,p_3 = \frac{P_3\,(L-a_3)}{H};\quad R_1\,p_1 = \frac{P_1\,a_1}{H};\quad R_2\,p_2 = \frac{P_2a_2}{H}
\end{aligned}\right\}\ (2)$$

And also,

$$\left.\begin{aligned}
&\triangle\, WZC \text{ similar to } \triangle\, bfP,\ \therefore\ WZ = \frac{fb \times AO}{H} = \frac{R_A \times H}{H} = R_A\\
&\triangle\, MND \text{ similar to } \triangle\, feP,\ \therefore\ MN = \frac{fe \times BO'}{H} = \frac{R_B \times H}{H} = R_B
\end{aligned}\right\}\ (3)$$

Inspection of equations (1) and (2) shows that $CE = S_1p_1$, $EG = S_2p_2$, $GK = S_3p_3$, $DF = R_3p_3$, $FJ = R_2p_2$, $JL = R_1p_1$. From these equalities there follows a simple method for constructing the string polygon.

Assume a polar distance H and lay it off as AO from the left point of support A to the right on the axis AB; at point O erect a vertical OO_2. On OO_2 in upward direction lay off each external load P from the same point O and connect the end points O_1, O_2, O_3, etc., with A by means of the rays s_1, s_2, s_3. From an arbitrarily selected point C of the vertical AK through A, lay off on AK in downward direction each segment B_nP_n intercepted by the axis AB and the ray s_n on the vertical load line P_n to which that ray corresponds, in the order in which they are passed in going from A to B. By the same procedure used in locating points O_1, O_2, O_3, locate now the points O'_1, O'_2, O'_3, etc., starting however, from the right-hand point of support B instead of from A, using the same polar distance H and the same scale of forces. Connect the O' points with B by means of the rays r. From an arbitrarily selected point D of the verti-

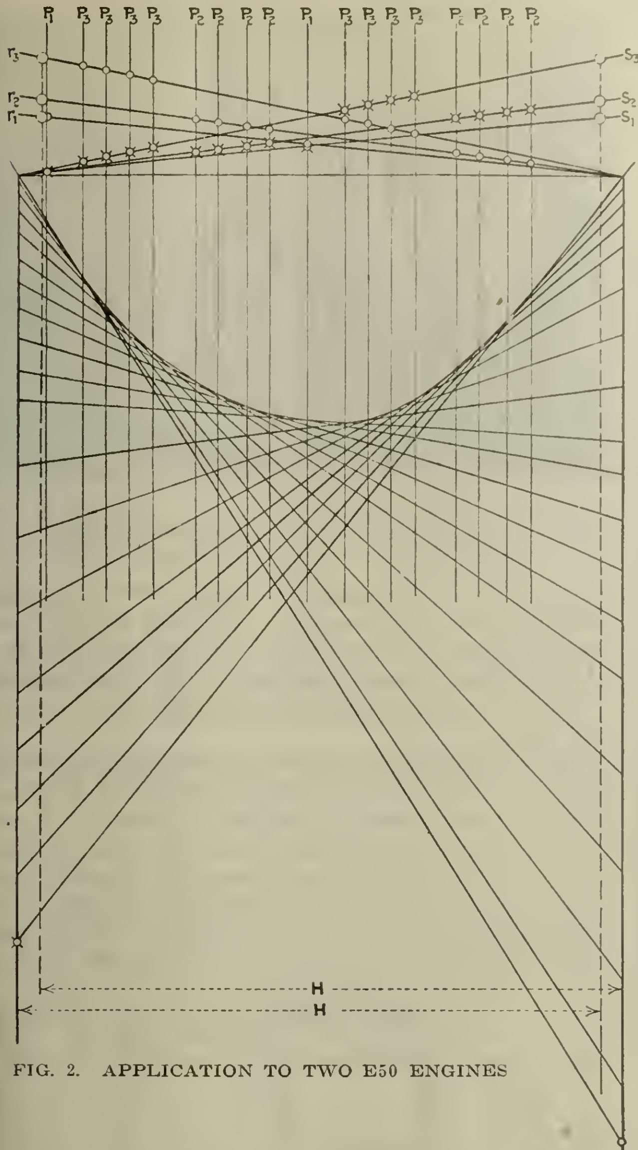


FIG. 2. APPLICATION TO TWO E50 ENGINES

cal BL through B, lay off on BL in downward direction each segment R_nP_n, intercepted by AB and ray r_n on the vertical load line P_n to which that ray corresponds, in the order in which they are passed in going from B to A. After this, merely connect each point on AK with its corresponding point on BL, and the string polygon is complete.

With this method, in each particular problem it is easy to estimate in advance the maximum required drawing space above the axis and under the closing line. For, the points C and D being arbitrarily selected, it follows that the direction and location of the closing line may be arbitrarily selected in advance. Furthermore, by sketching in a tentatively assumed length H, the greatest load P_o on a tentatively assumed scale of forces, and the two rays corresponding with that greatest load, it is possible to obtain at once the maximum required vertical clearance above the axis; the sum of the segments cut off from the vertical load lines by the axis and either the one or the other of these two upper rays (whichever gives the largest sum), is always greater than the maximum required vertical clearance under the closing line, DL.

The method gives very accurate results, as it substitutes accurate laying off of distances for the precarious paralleling of lines and in addition permits the use of a large scale of forces on account of the particular manner of laying off the loads. And finally, the finished string polygon carries two distinct checks: the first one being that the sum of the two independently determined reactions R_A and R_B must equal the sum of the external loads; the second one, that each pair of strings must have their point of intersection on the vertical load line to which they correspond.

Inspection of Fig. 2, representing the string polygon for the two locomotives of Cooper's standard loading E50, shows that the method is specially adapted for loading systems consisting of a small number of different groups of many equal loads each. For such systems both the analytical and the usual graphical method grow very unwieldy, while here the construction is simple, compact and accurate. For simple cases of loading both the analytical and the usual graphical method most probably will lead to the desired result more quickly, but even in such work the new graphical method may prove useful on account of its accuracy and reliability.

Oakum and Braces Save Suspected Partition Wall in Wasteway

By H. B. Fleshman

WHEN the earth dam of the Lyman Water Co., St. Johns, Ariz., the failure of which was described in *Engineering News* Apr. 22, 1915, p. 294, and *Engineering Record*, Apr. 24, 1915, p. 537, was redesigned, a 7 x 8-ft. wasteway was tunneled through rock at the south end of the dam and lined with concrete. As timbering was necessary in a portion of the tunnel, difficulty was encountered in placing concrete in the roof section. As a result there has always been a lot of seepage through the roof. Later it was decided to use one-half of this outlet as a pressure tunnel to deliver water to the main canal 20 ft. above and 50 ft. to the right of the lower end of the tunnel. A 6 x 6-ft. shaft and cross tunnel was built to connect with the wasteway tunnel. In the latter a 14-in. center wall was started but not completed. When work was resumed a settlement of the center wall was found leaving a space at the top the entire length of the wall varying from ½ to 1½ in. The wall also was left in the condition of a beam supported at one end (the bottom), and that end under suspicion of not being sufficiently strong to support a 22-ft. head of water. There was insufficient time before the irrigation season opened to line the roof and thus stop the leaks, nor could planks be fitted into the opening over the wall on account of the roughness of the concrete. Oakum was calked into the cracks with chisels and hammers. Braces of 4 x 4-in. timbers were set 6 ft. apart 4 ft. above the floor along the entire length of the waterway on the dry side. At an unusually weak spot in the roof the water broke through but was held back by a 3-ft. length of 2 x 12-in. plank fitted to the opening and wedged up by a vertical 4 x 4-in. strut. Water was turned into the canal on time and the improvised tunnel connection has been in use all season.

A leakage of about ½ sec.-ft. comes through the roof of the "dry" side of the tunnel, but it is clear and does not seem to be doing any damage. The several second-feet coming over the top of the wall and round the upper gates is about the amount necessary to pass down the river without lifting the gates.

Stream Bed Enlargements in Kansas

Eroded Channels Lead to Culvert and Bridge Failures—Vertical Drop Concrete Box With Retained Earth Fill Solves Problem

By Dudley Alkins, Jr.
County Engineer, Doniphan County, Kansas

In *Engineering News-Record*, May 20, editorial comment appeared on small highway bridges failing because of foundation weaknesses. We have a situation in this county which is not explained in texts or journals. This situation concerns the enlargement of stream beds and the subsequent engulfment of small bridges and culverts, footings and all.

Fig. 1 shows in the foreground, the original size of a channel draining 1,000 acres, being 30 ft. wide and averaging 8 ft. deep. Formerly, the creek turned to the left in the distance and meandered a mile to the Missouri River. Last year the Missouri River eroded the intervening fields and intercepted the drainage at a near-by point. There was a difference in elevation between the creek bed and the river of approximately 10 ft. so that the alluvial soil of the creek channel was easily cut back upstream during each freshet. The enlarged channel is 70 ft. wide and 15 ft. deep. The central part of the channel washes back, causing the banks to cave and slide. It was during the sliding that ten cedar piling were snapped off and a small iron bridge dropped into the new and larger channel. Such enlargements as illustrated in Fig. 1 continue for mile to the very end of each branch, but on a smaller scale. Doniphan County is mostly upland with loess hills adjoining the Missouri River bottom land, and offers short and steep creek channels leading back to the higher country.

FIG. 1. STREAM BED ENLARGED BY CHANGE IN MISSOURI RIVER CHANNEL

The ravine shown in Fig. 2 drains 14 acres. The wood bridge is 32 ft. long and 21 ft. above the waterway and only during rains is there any water passing through. The plan in Fig. 4 represents the box culvert which is to be built at this place. The purpose is to make an earth fill which will act as a dam and divert the storm water through the drop inlet to a vertical fall of 19 ft. There will be considerable impact from the force of the descending water which the extra thickness and reinforcing at the base of the inlet is to care for. It must be remembered that water flows through this culvert only during rain and probably amounts to 24 hr. of full capacity per year.

There is considerable economy in building a long culvert barrel and a low retaining wall at the outlet, as an alternative for a short barrel and high retaining wall. In order to prevent the earth fill from closing the outlet the high retaining wall must be quite long, thereby using more concrete than would the extra 20 ft. of barrel and a small headwall. Fig. 4 requires 45.9 cu.yd. of concrete whereby an alternate plan uses only 22.7 cu.yd.

FIG. 2. RAVINE DRAINING BUT 14 ACRES STILL BEING ERODED

FIG. 3. CONCRETE BOX CULVERT UNDERMINED BY ENLARGED STREAM BED

The most startling stream-bed enlargement problem yet encountered in the county is illustrated by Fig. 3. Eighty acres are drained through a channel 8 ft. wide and 2 ft. deep to a 4 x 5-ft. concrete box which is shown in the upper part of the picture. The channel downstream is 33 ft. deep and averages 30 ft. wide. The water has a fall of 27 ft. in one stage. A few years ago the downstream channel was no larger than the

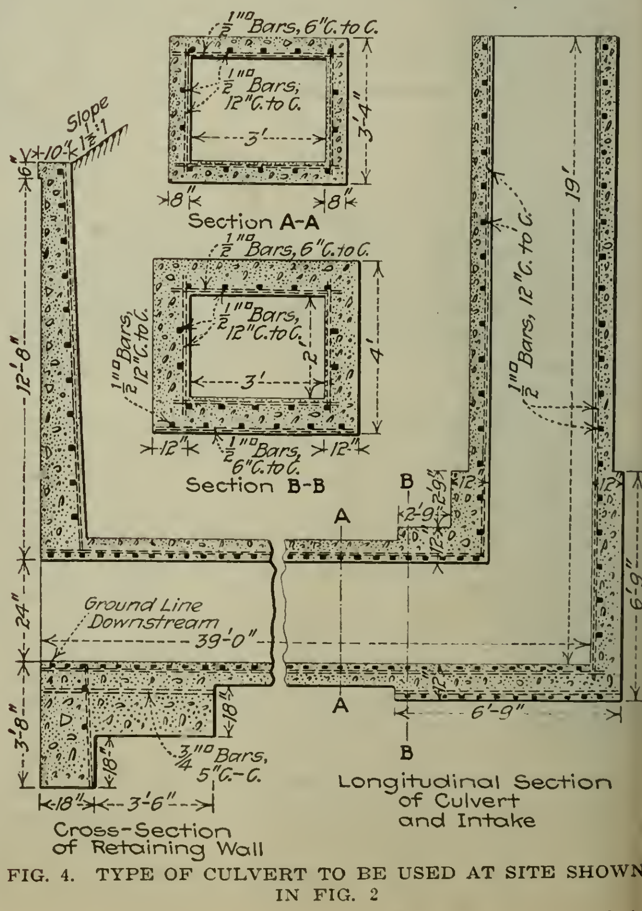


FIG. 4. TYPE OF CULVERT TO BE USED AT SITE SHOWN IN FIG. 2

upstream channel. The engineer who planned this culvert could hardly have foretold what would happen. Obviously no standard culvert footing would serve. Neither could any ordinary standard culvert last much longer, but had the present culvert been properly reinforced it would have been possible to build a concrete drop outlet in such a way as to hold the water harmlessly within walls instead of allowing it to erode further. A staircase flume was under consideration but as yet no definite plan has been arrived at.

The Kansas State Highway Commission requires standard field notes with each plan submitted for approval. One of the questions is "Is the stream cutting or filling?" We go that question one better before even deciding to build a concrete culvert by hiking downstream from the culvert site to find out if there are any stream-bed enlargements coming. When we find such a situation the proposed improvement is postponed, or, if urgent, is built of piling and planks. Most of this season's work is in mature stream beds, but some preventive work has been done to save good concrete culverts so endangered.

Wire Mesh Used for Concrete Flat Slab Reinforcement

Shortage of Steel Bars Leads to Adoption of Woven Wire for Secondary Bands of Girderless Floor

By S. Goldstein
Formerly Designing Engineer, John Monks & Sons, New York City, Now with Fred T. Ley & Co., New York City

On account of the difficulty of obtaining reinforcing bars, especially of the smaller sizes, wire mesh was used for the secondary bands of the flat-slab concrete floors of a recent warehouse building near New York City. For the main bands, where larger sections were required, the usual bars were used. In the absence of any building code regulating the flat-slab design, the writer used a combination of the Chicago and Corrugated Bar Co.'s regulations in computing and proportioning the moments over the various parts of the floor.

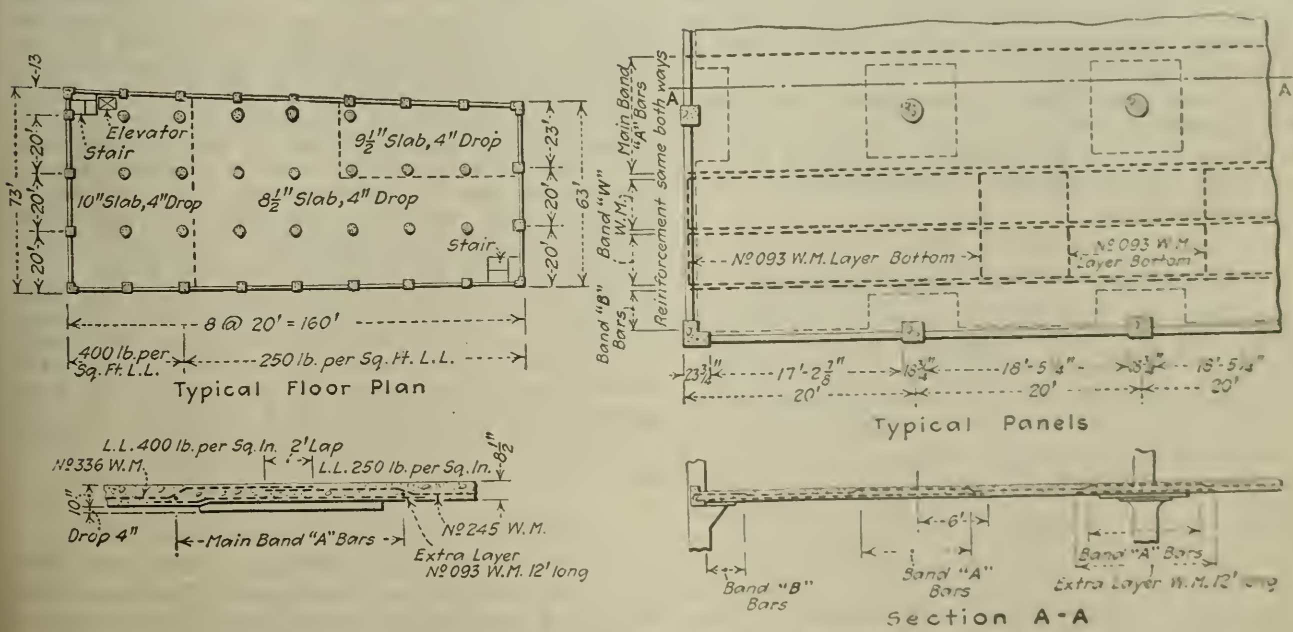
The building is of an irregular shape, being 160 ft. long and 63 ft. wide at one end and 73 ft. at the other end. The columns are 20 ft. centers, making the typical floor panels 20 ft. by 20 ft. The live-load on the floor was not constant, being 400 lb. per square foot over the first two bays from the wider end and 250 lb. per square foot for the rest of the floor areas.

The details of the reinforcement are shown in the accompanying darwings. At the mid-section where the secondary band crosses the main band the moment is negative and the wire mesh is hickeyed over the main band, leaving a long stretch (about half the span) without any reinforcement in the bottom of the slab. In ordinary all-bar design this is overcome by having part of the reinforcing bars (usually half) extended up to a short distance from center line of column. Where wire mesh is used it would be bad practice to cut abruptly all the positive reinforcement even along a line theoretically very nea the point of inflection. This difficulty was overcome by using a short band of wire mesh of small cross sectional area at the bottom of the slab over the main band long enough to lap about a foot with the secondary band before the latter is hickeyed up.

The wall panels, where the steel reinforcement ought to be increased due to the lack of continuity, an extra layer of wire mesh, of sufficient area to make up the necessary increase (about 20 per cent), was used and this extra layer was continued at the bottom of the slab into the wall spandrel on one side and over the main band to lap with the same band with the next panel.

One of the details shows the method of splicing two bands of wire mesh of different cross sectional areas where the live-load changes from 250 to 400 lb. per square foot and also where a long panel meets a regular 20 ft. panel.

An examination of the reinforcement in place before the concrete was poured showed that ordinary care was sufficient to avoid unnecessary congestion of the steel reinforcement with the exception of the corner panels where four layers of wire mesh had to be placed. For this reason the writer found it advisable to use bars in one direction and wire mesh in the other in the second-



FLAT-SLAB FLOOR USING WIRE-MESH REINFORCEMENT

ary bands of the corner panels of the upper floors, thereby avoiding excessive congestion of steel.

No difficulty was encountered in keeping the steel in proper position. The wire mesh was supported on bars, which in turn were supported on precast concrete stools. By the use of a hooked bar the wire mesh was lifted to proper position while the concrete was being poured. The cost of handling, bending and placing the wire mesh was considerably less than for reinforcing bars.

PLACING THE WIRE MESH IN THE FLAT SLAB FLOOR

The writer is of the opinion that because of the higher quality of steel and better continuity of the wire mesh, a higher working stress is permissible for the wire mesh than for bars, i.e. 18,000 lb. instead of 16,000 lb. per square inch. By the use of wire mesh for the secondary bands only, excessive steel congestion is avoided and the combination of wire mesh and reinforcing bars produces a structure more economical and at least as good as the ordinary all-bar design.

The building described is a three-story flat-slab reinforced-concrete factory-warehouse built for the Vacuum Oil Co., of Bayonne, N. J., by John Monks & Sons, of New York City, contractors and engineers, W. O. Hoffman, chief engineer.

Maintenance of Devon County Highways

Sir Henry Maybury, Director General of Roads, British Ministry of Transport, recently appeared before a meeting of the Devon Bridges and Main Roads Committee to explain the method of road classification which is now going on and which will become effective April 1, 1921, but more especially to plead that the Devon County Council assume all responsibility for the maintenance of main roads within its area. Devon is believed to be the only county in England which does not directly control maintenance of the main highways within its borders. At present main roads in Devon are maintained by rural councils under contract with the county council.

Sir Henry Maybury pointed out that when the Ministry assumed responsibility for the maintenance of first and second class roads April 1, the case of Devon could be more easily disposed of were all maintenance authority centralized in one governing body.

Relation of Zoning to the Work of the City Engineer

By E. S. Rankin

Engineer, Bureau of Sewers, Newark, N. J.

Extracts from a paper read before the American Society for Municipal Improvements, St. Louis, Mo., October, 1920.

In a city in which a stringent zoning ordinance is in force, the element of chance in the engineer's work is largely eliminated and decided economies effected, whether it be in the laying out of streets, or in their paving, sewering, or water supply, for it is obvious that with the assurance that a given section of the city will be occupied by a certain definite class and size of buildings, the engineer can much more intelligently design the public works necessary to properly serve that section.

With zoning ordinance in effect a street system can be laid out with streets of such width and such distances apart as best to serve the use to which the land will be put, and with the assurance that such use will be permanent. Parks and playgrounds can also be located where they will permanently be of the greatest service to the greatest number.

Perhaps the most obvious effect of which zoning will have on public improvements will be in its relation to the paving problem. In an industrial district durability and strength to carry the heaviest traffic will be the first consideration, while smoothness with an absence of noise will govern the selection of a pavement for a residence district. Of course these features are given consideration without a zoning ordinance, but there is no assurance that the character of the district will not change and the pavement become unsuitable. The writer has in mind a street in his own city paved a few years ago with telford. The street was well built up at the time with moderate sized one- and two-family detached houses, but adjoining a new railroad spur. Almost immediately following the paving of the street factories began to appear, attracted by the railroad, with the result that inside of a year the pavement was sadly in need of repairs and soon had to be replaced with more durable material. Had the street been restricted by a zoning ordinance to its original character, the pavement would have served every purpose for a number of years.

The effect of zoning on sewer design, with the substitution of known factors for estimates based on the judgment of the engineer, is very marked. For most of the remarks on this phase of the subject I am indebted to an article by W. W. Horner, vice-president of this society, in the report of the City Plan Commission of St. Louis for 1919. [An article by Mr. Horner on this subject appeared in *Engineering News-Record*, Feb. 21, 1918, p. 368.—Editor.]

New Engineer Officers from West Point

Fifteen of this year's graduates from West Point have been assigned to the Corps of Engineers. This number is slightly larger than is justified by the numerical strength of the Corps, but in view of the dearth of engineer officers it was regarded as advisable. These officers from West Point and thirty other young engineer officers will form the first class in the new "basic" course at the Engineer School, which future graduates assigned to the Engineers must attend.

Wet Concrete Hauled Three Miles for Pavement Base

Concrete Flows Freely After Half an Hour on the Trucks — Hydrated Lime Facilitates Spreading and Tamping

By C. B. Montgomery
Union Paving Co., Philadelphia, Pa.

MIXED concrete is being hauled an average distance of 3 mi. in constructing the concrete base for 150,000 sq.yd. of pavement at Philadelphia, Pa. Experience with wet-batch haulage has disclosed no inherent objections to the method. Samples of concrete taken from the streets show remarkable density and uniformity and have passed satisfactorily the required laboratory tests.

In preparing for operation the contractor, the Union Paving Co., built on its property at 30th and Locust streets, Philadelphia, a plant capable of producing about 800 batches, or approximately 200 cu.yd. of concrete per day, the layout of which is shown by accompanying sketch. The plant is favorably located for its purpose, being served by both rail and water transportation and centrally situated in respect to the streets to be paved. A steam-driven batch mixer of 30 cu.ft. capacity is mounted on a platform high enough to permit trucks to drive underneath. On this platform stands the mixerman, all materials and operations being under his constant sight and control and the mixed concrete subject to his scrutiny. Above the mixing drum is a divided measuring box for fine and coarse aggregates. Above the measuring box are storage bins of about 40 tons total capacity, while to one side extends a cement platform of 150 bags capacity. A 100-gal. tank on this platform with 2-in. discharge pipe furnishes a steady supply of water for mixing. The storage bins are filled from ground storage piles by a locomotive crane, which also supplies cement to the platform from an adjacent warehouse.

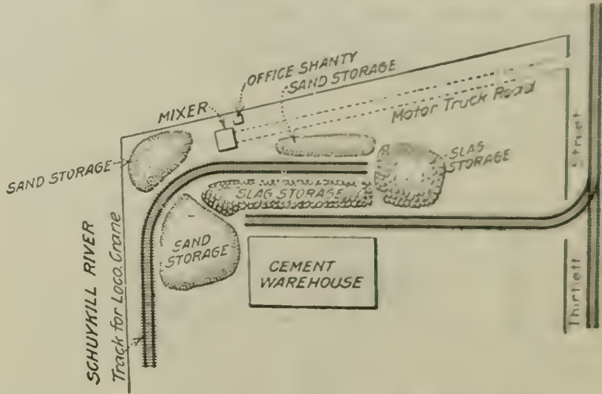
The working force for operating this plant consists of: One man opening cement bags; one man charging the measuring box; one mixer man; two men in the cement house; one handy man; one timekeeper loading and checking trucks; two men on the locomotive crane, and one foreman.

The mixture is 1: 3: 6, with slag as coarse aggregate. Hydrated lime is added to produce a denser, more plastic mix as well as to retard slightly the initial set. The lime proportion is 10 per cent to 15 per cent of the cement used, depending on the length of haul. A stiff consistency is maintained, about 5 per cent to 6 per cent by weight of water being used in mixing. The slag on the ground storage piles is well sprinkled before being placed in the bins, to prevent it from absorbing water from the mortar.

Two-ton dump trucks with fairly tight steel bodies are used for transporting the wet material, but no special care is taken to make the bodies watertight. Five-ton trucks were tried first and, although somewhat cheaper, it was found that the small trucks were quicker, more flexible, did not require so long a time for loading, and the smaller mass of concrete had less tendency to pack together in transit.

In central-plant concrete mixing, speed and continuous operation are important. Each truck driver is impressed with the need of delivering the material promptly and if, through accident or neglect, a load is unduly delayed it is not used but sent to a dump and the truck owner responsible is charged for the lost material. The time elapsing between the start of mixing to final placing in the street averages from 15 min. for a 2-mi. haul to 35 min. for a 5-mi. haul. The average distance from the plant to the streets is about 3 mi. Before loading, each truck body is sprayed with water and lightly sprinkled with wet sand. This prevents the wet concrete from adhering to the sides or bottom of the truck. Oil was at first used for this purpose but water proved more effective. The trucks also are covered with heavy canvas to prevent the wind and sun from drying out the exposed concrete.

Some of the advantages resulting from the central mixing plant are: More positive control, hence greater



SKETCH PLAN OF CENTRAL MIXING PLANT

uniformity of product; reduction of labor force to about one-third for equal yardage; less interference with traffic by eliminating storage piles on the street; less frequent moves, with attendant delay, transportation cost and damage to machine; maximum efficiency of plant by more continuous operation; reduced mechanical trouble with mixer by using a heavier machine, rigidly placed, together with convenience of spare parts for prompt repairs; economies through the choice of fuel for motive power as soft coal, electricity, etc., not possible with a street paver, and the saving of cement sacks formerly lost or destroyed on the street.

Suggestions from Rebuilt French Cities

Excess condemnation and final resale or leasing of lands adjacent to areas being taken for street widening and opening has enabled many cities and towns in the devastated region of France to finance the whole of these improvements. An outline of this practice, together with a suggestion that it be adopted more generally in the United States, and also that benefits as well as damages for street improvements be assessed against the abutting property, was presented at the recent meeting of the American Society for Municipal Improvements by George B. Ford of the Technical Advisory Corporation. Contrary to the generally-accepted views, the French are permitting many street changes in rebuilding their cities. They are the more prone to do this since the government pays the larger part of the bill. Co-operative societies have been formed in most of the towns which enable the employment of one contractor, one engineer and one architect, instead of many of each, and to standardize the many unit parts of their buildings, such as windows and doors.

Planning the Future of the Cleveland Water Supply

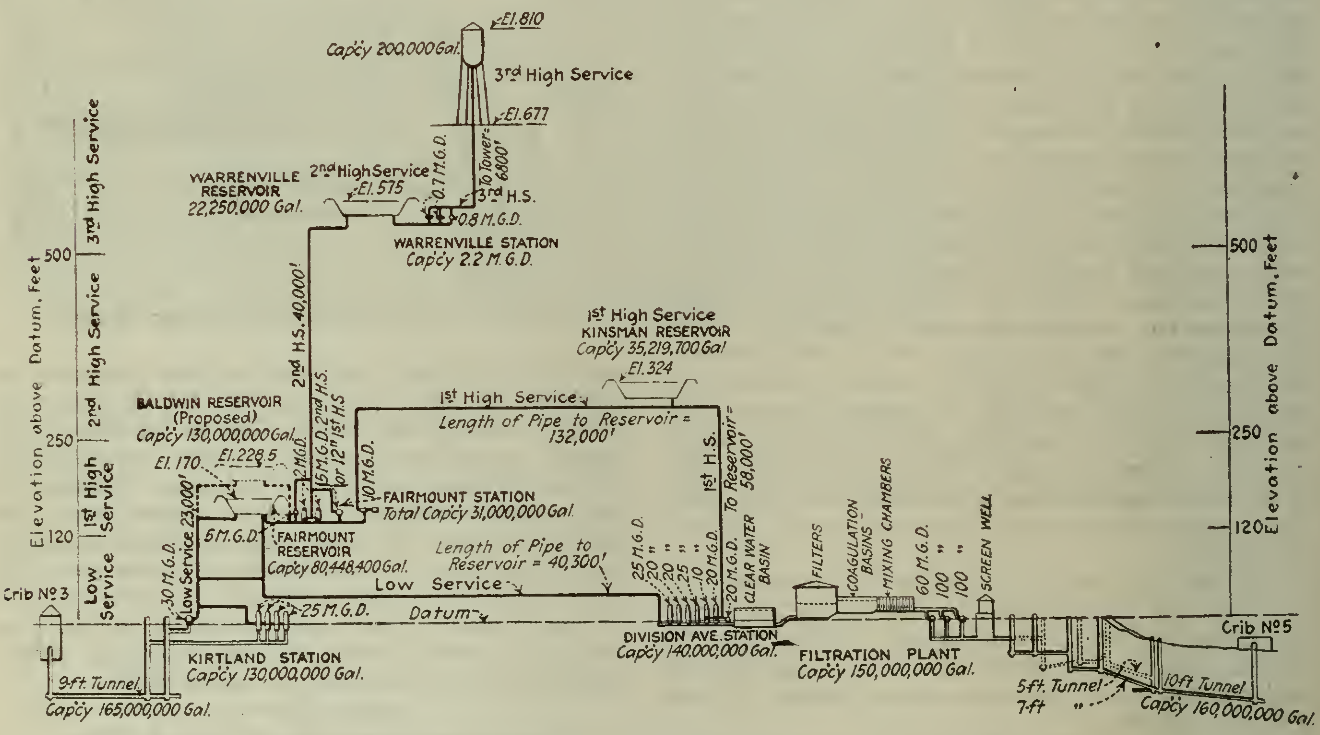
Methods Followed Lead to $30,000,000 Program by 1940 Delivering 430,000,000 Gallons Daily from Four Intakes of Which Two Will Be New

BY A. V. RUGGLES
Engineer of Construction and Surveys, Division of Water, Cleveland, Ohio

A COMPREHENSIVE plan for the future development of the water-supply system of Cleveland, Ohio, has been made by the engineers of the Division of Water. The methods of investigation pursued, the results obtained and the conclusions reached as to the program to be followed have been set forth in a pamphlet which contains a series of reports by the writer to G. B. Dusinberre, former commissioner of water, and to J. T. Martin, present commissioner of water. The program provides for Cleveland's furnishing water to an ever-widening area which has been assumed to have expanded

In 1917 the city was able to draw water from Lake Erie through two separate supply tunnels, and although pumping facilities at the two stations at the lake front were ample for immediate needs, it was apparent that in the outlying regions, and particularly in the high service districts, the existing facilities for supplying water would be heavily taxed within a few years. Subsequent events have proved this to be the case to a greater extent even than anticipated, due to the unprecedented demands for water during and since the war.

As early as 1917 it was realized that a careful study



DIAGRAMMATIC SKETCH OF CLEVELAND WATER-WORKS SYSTEM

by 1,940 to include the whole of Cuyahoga Co. together with some territory outside the county to the east and including a total area of approximately 475 square miles. Studies were carried on during the greater part of 1917, discontinued for the period of the war and resumed early in 1919. The final report of Sept. 28, 1919, gave conclusions as to future demands for water in all districts to be supplied at successive periods until 1940; and recommendation as to size, location and times of installation of the various new intake tunnels, pumping stations, filtration plants, reservoirs and main feeder pipe lines to meet these demands. In November, 1919, J. W. Frazier, J. H. Herron and Robert Hoffman were designated by Mr. Martin as a special commission of engineers to review the program of the Division of Water. Their report approved the city's plan, summarized the important features of the construction program and also urged a raise in rates for water to an extent necessary for the proper financing of work.

should be made of the future development of the distribution system. An investigation of the larger mains was begun by the writer, primarily to determine what additional supply mains would be needed to care for the city's rapid growth. The facts which it was deemed desirable to establish were the size and location of these pipe lines and the dates on which they should be ready to be put into service. This naturally led to a detailed study of rates of consumption, the variations in consumption in different sections of the city, maximum as compared with average consumption for the city as a whole and for the several service districts, and the probable growth and distribution of the population through the areas to be served.

As a result of the methods carried out to ascertain the solution of the problem the following summary of the report, under five headings, has been prepared:

Existing Arrangement of Pumping Stations, Reservoirs and Distribution System—The general layout of the Cleveland system as it exists today is shown by the accompanying

sketch. By the completion of the 150,000,000-gal. rapid sand filter plant in 1917 the city was able to secure water from two independent intakes, one supply being filtered and the other chlorinated.

Previous to 1904 the entire water supply of Cleveland was obtained from Lake Erie through an intake (crib 4), located a short distance west of the mouth of the Cuyahoga River and a mile from the shore. This intake was connected to a pumping station at the shore on Division Ave. by two tunnels, 5 ft. and 7 ft. in diameter. In 1904 a new intake (crib 3) was completed, having a permanent steel crib extending above the lake surface, together with a 9-ft. brick-lined tunnel and a pumping station. The crib is four miles from shore and in 55 ft. of water. The pumping station (Kirtland Station) which this intake and tunnel serve is at the foot of East 49th St., with a capacity of 130,000,000 gal. daily, all low service pumps.

In both pumping stations and in the filtration plant on the West Side the equipment provided was ample for immediate needs. Provision was also made to care for increased output up to the capacity of the two intake tunnels, each of which can bring in about 165,000,000 gal. daily, by additional pumps to be installed as demands should grow. Some of this water is repumped in order to meet the needs of areas of high level.

The low service district, comprising all parts of the city less than 120 ft. above lake level, has been provided with reservoir storage of 80,000,000 gal. on the east side at Fairmount. The first high service district comprises that portion of the city between El. 120 and 250, the second high service between El. 250 and 500 and the third from El. 500 to 810.

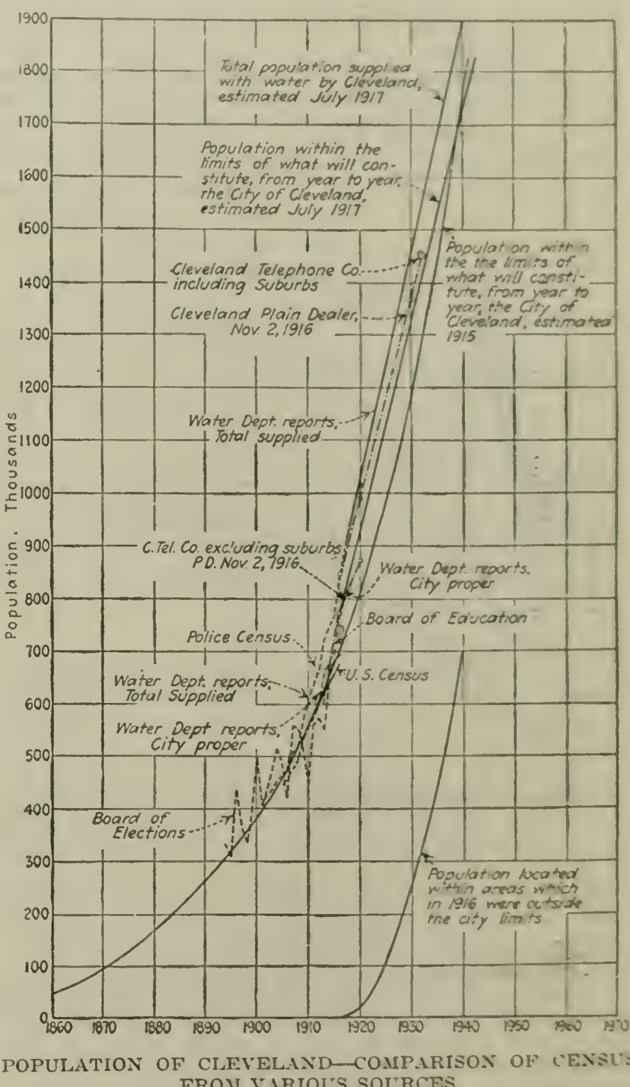
In 1913 a new low service reservoir was planned and its construction is now under way. This reservoir (Baldwin) is located just east of and 55 ft. above the Fairmount reservoir. Its capacity will be approximately 125,000,000 gal. and it will have a beneficial effect in increasing the pressure in the low service district.

Existing Conditions as to Flow in Feeder Mains—In 1919 there were built more than 30 new permanent pitometer vaults at strategic points on the large feeder mains and measurements have been taken at all these. These records show to how great an extent these main feeder lines were being pushed. The results have been reassuring, showing that the mains are, in general, ample for immediate needs; that the velocities are not excessive, and that the large mains laid in tunnels under the Cuyahoga River to connect up the East and West Sides of the city in the low service district are sufficient for the needs.

One group of pitometer vaults forms a ring around Kirtland station, each about one mile from the station, on a large main. These are of value in determining the size and location of new mains leaving the stations to care for the output of additional pumps from time to time. Another similar ring surrounds Division station. Other new vaults, scattered about the city, together with quite a number of older vaults, have enabled tests to be made, throwing new light on problems of extension of the distribution system at various locations. For example, in a general study of conditions in the first high service, 48-hr. runs were made to include a Sunday and Monday, during which time was observed not merely velocities in the mains at the pitomter vaults but also pressures at chosen points, pumpage at Division and Fairmount stations into the first high service district, and changes in flow line in the first high service reservoir at Kinsman. Such a run was made on the first day of the general strike in the steel mills in the fall of 1919 when the industrial demands for first high service water suddenly dropped. This run was repeated under conditions of normal industrial demand and again when the hot weather domestic demand had reached a peak.

Existing Conditions as to Pressure—Inspections of 30 recording pressure gages at the fire stations are made at intervals by A. G. Siedle, engineer of waste detection, and charts from the various engine houses are now mailed in once a week directly to the Division of Water.

Pressures are usually at a minimum about 9 a.m. and for each engine house gage a graphical record is kept of pressures at this time, month by month, showing the average pressure at 9 a.m. and also pressure at this time on the worst day of the month. The yearly average pressure at 9 a.m. on the same diagram shows the tendency to improve or otherwise as the years go by, and a line giving static pressure from the reservoir is of value for comparison with the actual, which latter may be higher than static, if it gets direct friction through long lines. These data are of assistance in deciding upon extensions of the distribution system and as first hand evidence when complaints come in on account of poor pressure.



POPULATION OF CLEVELAND—COMPARISON OF CENSUS FROM VARIOUS SOURCES

Population by Districts—On one of the drawings are shown population curves for Cleveland from the U. S. Census, from the Cleveland Board of Education, from the Board of Elections, from the Cleveland Telephone Co. and from other sources. The Board of Education multiplies its returns for all parts of the city by 4.25 to give total population.

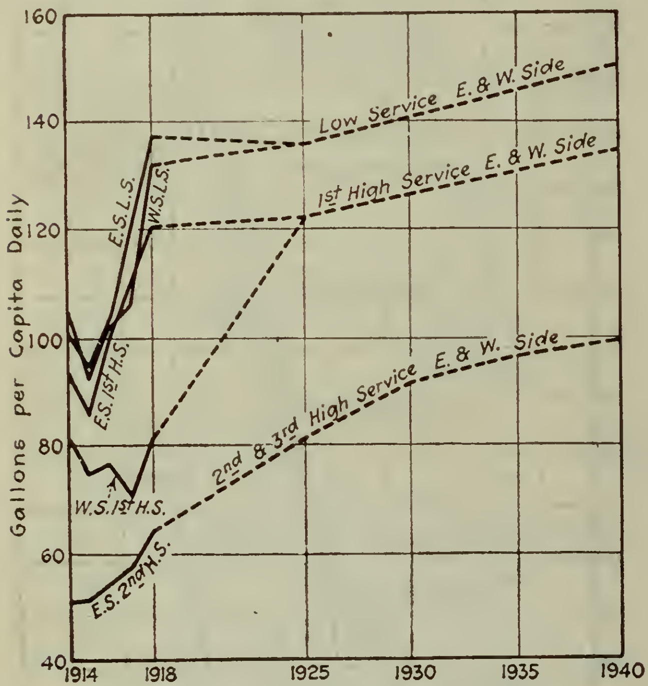
Somewhat similarly the Board of Elections' population curve is based on the number of registered voters year by year, which varies greatly from one election to another. The curves which have been plotted from the results of the Board of Elections vary so much that they are of doubtful value. The Board of Elections uses a separate factor for each ward by which it multiplies the number of registered voters to give total population.

The Cleveland Telephone Co. made careful population estimates for Cleveland, its various parts and outlying

suburbs, for the years 1916 and 1932. The results of the U. S. Census have been given especial weight in the curves adopted, and yet at the same time it is felt that these figures are too low.

In 1917 Cleveland contained, as now, 26 wards, and for each of these wards population curves were drawn, superimposed as obtained from the Board of Education, Board of Elections, the Cleveland Telephone Co. and the U. S. Census. For each of these 26 wards a curve was adopted, guided by the other four curves mentioned, and giving such populations for each ward year by year from 1890 to 1940, that for each of these 51 years the populations from the 26 curves total up to the same figure as given by the total curve.

Determination of future suburban population was guided in large degree by consideration of density or population per acre. In a rough way, taking the eight West Side



WATER CONSUMPTION BY DISTRICTS

wards, the product of the "distance from the center of a ward to the public square" times its "density of population" is a constant, the equation of an equilateral hyperbola. Similarly, for the 18 East Side wards another constant holds good in a rough way. By adopting fractional exponents for D and P in the equation D (Distance) $\times$ P (Density of Population) $=$ C (Constant), the rule was found to work better but the attempt to apply it to the suburban regions gave results varying too widely for areas so large as the groups of villages we had adopted. Drawings were prepared showing by different colors the groups of villages, their population and density for 1918 and 1940. Similar figures for each of the 26 Cleveland wards on the same map permit of comparison of adjacent or various regions and indicate the trend of growth.

Consumption by Districts—The pumpage per day per inhabitant increased with some variation from 101 gal. in 1890 to 172 gal. in 1901. At this latter time installation of meters was commenced, and when in 1909 the city had become practically entirely metered, the per capita consumption was found to have decreased quite uniformly to 94 gal. daily. Since 1909 the per capita consumption has gradually increased to 116 gal. daily in 1917. In 1918 it was 137.5 gal. daily due to the night and day operation of factories at top speed for war orders. In 1919 instead of dropping back to normal level, it remained at 130 gal. daily, and conditions so far in 1920 indicate a continued rise as compared with last year. The studies which have determined the actual rate of consumption in all parts of the city for a period of 5½ years just ended indicate unmistakably a growth in per capita consumption of water both in domestic and in industrial use. The former seems reasonable in that new houses have better facilities as to bath tubs and other conveniences than many of the houses in the older parts of the city. Factories use 60 per cent of the total consumption in the city, and all things point toward Cleveland's continuing to be a city of many large and diverse industries.

The low service district, now roughly 50 per cent of the total supplied by area and 80 per cent by volume of water used, will in a few years receive pressure from Baldwin reservoir instead of from Fairmount reservoir as now, producing an increase in head of 55 ft. or 24 lb., tending to increase both legitimate use and leakage. Being guided by these considerations we have prophesied a gallons-per-capita-daily curve for the future increasing uniformly from 130 in 1919 to 150 in 1940. This is an average for the total population supplied. Different values for this figure have been used in the different parts of the city in forecasting future demands, the forecast being guided by the recent past results.

Knowledge of per capita consumption combined with population gives a knowledge, for any year, of average daily demand. The following table shows past relation between the average and maximum daily demands:

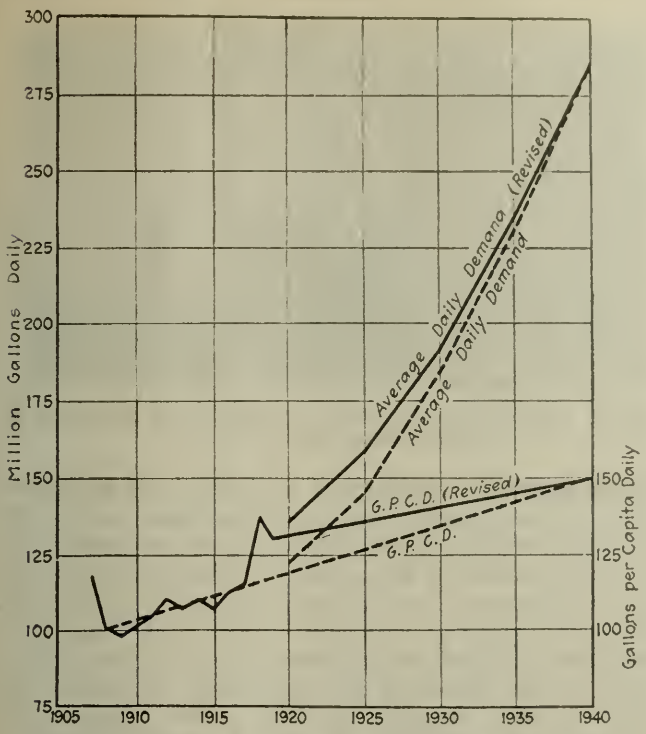
Year	Daily Pumpage. Max.	M.g.d.	Ratio	Year	Daily Pumpage Max.	M.d.g.	Ratio
1900	88.5	67.1	1.32	1910	92	61.0	1.51
1901	89	69.6	1.28	1911	100	65.7	1.52
1902	93	69.95	1.33	1912	91	73.1	1.25
1903	92	62.0	1.48	1913	107	76.8	1.39
1904	107	61.6	1.74	1914	111	82.0	1.35
1905	93	60.4	1.54	1915	111.5	80.0	1.395
1906	86	59.0	1.45	1916	127	95.65	1.33
1907	79	58.9	1.36	1917	146	103.9	1.405
1908	79	52.0	1.52	1918	177.5	123.6	1.44
1909	09.5	52.8	1.51				
						Average	1.43
						Use	1.50

The forecasts of future pump installations required have been made on the basis that in each service district there would be enough reservoir capacity to care for maximum hourly fluctuations. It was believed that, as a matter of safety, it is advisable to carry reservoirs at least to this point, and as work on installations continues, detailed studies will be made of each separate problem to determine the maximum economy as between money spent for reservoirs and that spent for pump installations.

To determine the actual rate of consumption in the various parts of the city, and the variations in these rates from time to time, a water consumption ledger was initiated in the spring of 1917 by the writer. In this were entered figures of actual consumption of water from the meter reading books for six-month periods, showing winter consumption separate from summer; large connections 1 in. and over, separate from those smaller, thus practically separating industrial from domestic use; and keeping consumption separate as between the different service districts. A continuous record of 5½ years from 1914 to 1919 has been summarized, keeping the service districts separate, and showing for this period a summation of consumption by wards as indicated by the meter readings.

Factors between station pumpage and consumption as indicated by meter readings averaged for the low service district 1.173, for the first high service 1.321 and for the second high service 1.471.

Another study shows gallons-per-capita-daily figures for each ward, year by year from 1914 to 1919, "large" and "small" connections separate, and the total of the two. The consumption indicated by meters was multiplied by the proper factor for the six-month period and the service district, to give corresponding station pumpage needs. This set of sheets showed that Ward 9, which contains the congested downtown business district, has a much higher per capita consumption than any other ward. It was therefore kept separate, in the analyses of future demands for water, from the rest of the East Side low service.



FUTURE TOTAL AND PER CAPITA CONSUMPTION

The next study gave the story of past performances of gallons-per-capita-daily station pumpage required for each service district east and west of the Cuyahoga River, and in each case what proportion it was to the gallons-per-capita figure for the entire city; and finally, graphically, were shown the estimates adopted for the future behavior of these quantities and ratios up to 1940.

For each of the years 1925, 1930, 1935 and 1940, by combining these chosen values of per capita consumption with the population in each service district east and west of the river, the corresponding demands for water were obtained.

In 1940 maximum daily demands for water will have reached the following figures:

	East of River M.g.d.	West of Rive M.g.d.
Low service	135.3	69.0
First high service	37.7	75.6
Second high service	49.3	7.8
Third high service	4.3	2.0
	226.6	4 4
Ward 9 low service	49.8	
Total	276.4	
Total East and West side		0 4

The maximum daily amount pumped from the lake to date has been about 170,000,000 gallons.

The Resultant Program — The figures obtained have demonstrated the necessity of having ready for use prior to 1930 a third intake crib and tunnel of a capacity of 165,000,000 gal. daily located at the eastern extremity of the city, with pumps and filters installed at first up to a capacity of 75,000,000 gal. daily, and land acquired at the outset and laid out so as to provide for ultimate extension to the full capacity of the tunnel.

Just prior to 1940 a fourth intake and tunnel of 165,000,000 gal. daily capacity must be ready for service farther west than the Division station, with pumping station and filtration plant built at first only to half capacity. Both of these stations will pump some water to the first high service, and the new East station will pump some direct to second high service. The East Side second high service reservoir will have to be increased in capacity; and a West Side first high service reservoir constructed, from which a relatively small amount of water will be boosted to a reservoir for second high and to a standpipe for third high service.

The studies have enabled a logical determination to be made of the successive pump installations needed at the four lake pumping stations, and at the inland booster stations, on both the East and West Sides of the city, to care for maximum daily demands. As pump installations are actually made, attention is paid to providing pumps in reserve, and consideration has also been given to providing enough extra pump capacity so as to be able to supply the entire demands in 1940, with any one of the four shore stations out of use temporarily, at a time of average demand. The knowledge obtained as to past and probable future demands for water in various parts of the city and country, also, has enabled computations to be made determining the size, location and time of installation of the necessary additional large pipe lines to connect up the numerous pumping stations, filtration plants and reservoirs as they are built and enlarged. The estimate of cost of the additional facilities needed in the next 20 years, exclusive of the ordinary growth of the distribution system, runs to about $30,000,000, of which one-third is to be expended within the next five years.

Waterways Contracts To Guarantee Wages and Prices

An AGREEMENT by which the state will absorb 80 per cent of any increase above scheduled prices and wages is contained in the contract for structures for the Illinois Waterway. In case there is a decrease below the scheduled figures the state and the contractor will share equally in the saving.

If an increase in freight rates occurs, which increases the cost of materials, the state will absorb the entire increase. The base prices and wages are as follows:

WAGE SCALE

Occupation	Hourly Rate	Occupation	Hourly Rate
Blacksmith	$0.70 to $0.75	Machinist	$0.80 to $0.85
Blacksmith helper	.60 to .65	Machinist helper	.60 to .65
Boilermaker	.75 to .80	Oiler	.55 to .60
Boilermaker helper	.60 to .65	Pipe fitter	.70 to .75
Brakeman	.52½ to .57½	Pipe fitter helper	.60 to .65
Carpenter, fine	.95 to 1.00	Pump man	.60 to .65
Carpenter, rough	.70 to .75	Rigger	.60 to .65
Carpenter, helper	.60 to .65	Steel setter	.75 to .80
Derrick runner	.70 to .75	Teamster	.55 to .66
Dinkey runner	.60 to .65	Team and driver	1.00 to 1.10
Drill runner	.60 to .65	Truck driver, heavy	27.50 to 30.00 a week
Electrician	.80 to .90		
Electrician helper	.60 to .65	Truck driver, light	25.00 to 27.50 a week
Fireman	.55 to .60		
Labor, special	.55 to .60	Watchman	$100 to $110 a month
Labor	.50 to .55		

PRICE SCALE

Cement at $1.85 per bbl., net, f.o.b. cars Marseilles.

Concrete material, consisting of coarse and fine aggregate, all sizes, and of bank run gravel, at $1.05 per net ton, f.o.b. cars or boat, Marseilles, weights made by the Western Weighing Association to govern.

It is understood that eight hours shall constitute a standard day's work. Overtime in excess of eight hours shall be rated as time and one-half, and Sundays and legal holidays shall be rated as double time for wages.

Ter Meer Sludge Dewaterer at Milwaukee

At the Milwaukee sewage testing station a Ter Meer centrifugal sludge dewatering machine from Hanover, Germany, was put in operation for experimental purposes in October. T. Chalkley Hatton, chief engineer, Milwaukee Sewerage Commission, in speaking of it at the recent convention of the American Society for Municipal Improvements stated that in a preliminary test a cake 4 in. thick had been obtained and that so far the machine is giving a satisfactory product. Mr. Hatton stated that the sludge varied greatly between summer and winter as to colloid content, making the operation of any press uncertain. He had therefore employed an expert in colloidal chemistry to study the colloids in sewage with a view to their control.

Well Points Used in Excavating For Beach Resort Hotel

Water Removed From Sand by Pumping Made More Difficult by Tidal Action—Costly Use of Sheet Piling Avoided

By Frank P. Kemon
Stapleton, Staten Island, N. Y.

WHAT is believed to be the most extensive excavation in quicksand ever attempted without the aid of heavy steel and timber sheet piling was successfully handled by the well-point pumping system in connection with the erection of the sixteen-story Ambassador Hotel Annex at Atlantic City, N. J.

Owing to the scarcity of steel sheet piling and the short time allotted the contractor in which to perform his contract, it became necessary to devise some means, other than that ordinarily used. The well-point pumping system was decided upon as the only method by which the work could be completed within the allotted time. James V. Ferry, treasurer of James Ferry & Son, Inc., contractors for the excavation and foundation work, who had had previous experience with the well-point pumping system, decided upon its use in this particular case.

The excavation generally was 150 ft. by 300 ft. by 18 ft. deep, and 24 ft. in machinery and elevator pits. Surface water was encountered about 3 ft. below the street level and tidewater about 10 ft. below the street level.

The pumping plant consisted of a 4-in. pipe line, laid on all four sides of the proposed excavation and about 6 ft. outside, tapped every 4 ft. throughout its entire length with 2-in. nipples and tees, connected to right- and left-hand hexagon nipples. These were connected to a 2-in. flexible metallic steam hose, in turn connected to 20-ft. sections of 2-in. pipe and finally leading to 6 ft. well points. The 4-in. pipe line was laid about 2 ft. below the street level and a number of plugs and tees were installed to dig elevator and machinery pits after general excavation had been done. A number of shut-off valves were also installed, so that any part of the main line could be cut off and greater pumping capacity concentrated at any point where it developed that it was needed. The main line was connected to four triplex pumps, one at each corner of the excavation, duplicate pumps being installed so that repairs could be made without having to stop pumping.

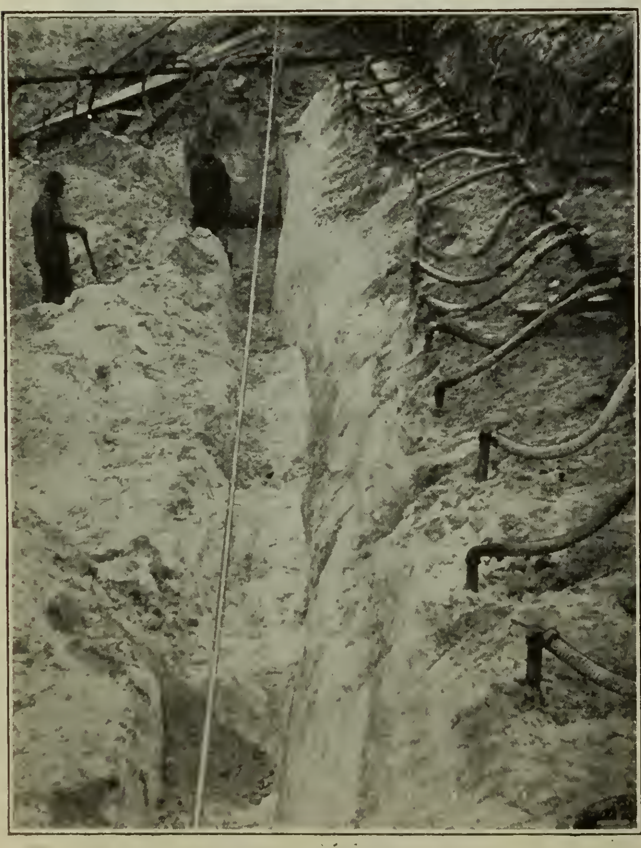


FIG. 1. WELL POINT INSTALLATION FOR AMBASSADOR HOTEL ANNEX

FIG. 2. EFFICIENCY OF WELL POINT SYSTEM INDICATED BY VERTICAL SAND WALLS

The 26-ft. well points were jetted into place with a 3-in. water line and the entire plant was started about a week ahead of excavation. Pumping was kept going constantly for three months after the concrete walls were finished. So successful was the system that men were able to work throughout the winter of 1919-20 in the excavation without boots. The absence of water allowed accurate tests to be carried on for determining the bearing quality of the soil. The use of piling, originally intended for the foundation, was entirely eliminated.

In order to test the bearing power of the soil a sand bin was constructed of 2-in. x 10-in. timbers with supporting legs of timbers 12 x 12 in. The bin was made 7.94 ft. long, 7.65 ft. wide, and 13½ ft. high, and successively loaded. The initial loading was 2,250 lb., the second 8,531 lb., and thereafter approximately 3,300 lb. were added in twenty-seven different stages. Readings were taken upon four nails originally set at the same elevation at the base of the bin, after each new loading. Twelve loadings and readings were made the first day, twelve the second, and five the third day. The total average settlement under a total load of 96,500 lb. was 1½ in.

The well point pumping system was kept in operation until the substructure walls and floors had been heavily waterproofed and until the permanent drainage system had been installed. The permanent drainage system consisted of the laying of a network of 6 in. porous tile pipe in gravel-filled trenches and all leading to a sump where a pump was installed with a connection to the sewer.

The hotel annex was erected at a cost of $1,500,000, Warren & Wetmore being the architects and the Thompson Starrett Co., general contractors.

Hints on the Writing of Engineering Reports

Projects Must Be Explained in Terms Which Business Man as Well as Technical Expert Can Understand

By Daniel W. Mead
Consulting Engineer, Madison, Wis.

> Speaking informally before a group of Wisconsin engineers some months ago, Mr. Mead emphasized certain fundamentals in the preparation of engineering reports. In the belief that an amplification of his remarks would be valuable, not only to the young and inexperienced engineer, but also to the older members of the profession who commit many sins of omission and commission in report writing, "Engineering News-Record" has induced Mr. Mead to prepare the accompanying article. He has had such a wide experience in the investigation of new projects that his advice on how best to present the results of such work merits careful reading.

PRELIMINARY to the preparation of an engineering report, the principal matter to be considered is the correct solution of the problem under investigation. It is a fundamental necessity that the engineering examination be so complete and the data so thoroughly studied as to result in the formation of clear and intelligent conclusions on the manner in which the development of the project should be accomplished and on its feasibility as a business venture. After this solution has been reached the important matter to be kept in mind in the presentation of the subject in the report is the capacity of the parties for whose understanding of the project the report is prepared.

When the report is prepared by an engineer for his superior, or for other engineers who are familiar with many of the details of the project discussed, it may be unnecessary and undesirable to do more than discuss that phase of the subject which has been submitted for examination. Under such conditions the report may deal solely with details in as technical a form as the understanding of the parties for whom it is written may make desirable. In any event, the men who are to read and understand the report are to be kept constantly in mind and their knowledge of the situation and their understanding of the subject should modify both the manner and the detail in which the subject is treated.

New projects, such as water power or industrial developments, irrigation, drainage, flood protection, or other similar matters, involve not only the solution of numerous intricate problems but also their explanation in a clear, logical and convincing manner to an audience of varied degrees of interest and understanding. These interested parties include the projectors and various others who may be interested as part owners of lands or investors in the property or in the securities to be issued for its development, bankers or financial investors who may contemplate furnishing the funds for construction and the engineers who may be called upon to examine into the manner and methods of development, the plans proposed and the general feasibility of the scheme outlined in the report. In such cases the preparation of the report becomes more complicated, as it must be both elaborated and simplified so as to be made available for the understanding of all those interested in any of its phases.

Under such circumstances the needs of all the various readers should be clearly kept in mind and the report so prepared that the kind of information sought by each reader will be readily available. Commonly the banker or financier can know little of the technical details of a project and will seldom attempt to acquire such detailed knowledge. He will base his judgment of the project on his confidence in the opinion of the expert who has made the investigation or whom he may have chosen to examine the property and pass on its feasibility. He is particularly interested in the conclusions, and commonly confines his attention largely or entirely to the final opinions expressed. For this reason it is usually desirable that such conclusions be explained in a concrete and condensed form embodied in a page or two of the report and as a part of its closure. It is sometimes found more satisfactory to embody these conclusions or findings in a brief introduction to the report, as a part of the letter of transmittal.

When such a report is intended to appeal to business men, projectors or investors in the proposed project, the body of the report should be written with these parties in view. There are few projects of this kind which are so complicated that they cannot be explained in simple and untechnical language, so that any good business man can understand the basis for the conclusions and their validity. An exception may be made for some of the technical features, for which the business man must depend upon the integrity and ability of the experts who have made the original investigation or those who have been called in to review the same. For these reasons purely technical details, as a rule, should be omitted from the main body of the report and the project should be presented clearly and logically and simplified as far as possible.

The third class of readers for whom such a report must be prepared comprises the technical experts who may be called in by the financial interests to pass upon the correctness of the conclusions drawn and the general feasibility of the project. These men are necessarily interested not only in the explanation of the project as a whole and the conclusions arrived at by the authors of the report, but also in the technical features on which the conclusions are based. It is therefore desirable for the benefit of such experts, and in order to save time and expense in the investigation, that there should be attached to the report, in the form of appendices, a presentation and discussion of technical details so complete that the technical advisers

may ascertain without unnecessary research all the data on which the conclusions are based, their source and reliability, the scientific basis on which the conclusions are based, and the principles on which the conclusions depend. Formulas used and methods of computation, especially where more than one method might possibly be used, should be given, and the solution of complicated problems should be shown at least in general outline.

Form of Presentation

Photographs, drawings and diagrams are frequently helpful in the description of locations and material conditions. All illustrations should be clearly made, properly titled and so numbered or lettered that they may be referred to definitely in the text and may be found easily when reference is made. In the main report side or center headings should be so frequently used as to indicate clearly the subject discussed in each section. A table of contents should be included, giving in proper order the page where each subject is discussed, the appendices and their sub-headings, and the list of illustrations and tables.

If the project is sound, its presentation in the manner suggested should not be difficult, provided that the engineer on his part can offer a satisfactory solution. Failure to arrive at clear and definite conclusions, or to make plain to the business man the methods of solution and the advantages to be derived, will render the consummation of the project doubtful. A failure to give the fundamental data on which the conclusions are based—or at least to point out their source—may involve large and unnecessary expense and delay and possibly unfavorable reports from experts who might otherwise accept and confirm the conclusions reached.

A careful preparation of a report in the manner outlined above will greatly facilitate the understanding of the project on the part of all those who may be interested and will result in a considerable saving of time, energy, and expense in the preliminary stages of promoting and financing a project.

Advantages of Lining Irrigation Canals

In the report making recommendation as to methods and designs suited to conditions on the proposed Columbia Basin irrigation project, the commission advises that the supply canals be lined with concrete and gives the following reasons for this decision: (1) Such lining permits the use of higher velocities than could be allowed in earth canals. (2) The higher velocity permits the use of smaller cross-sections with less expense for excavation. (3) A smaller cross-section of canal is practical to construct on hillsides where a larger canal might be impossible. (4) Lining reduces the seepage losses to a negligible amount. (5) The low maintenance of a lined canal is much less than that of an unlined canal. (6) The volume of water in the canal is comparatively small and easier to dispose of when shutting down. (7) Concrete lining permits the use of a section with highly desirable hydraulic properties and maintains the banks so as to retain those qualities. (8) Concrete lining avoids the perforation of banks by burrowing animals, the erosion of the banks by wave action in the canal and the growth of brush and weeds where they will interfere with the flow of the water.

Diagram to Determine Horsepower of Gasoline Engines

Eight Years' Experience in Selecting Engines for Dragline Excavators Indicates Swedish Formula Best for Purpose

By C. E. Lounsbery
Assistant Engineer, U. S. Reclamation Service, Denver, Col.

IN SELECTING a gasoline engine for use in construction plant or for similar purposes, special attention should be given to the power requirements, since both over-powered and under-powered engines are uneconomical. There are two methods of selecting an engine. One is to calculate the horsepower by some formula involving the dimensions and speed of the engine and then select an engine having the required dimensions and speed. The other method is to select from a manufacturer's catalog, relying on the power as rated therein. For the first method, one is confronted by various empirical formulas which do not check each other. For the second method, it will be found that the rated horsepowers given by manufacturers mean very little. A conservative manufacturer will base the rated horsepower on continuous operation over long periods of time, while a liberal manufacturer will base it on that developed by the Prony brake test during a trial run. Frequently the catalog fails to give the speed upon which the rated horsepower is based.

In general it is best to adopt a formula for use in selecting engines. There are numerous empirical formulas used to calculate horsepower, most of which are accurate enough under certain running conditions and for certain types of engines, but are not suitable for general field use. The three most worthy of mention are the following:

(1) The S. A. E. (Society of Automotive Engineers) formula,

$$b.hp. = \frac{D^2N}{2.5}$$

(2) The British formula,

$$b.hp. = 0.45(D - 1.18)(S/D)$$

and

(3) The Swedish Royal Automobile Club's formula,

$$b.hp. = \frac{D^2SnN}{C}$$

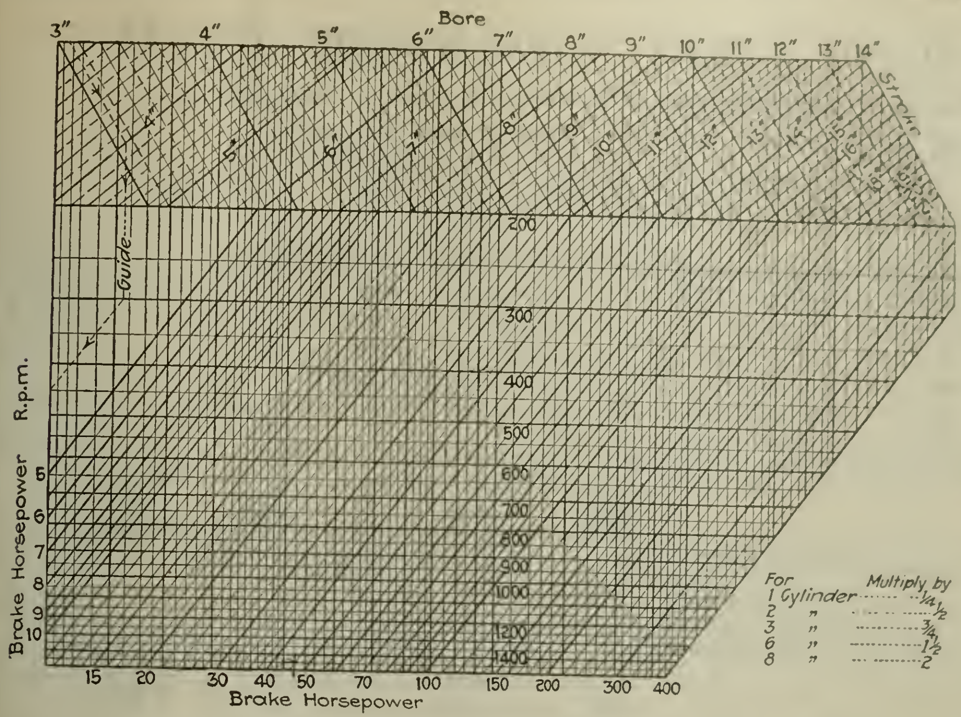
In the above formulas $b.hp.$ = brake-horsepower; D = bore in inches; S = stroke in inches; n = number of cylinders; N = number of revolutions per minute; C = a constant.

The first (S. A. E.) formula is a good example of those which are suitable for certain specific conditions. The form shown above is a reduction from

$$b.hp. = \frac{PASnE}{33{,}000 \times 4}$$

considering a four-cycle engine, in which $b.hp.$ = brake-horsepower; P = mean effective pressure per square inch; A = area of piston in square inches; S = piston speed in feet per minute; D = number of cylinders; E = efficiency of the engine.

The latter form embodies all factors necessary for the calculation of horsepower, but is difficult to use



BRAKE HORSEPOWER FOR FOUR-CYLINDER GAS ENGINES

because the mean effective pressure and the efficiency must be assumed. The reduced form makes these assumptions as well as the assumption for speed. The assumptions made are (1) that all automobile engines will deliver their rated horsepower at a piston speed of 1,000 ft. per minute; (2) that the mean effective pressure is 90 lb. per square inch, and (3) that the mechanical efficiency of the engine is 75 per cent. At the present time most automobile engines deliver their maximum power at a piston speed of about 1,500 ft. per minute. Certain assumptions must be made also for the British formula.

The Swedish formula is adapted to any type of engine. Its value lies in the fact that it takes account of the cylinder dimensions and the speed, which makes it possible to compare engines upon a rational basis. In the original formula, the value of C was taken as 15,240. The modern engine, due to improved design and construction, is much more efficient than the earlier engines, which has led to the adoption for C of a value of 13,000 for four-cycle engines and 10,000 for two-cycle engines. These values are recommended in the 1918 edition of Dyke's *Automobile and Gas Engine Encyclopedia.*

This formula gives the approximate horsepower which the engine should develop when new, as shown by the Prony brake test. After a period of use the engine will become less efficient, due among other things to wear and deposits of carbon, and will not deliver the calculated horsepower during long periods of continuous operation. This fact must be considered in selecting an engine.

Engineers of the U. S. Reclamation Service have adopted the Swedish formula, and have reached the conclusion that an engine should show by this formula a rating 25 per cent in excess of the power actually required. This value is chosen arbitrarily and should not be taken with too much assurance. The experience of the engineers of the Reclamation Service has extended over a period of about 8 years. During this period dirt moving machines of various kinds have been operated at isolated points in the West but the greater part of their experience has been with drag-line excavators. These machines operate under severe conditions, often running three eight-hour shifts per day for six days in the week. This service requires efficient, well-built engines of the heavy-duty type.

The accompanying diagram was made for four-cylinder engines, using the Swedish formula with a value for C of 13,000. The range in sizes is from 3 x 3 in. to 14 x 21 in.; in speed from 200 to 1,500 r.p.m. and in horsepower from 5 to 400. On the right-hand side of the diagram are given factors by which the horsepower for a four-cylinder engine may be multiplied to obtain that for one-, two-, three-, six- and eight-cylinder engines. For example, suppose it is desired to find the horsepower of a six-cylinder engine having a 6½-in. bore and 8-in. stroke, running at 500 r.p.m. Enter at the top of the sheet with 6½ and follow the line to the right and down till it intersects the stroke line 8 running diagonally in the opposite direction. Follow vertically downward from this point until the horizontal (r.p.m.) line marked 500 is intersected. From this point follow to the left and down, estimating between lines, and read at the bottom, 52 hp. At the right of the diagram find the factor to be applied for a six-cylinder engine. Multiplying 52 by the factor 1½ gives 78 hp. which the engine should develop by brake test. This engine should reasonably be expected to develop about 62 hp. under severe working conditions.

The diagram was drawn for four-cylinder engines because the writer was particularly concerned with engines of that class. Probably it would be easier to use if it were drawn for a one-cylinder engine. The factors to be applied for other numbers of cylinders would then be whole numbers instead of fractions.

An important point which arises is the speed at which it is advisable to run an engine. Heavy-duty engines should not be considered in the same class as the automobile type and should run at slower speed. The Reclamation Service engineers are conservative in this respect, and limit the piston speed of heavy-duty engines to from 700 to 800 ft. per minute.

New National Park Dedicated

The formal dedication of Zion National Park, Utah, created by Congress Nov. 19, 1919, as the nineteenth member of the National Park System, was carried out recently with Stephen T. Mather, director of the National Park Service, presiding. The new park is in extreme southwestern Utah and is reached from both Salt Lake City and Los Angeles by the Salt Lake Route to Lund.

A Study of Rapid Transit Station Design—Part II

Good and Bad Features in Arrangement of Platforms and Street Approaches—Dimensions and Capacities that Have Been Found Satisfactory

By Olof A. Nilsson
Designer, Transit Construction Commission
New York City

THE trend of development in station planning since rapid transit has become one of the important factors in the life of modern metropolitan cities will be apparent from a comparison of the earlier and later designs as shown in the accompanying illustrations.

Paris has a rapid transit system consisting of a number of independent two track lines, traversing the city in different directions. The first line, 6.4 miles in length, was opened for traffic in July, 1900. The lines all have loop-ends, permitting the trains to run continuously back and forth and around the loops without the use of switches and cross-overs. For the most part these lines are built underground with stations as close to the surface as the method of construction and the topographic conditions allow. The standard platform length is 246 ft. and the width (of side platforms) about 13.5 ft. Intermediate stations are generally of the side platform type, while most of the end stations have island platforms. The latter have also, in general, separate stopping places for loading and unloading, so that incoming and outgoing passengers are kept separate from train to street.

The simple arrangement of intermediate stations is indicated in Fig. 13. There is one stairway from the street, 10 to 13 ft. wide and common for both entrance and exit. This stairway leads to a lobby, where tickets are bought, and from the lobby a passageway and two stairways, all about 9 ft. wide, communicate with both platforms. Reasons of economy and a desire to avoid obstructions in the streets and public squares apparently originally determined the use of only one entrance to each station. On August 10, 1903, however, an accident took place near a station, which cost the lives of 84 passengers. This great loss of life was caused by the fact that the station lights were extinguished and the passengers were unable to find their way to the only exit of the station. After this a second entrance was built at some of the stations with heavy traffic, and other safeguards were provided to prevent the recurrence of a similar accident.

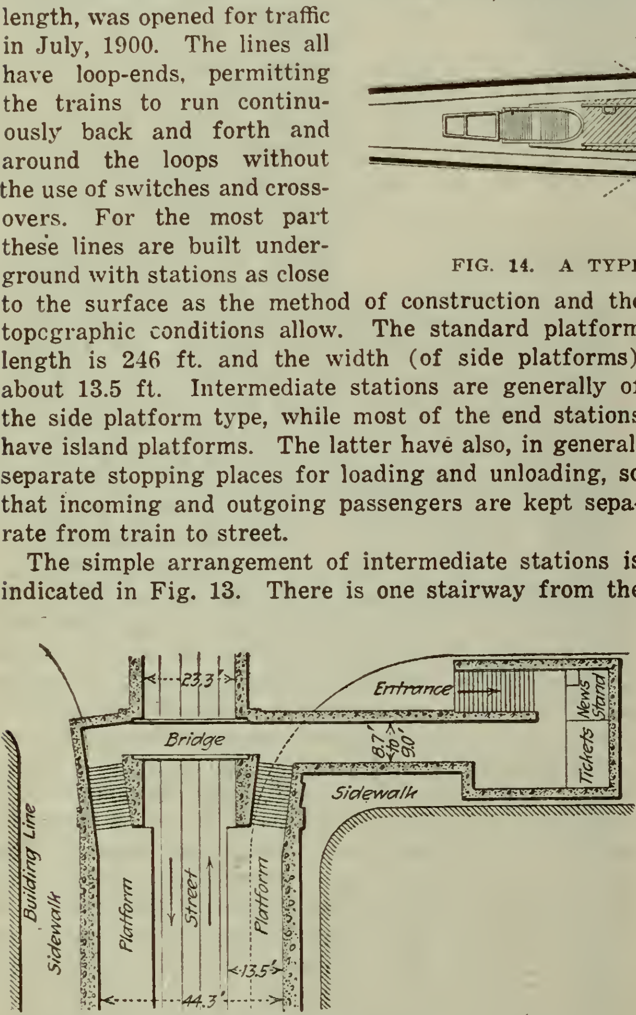


FIG. 13. TYPICAL STATION OF THE PARIS SUBWAY STATION

At some points, where two lines on the same level join, stations are built side by side forming a twin station with one island and two side platforms. Transfers between trains using the island platform is made direct across the platform, while passengers who land on the side platforms must make use of a mezzanine, located at one end of the platform, to effect a transfer. At other points where two lines meet—either on the same or on different levels—the stations are built separate, but near together, and communication is established and transfers made possible by means of stairways and passageways. Where three lines meet or cross there is a similar arrangement but naturally much more complicated, with greater inconvenience to transferring passengers. On this system the passenger traffic is many times as heavy as was anticipated when the plans were made, and during the busy hours of the day the platforms at the most important stations are uncomfortably crowded.

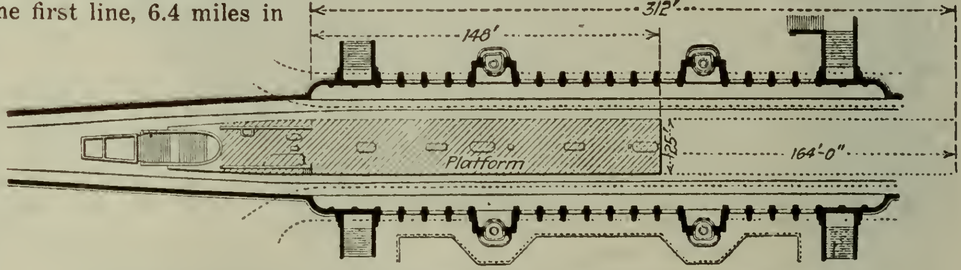


FIG. 14. A TYPE OF INTERMEDIATE STATION ON BERLIN SUBWAY

The general type of intermediate stations on one of the additions to the rapid transit system of Berlin, the Schöneberg subway, is shown in Fig. 14. This is a two track line, which was opened for traffic in December, 1910. The stations, of the island platform type, have platforms 25 ft. wide and entrances at the ends through stairways 13 ft. wide to the middle part of the street. They were planned to be built in two stages, the first part only, as shown in full lines, to be completed at the opening of traffic, the second part, shown in dotted lines, to be added when necessitated by the growth of traffic. The first part of the station with a platform length of 148 ft. accommodates a train of 3 cars; the completed station has a platform 312 ft. long and accommodates a 7-car train. The middle part of the platform is occupied by various stands and enclosures for station attendants, newspapers, etc.

Boston has a rapid transit system consisting of subways, elevated railroads and surface lines, all combined into one system with one fare and free transfers at all stations where different lines meet. The first under-

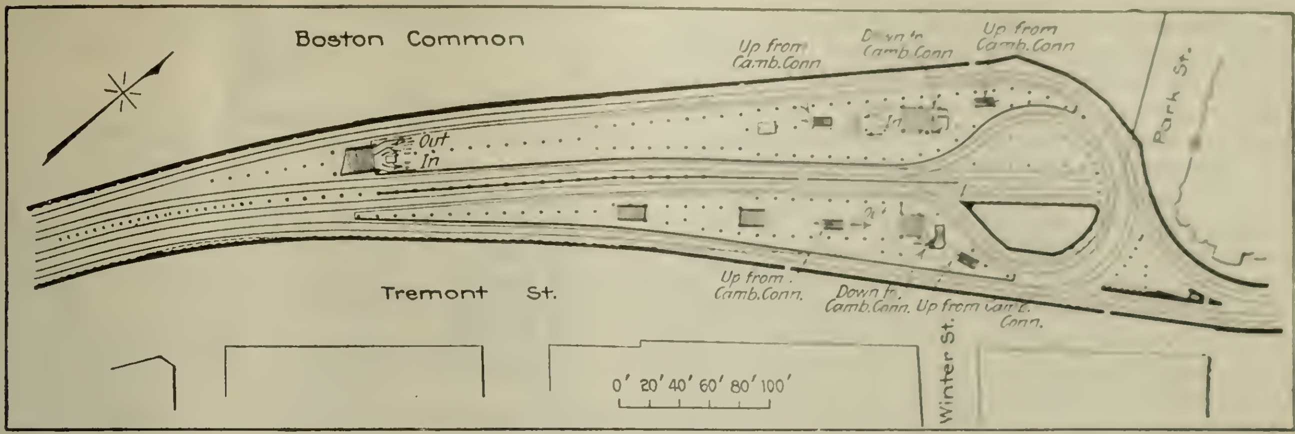


FIG. 15. PARK STREET STATION ON BOSTON SUBWAY

ground link in the system was the Tremont St. subway for surface cars, which was opened for traffic in 1897; the latest addition is the Dorchester Tunnel, which was completed to Andrew Square in 1918. The surface lines running into different cities and towns surrounding Boston are linked up with the subway and elevated lines at a number of points by transfer stations which have been designed to facilitate as much as possible the transfer of passengers between the surface and the subway or elevated lines.

The busiest station on the system, the Park St. underground station at the intersection of the Tremont St. subway and the Cambridge-Dorchester tunnel is shown in Figs. 15 and 15a. The lower level station, for Cambridge-Dorchester trains, is 350 ft. long and has two side platforms for unloading and one island platform for loading. The former are 10 to 12 ft. wide, the width of the latter varies from 18 to 30 ft. tapering from the center toward the ends. The upper level—for the Tremont St. surface cars—has two island platforms the outlines of which are indicated in the illustration Fig. 15a. Each track has berths for eight cars along the straight portion of the platform. The east platform (exclusive of stairways) contains about 9,625 sq.ft. and the westerly

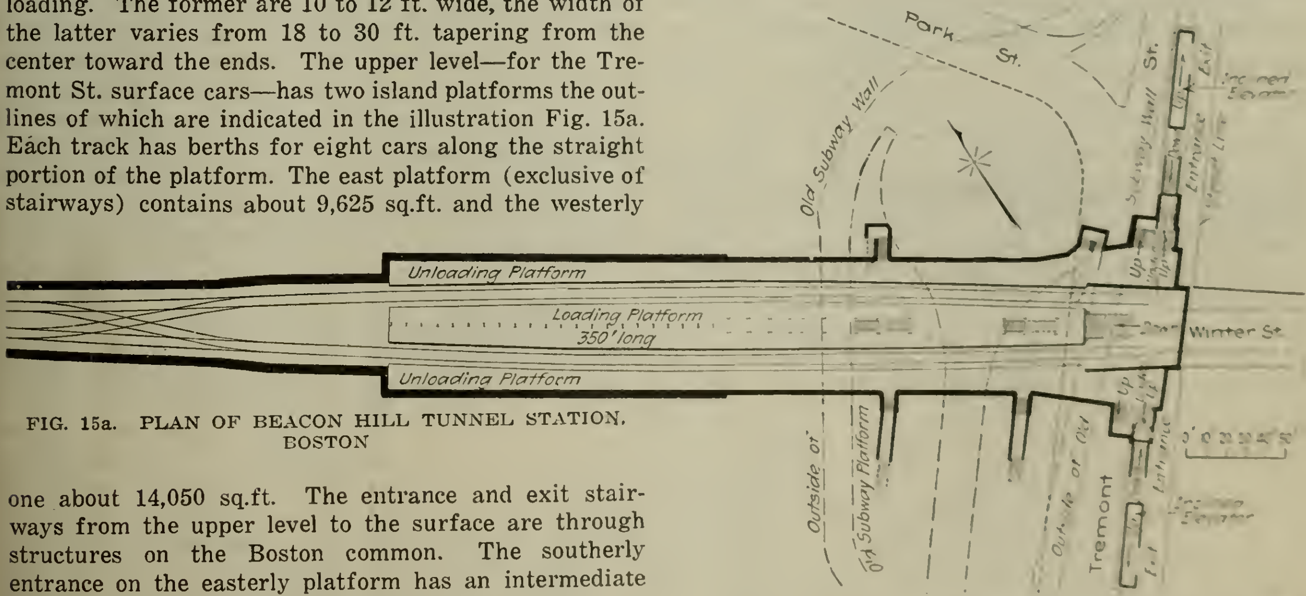


FIG. 15a. PLAN OF BEACON HILL TUNNEL STATION, BOSTON

one about 14,050 sq.ft. The entrance and exit stairways from the upper level to the surface are through structures on the Boston common. The southerly entrance on the easterly platform has an intermediate lobby or mezzanine above the platform for the control; on the other entrances the control is on the platform. The lower level has an entrance lobby at its easterly end just east of the Park St. structure with stairways to the street and from the unloading platforms, ticket control and a wide stairway to the loading platform. From both unloading platforms there are escalators to the street surface. For direct transfer between the two stations there are six stairways, one from each platform on the lower level to each one on the upper.

The Broadway transfer station on the Dorchester tunnel, Fig. 16, is built as a two level island platform station, the lower level for subway trains and the upper one for surface cars, which are here depressed below the street. Stairways in the center of the island platforms provide direct communication between the two levels. At the northerly end of the lower level platform there is an escalator to a landing just below the street surface. From this landing (connected through a ramp to the upper level or lobby platform) stairways lead to an island platform for surface cars which are not depressed. This platform is protected by a steel and wood shelter and is a prepayment station for passengers entering at this point. Thus passengers may transfer between the cars on any of the three levels.

The present terminus of the Dorchester tunnel, the Andrew station at Andrew Square, is shown in Fig. 17. Instead of depressed surface tracks with direct connection between surface and subway cars as in the previous illustration this transfer station has the platforms for the surface cars at the street level and connection to the subway platform below is provided by a subsurface mezzanine floor. The surface station, enclosed within a one story building 115 ft. wide and 297 ft. long, has an island loading platform and two side platforms for unloading. From these three platforms stairways lead down to the mezzanine, which by passages and stairways

communicates with the subway platforms below. There is also an escalator from the southbound subway platform to the loading platform on the street level. The general passenger movement being from the unloading platforms in the surface station to the northbound subway platform and from the southbound subway platform to the loading platform on the street level, this arrangement gives escalator service to the majority of passengers transferring from subway to street level.

An extensive rapid transit system including both subways and elevated roads has been planned and is being built in Philadelphia and the stations on this system are good examples of modern, well planned, rapid transit stations. Fig. 18 shows the Girard Ave. express station on the Broad St. subway. The platform length is 550 ft., the width at the center 20 ft. 9 in. tapering toward the ends through a large radius curve on the outside platform edge. The platforms are accessible from the street through a mezzanine under Girard Ave. which has eight stairways from the street and three to each platform. In addition there are stairways for exit only, near the ends of both platforms.

A local side-platform station on the same line at Ridge Ave. has a similar arrangement with entrances and exits at the center and additional exits near the ends. The platforms, 12 ft. wide except at the ends, where the width is 10 ft., are unobstructed through their entire length, platform columns being eliminated and the stairways being built in recesses outside of the walls of the main structure. Another local station at 12th and Arch streets on the "delivery loop subway" has entrances at or near the ends with additional exits at the center.

The problem of locating entrances and exits is frequently a difficult one for the station designer. On

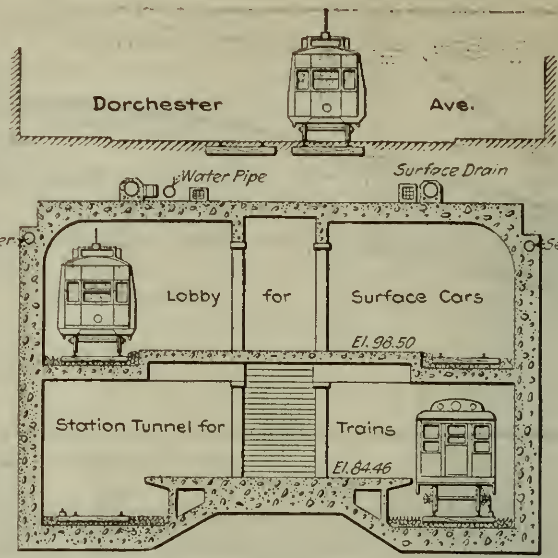


FIG. 16. SECTION OF DORCHESTER TUNNEL, BOSTON

a busy street the presence of an elevated stairway or a subway kiosk on the sidewalk is, as has been demonstrated in New York, a serious impediment to the movements of pedestrians. On the other hand a subway or elevated entrance located entirely inside the building lines of an adjacent business building, not only has the virtue of not being a sidewalk encroachment, but is also an actual asset to the owners of the building, increasing in value as the traffic increases. This has also been demonstrated in New York where property owners in general are alive to the advantage of having a subway entrance on the premises, and are quite willing to grant the space for and pay the cost of an entrance without any other compensation than the resulting increment in rental value. In the building of the Frankford elevated railroad, it was aimed to avoid placing the station stairs on the sidewalks. At all stations on this line, a building containing the stairways, controls, toilets and waiting room has been built within the building lines on property taken for the purpose under condemnation proceedings. At the platform level there is a bridge from the station building to the platform. Such a station is located at Ruan and Church streets. It is a rectangular building and control may be either at the street level or at the platform level. It is obvious that the advantage of an unobstructed sidewalk is not the only one that may be secured by this method of building elevated stations. Rental space at a point passed twice daily by thousands of passengers is extremely valuable for certain businesses and by placing con-

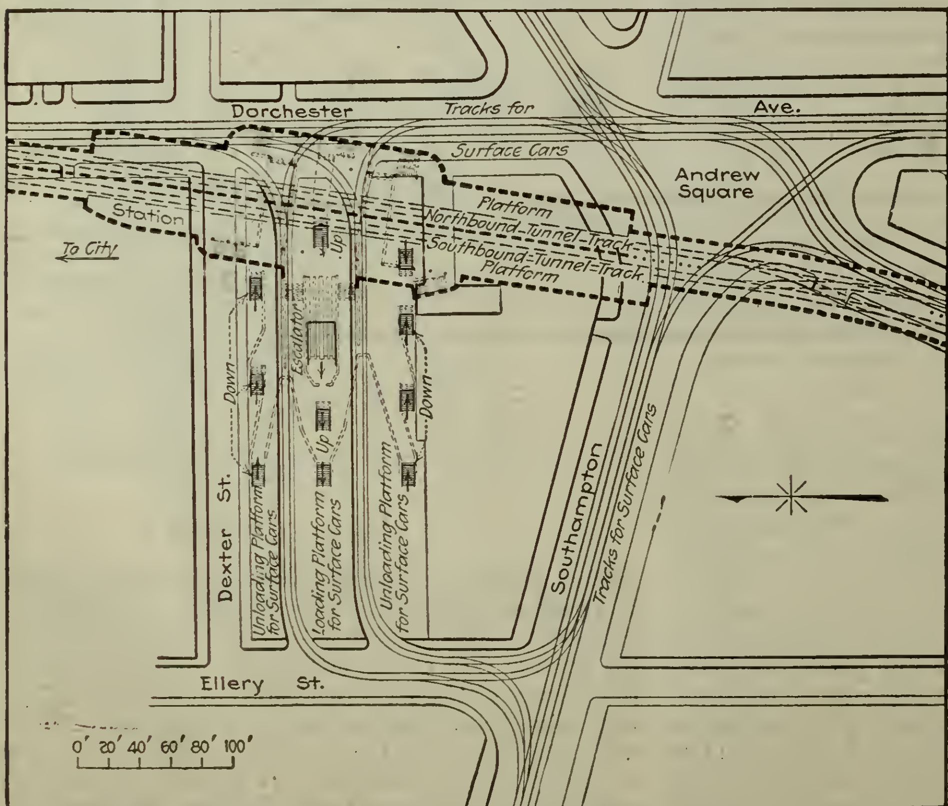


FIG. 17. ANDREW SQUARE STATION, DORCHESTER TUNNEL, BOSTON

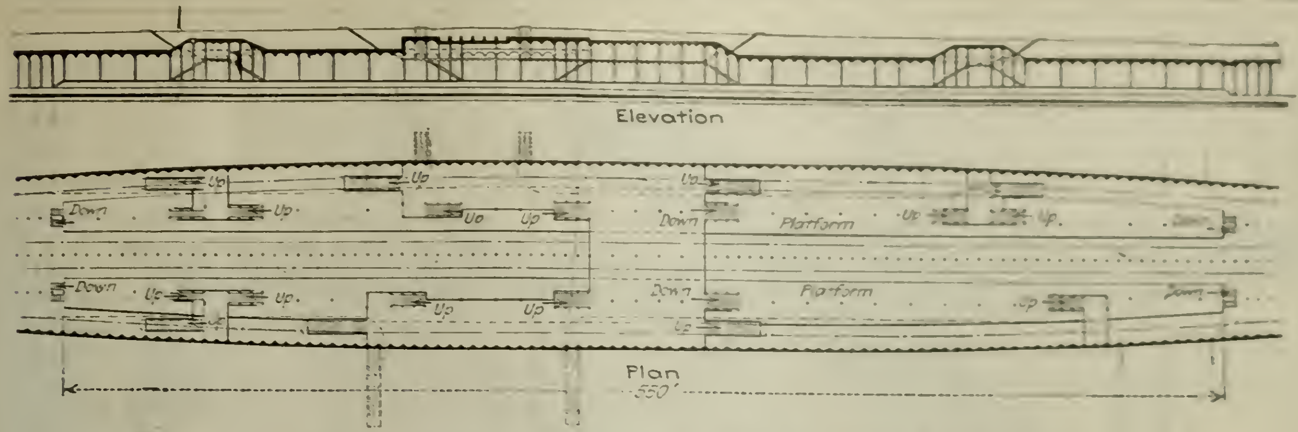


FIG. 18. GIRARD AVENUE SUBWAY STATION, PHILADELPHIA

trol, toilets and waiting rooms at the platform level, occupying on the ground floor only as much space as is needed for stairways and entrances, it should be possible to secure a very considerable rental for the remainder of the ground floor area. It is, indeed, entirely reasonable to assume that in many cases, the loss of income from the portion of the lot required for station purposes, would be more than offset by the increased yield due to the presence of the station from the remaining portion.

New York has a greater mileage of rapid transit railroads than any other city in the world. When the dual system, as planned at present, is completed it will comprise about 225 miles of subway and elevated lines and will have a total of 620 miles of single track. In addition to the dual system New York has the Hudson & Manhattan railroad, the Westchester railroad and the suburban lines of the steam railroad systems that enter the City. On the dual system there are about 400 stations including many different types.

The Brooklyn Bridge station of the first subway in New York, opened for traffic in 1904, is shown in Fig. 19. This station, the same as the other express station on the original subway, was built for 8-car express trains with platforms about 350 ft. long. The width of the express platform at the center is 20 ft., narrowing toward the ends. The stairways from the platforms are 8 ft. wide and the mezzanine platform or bridge spanning the tracks is 20 ft. wide. The two side platforms of the station have never been used. When the rapidly growing traffic made the train service originally adopted insufficient, the express platforms were lengthened to 480 ft. and ten-car express trains put in service. A ten-car train is 520 ft. long so that the end doors of the first and last cars do not come within the platforms and are not used. The full lines show the station as originally built and the dotted lines the express platforms as lengthened.

The Chambers St. station of the 7th Ave. subway opened in 1918, is shown in Fig. 20. It is located not

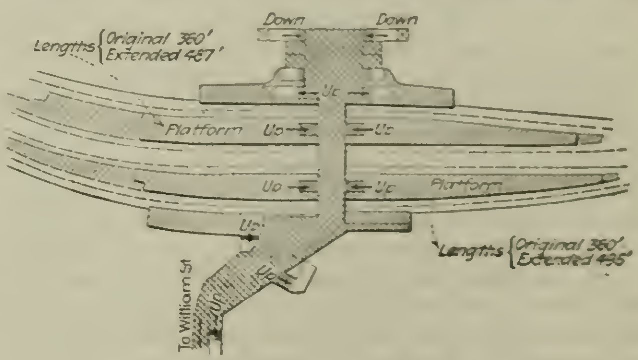


FIG. 19. BROOKLYN BRIDGE STATION, NEW YORK SUBWAY

far from the Brooklyn Bridge station and invites a comparison with the latter. The platforms are 18.5 ft. wide and 485 ft. long. Instead of a narrow bridge spanning the tracks we find a large mezzanine floor under the intersection of Greenwich and Chambers streets with stairways to the four street corners. From each platform there are four stairways to the mezzanine. Should additional stairways and mezzanine area be

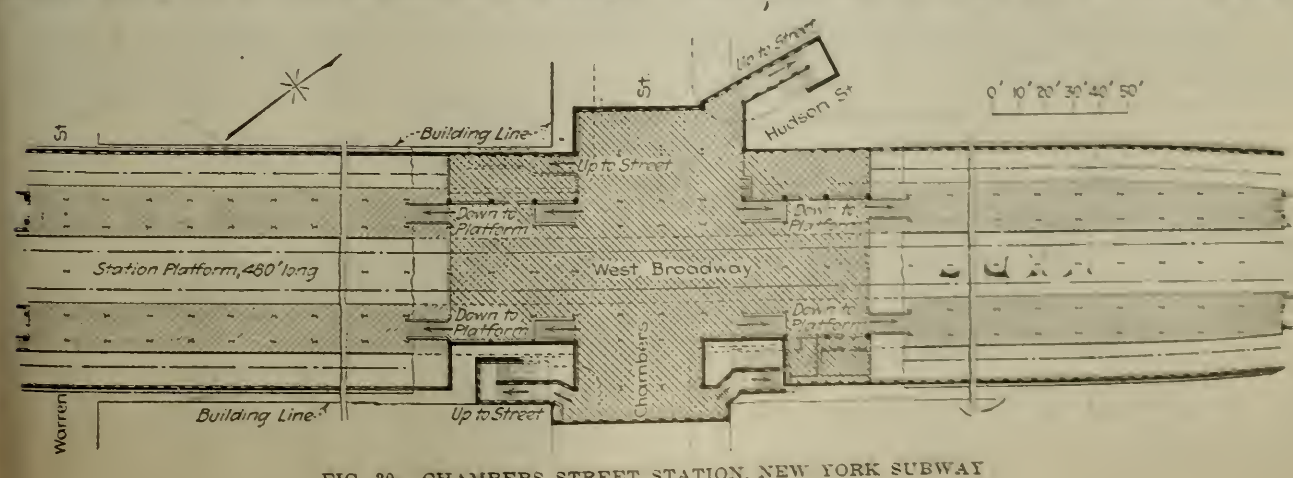


FIG. 20. CHAMBERS STREET STATION, NEW YORK SUBWAY

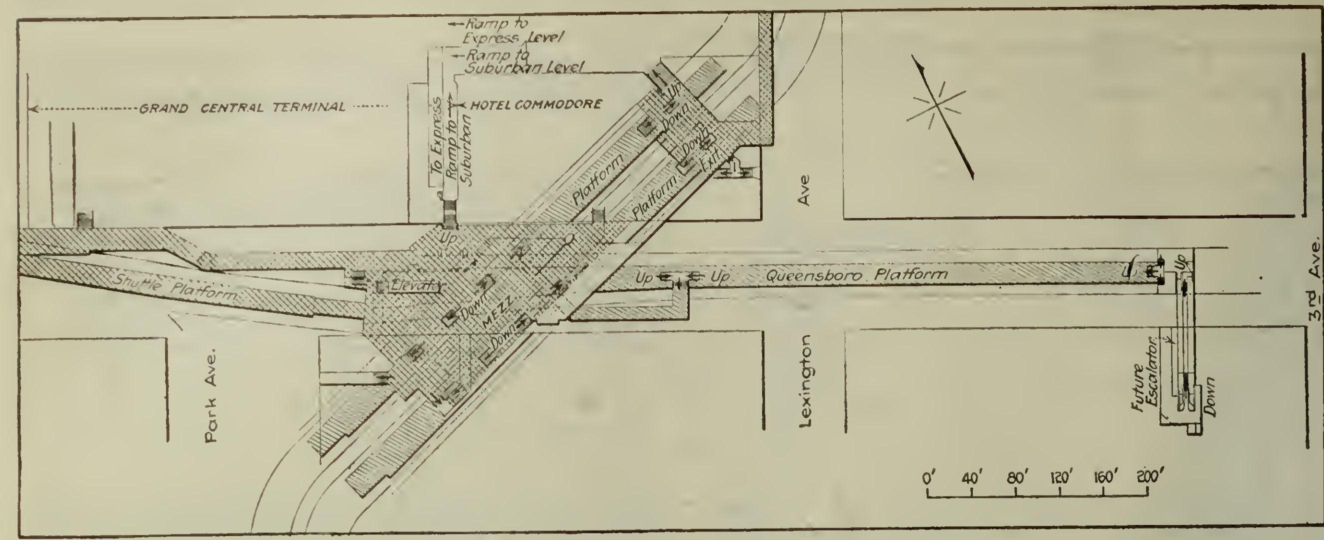


FIG. 21. GRAND CENTRAL SUBWAY STATION, NEW YORK

required the mezzanine can be extended over the platform in both directions.

A station that by virtue of its location is destined to have a very heavy traffic is the Grand Central station of the Park Ave.-Lexington Ave. subway (Fig. 21) opened for traffic in August, 1918. It is located diagonally across Forty-second St. between Park and Lexington Avenue, and is adjacent to and by means of underground passages connected with the New York Terminus of the New York Central and the New York, New Haven & Hartford railroad systems, and the Grand Central Terminal. Directly below the station and connected to it by means of a ramp, a stairway and three elevators is the Grand Central Station of the Queensborough subway, which here runs under Forty-second St. There is also a shuttle service under Forty-second St. from this station west to the Times Square station on the Seventh Ave. line. It is evident that in addition to the traffic originating in the neighborhood, rapidly being built up with large office structures and hotels, an unusually large transfer traffic will result from the meeting and intersection of these traffic lines.

The main outline of the station, Fig. 21, shows it to be of the ordinary type for four-track express stations with two island platforms of varying width about 485 ft. long. Each platform has, in addition to two stairways leading down to the passageway and ramp communicating with the Queensborough station below, six stairways leading to two mezzanine floors above the platform. From these mezzanine floors there are numerous passages and stairways leading through adjacent buildings to the street level and opening on Forty-second St., on Park and Lexington Aves., and as far north as Forty-fifth St. A short ramp connects the larger of the two mezzanine floors with an island platform serving the shuttle trains to the Times Square station.

It would be easy to have ideal rapid transit if cities were planned and built to order with the laying out of a subway system as the first step in such building. It is a different problem to supply means of rapid transit in a metropolis, which is a growth of generations or centuries. The streets, lined with tall buildings, are narrow and crooked where width and straight lines are needed for stations and the space under the street surface required for the latter is already taken up by the different structures that form the organs of supply and evacuation and of transmission of intelligence by which the life of the city is carried on. Fig. 22 shows a station built under such conditions, the Wall St. Station on the William St. line. The street is at that point only 38 ft. wide and has a slight bend. The station is there-

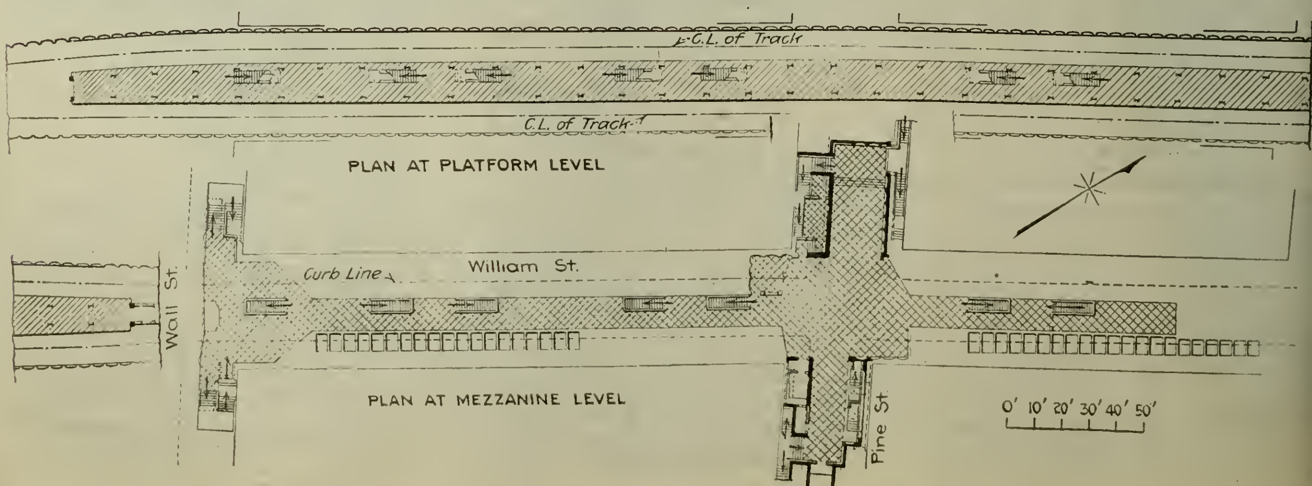


FIG. 22. WALL STREET STATION, NEW YORK SUBWAY

for on a curve (although of such large radius that it is no disadvantage) and the platform width varies from about 12 ft. at one end to a maximum of 14 ft. at the center. There are seven stairways between the platform and the mezzanine floor above and from the mezzanine there are stairways to the surface on Pine and Wall streets.

The examples of rapid transit stations here illustrated have been built to suit widely different conditions in traffic volume and in other respects. A comparison of the size of stations built 20 or 25 years ago with those of today gives a striking illustration of the growth of rapid transit during this period. On the first New York subway the platforms were originally planned for a length of 200 ft. on local and 350 ft. on express stations (this applies only to the island platforms) serving respectively five- and eight-car trains. It was not long, however, before it became necessary to lengthen the express station so that ten-car trains could be used, and lengthening of the platforms of the local stations is now under consideration. On the Centre Street Loop, which was the next line to be built, the platforms were made 435 ft. long and on the Fourth Avenue subway in Brooklyn the express and local stations were made 480 and 435 ft. long respectively.

Since the dual system contracts were executed in 1913, no station on the Interborough system has been built less than 480 ft. in length and on the New York Municipal lines the latest stations have been made 530 ft. long, accommodating trains of eight 67-ft. cars. The length of express platforms on the rapid transit system in Sidney, New South Wales is 520 ft. and on the Philadelphia system it is 550 ft.

It is not necessary to repeat that the arrangement shown in Fig. 13 is a bad one. For a station of this length—about 250 ft.—one point of ingress and egress would be sufficient if placed at the center of the station, but if placed at one end there should be at least an exit at the opposite end.

On a two-track line an island platform station of the type shown in Fig. 14 is both economical in operation and convenient for passengers. Where conditions permit the placing of the entrance in the longitudinal axis of the platform and where the station length and traffic volume are such that an entrance at each end is sufficient, a mezzanine can be avoided and the station built close to the street surface.

The stations shown from the Boston rapid transit system are of a special type—transfer stations between surface cars and subways.

The Girard Avenue station of the Broad Street subway in Philadelphia, shown in Fig. 18, has platforms 550 ft. long and 20 ft. 9 in. wide at the centre and six stairways from each platform with a total width of 37 ft. The corresponding figures for the Chambers Street station in the New York subway, Fig. 20, are, length 480 ft., width 18 ft. and four stairways, totaling in width 27 ft. The mezzanine of the New York station has a gross area of about 10,000 sq.ft. with four entrances, all located near Chambers Street, on which the station is centered. The mezzanine of the Philadelphia station is about 8,000 sq.ft. gross area and connects with the street by 8 stairways. The two additional exits near each end of the station make a total of twelve connections with the street, four on Girard Avenue, one on Stiles Street and seven located at different points along Broad Street.

In conclusion it may be pointed out that the differences in station design which a comparison of rapid transit systems in different cities and countries discloses are partly the result of and are based on the experience gained under differing local conditions. Among these differing conditions are: The city plan and streets, the habits and customs of the people as to travel, operating methods, etc. What may be adopted for good reasons and after careful investigations in one place may be rejected for equally good reasons in another. The station planner, therefore, as in all other engineering work, while learning from the experience of others, must above all begin by analyzing the conditions of his own special problem.

Resurfacing Flexible Pavement

By H. T. Macfarland
Barber Asphalt Paving Co., Philadelphia, Pa.

In resurfacing a section of Broad Street one of the heaviest traffic streets in Charleston, W. Va., during the early part of this year, the fact was brought to light that the original brick pavement had been laid over boards. To meet this condition, which imparted to the pavement unusual flexibility, it was necessary to adopt exceptional construction methods.

Broad street, from Quarrier St. to Smith St., was paved with brick in 1894, and from Virginia St., to Quarrier St., in 1899. Investigation showed that after the grading was completed, 2 in. of sand had been spread, on which had been laid 2-in. planks which had been dipped in tar. Over the boards 2 in. additional of sand had been placed, and on this base the brick had been laid.

Despite the fact that they had been down for 21 and 26 years, the boards were in good shape, but when exposed to the air for a few days they began to weather. The subsoil was so firmly compacted that it was difficult to break it with the heel. In some places it was found that the sand both under and over the planks had shifted, and upon advice the contractor removed the brick in such places, and added sufficient sand to bring the surface up to grade.

Several sections were in bad shape, and at these points the old brick, sand and boards were removed. Fresh sand and new planks were placed, then new brick were laid and the section thoroughly rolled. No concrete or other rigid type patches were made, because of the flexibility of the old pavement. It was feared that the impact of heavy trucks as they struck the patched spots, and as they skipped from the nonflexible to the flexible sections would seriously damage the pavement. All minor depressions were brought to grade by the addition of extra binder.

The surface mixture was composed of Cold River sand, coarse sand, Lake Erie sand, fine sand, limestone dust and 12 per cent asphalt, gaged by bituminous content. To complete the work required about thirty-five more tons of Trinidad Lake asphalt than the contractor had figured upon for binder and top. The extra material was used to give the resilence essential because of the flexibility of the foundation, and also to provide an excess of asphalt, so that any cracks which might develop during the cooler periods might heal under the summer sun. G. T. Fogle & Co., were the contractors.

Old Brick Pavement Resurfaced With Asphaltic Concrete

Deep Depressions Concrete Filled—Uneven Cross-Section Leads to Payment on Both Square and Cubic Yard Basis

By Roy M. Green
President, Western Laboratories, Lincoln
and John L. Hershey
Special Engineer, Beatrice, Nebraska

MANY cities are now confronted with the problem of how best to utilize their old brick pavements after their surfaces have become rough and worn by years of traffic. Such a condition has been met and overcome in Beatrice, Neb., by resurfacing them with either a sheet asphalt or an asphaltic concrete mixture laid directly on top of the old pavement. A number of streets have been resurfaced in this manner during the past few years but the most recent work has been that of resurfacing West Court Street with an asphaltic concrete wearing surface.

TYPICAL CROSS-SECTION OF RESURFACED STREET

The old pavement cross section, shown in the accompanying figure, was laid with a crown of 8 in. in a width of 43 ft. between gutters. When this pavement was originally constructed the subgrade was finished and rolled and a 6-in. sand base laid directly upon it. On top of this sand base was laid a foundation course of brick, laid flat. A 2-in. sand cushion was then spread over the brick foundation and the brick wearing surface was set directly upon this cushion. The bricks used for this work were $2\frac{1}{4}$ x 4 x 8 in. in size. The bricks in the wearing surface were set on edge. Sand was used to fill the joints.

Since an abandoned street car track was located in the center of the street, the traffic had always stayed away from the center of the pavement and traveled along the quarter points. Traffic had, in this way, worn the quarters until they were from $1\frac{1}{2}$ to 2 in. low. There were, also, depressions from various other causes such as settlements caused by street openings and worn bricks which had caused pot holes. In fact the street had been very rough for several years and traffic had avoided it as much as possible.

The uneven surface of the old pavement and the worn condition of the bricks along the quarter points produced such an irregular base that considerable work was necessary to produce a more regular section before the surface of asphaltic concrete could be applied. This was necessary in order that a suitable cross section could be obtained for the finished surface, otherwise the irregularities in the base were certain to be apparent at the surface.

In doing this work the deep depressions were repaired by taking up the bricks in the top course, removing the sand cushion and filling these openings with portland cement concrete laid on top of the foundation course of brick. The pavement was then thoroughly cleaned by flushing and the local depressions and the depressions along the quarter points were filled with a binder mixture of Joplin flint chatts and asphalt cement. This produced a working base which, however, was not accurate enough to make it possible to lay a uniform thickness of 2 in. of wearing surface mixture and obtain the proper finished cross section.

The old brick gutters were so irregular that they did not drain in many places. For this reason it was impossible to use the old brick as a gutter without topping it. Also, the edge of the asphalt surface would have been subjected to a great deal of wear had it been laid only to the inside edge of the brick gutter since it would have been necessary to make a feather edge at that place. Further, any high water in the gutter would have easily penetrated beneath the asphalt surface at the edge. The asphalt surface was, therefore, carried across the gutter. On the west end, where the grade of the street was sufficient to carry the drainage without covering the shoulder to the sidewalk line the surface was carried only to *A*. (See cross-section.) In other places it was carried up to the sidewalk *B*. In the former case the old brick at the edge was heavily squeegeed with asphalt cement so that the entire street now has the appearance of being completely covered with the asphalt wearing surface. Due to the irregularities of the base it was impossible to adhere to a thickness of 2 in. of wearing surface, as a much greater thickness was required in many places. Unit bids were, therefore, received on the 2-in. wearing surface on a square yard basis, and also bids on binder on a cubic yard basis. Accurate records were kept of the weight of all the surfacing material and binder used in the work. The contractor was paid his unit price of \$1.50 per square yard for all the surface laid. The weight of the 2-in. surfacing was then deducted from the total amount of mixture used and the difference was paid for as binder at a rate of \$15 per cubic yard. This gave an equitable method of payment for the work, which protected both the contractor and the city.

The surface mixture of asphaltic concrete was designed for the heavy traffic to which this street is subjected. The mixture was made of fine Platte River blow sand, Joplin flint chatts, and limestone dust mixed with asphalt cement, analyses of the mixture being made daily, and a typical analysis showing the following composition.

	Percentage
Bitumen	7.96
Aggregate:	
Passing 200 sieve	6.2
Passing 80 sieve on 200 sieve	13.5
Passing 40 sieve on 80 sieve	14.0
Passing 10 sieve on 40 sieve	16.3
Passing $\frac{1}{4}$ screen on 10 sieve	24.7
Passing $\frac{1}{2}$ screen on $\frac{1}{4}$ screen	17.3

As a result of this work Court Street has been changed from a very rough and undesirable street to a smooth and perfectly satisfactory street at a very low cost to the city. The work was done by the Abel Construction Co., of Lincoln, Nebraska, under the supervision of John L. Hershey, Special Engineer, Beatrice, Neb., and Clark E. Mickey, Consulting and Testing Engineer, Lincoln, Neb.

Notes from Foreign Fields

TROUBLES AND JOYS OF A TRAVELER—HOMEWARD BOUND

By E. J. Mehren
Editor, *Engineering News-Record*

IT SEEMS fitting in closing this series of notes that I should indicate some of the ways in which travel in Europe differs from what it was before the war, and that I should also pay my respects to those who have helped me in studying the engineering situation here—studies that have been interpreted in an impressionistic way in these notes.

After a circuit of the western countries of the Continent I am again in London, homeward bound. With a few days here to wind up some unfinished business, but without rush, I can look back at three and a half strenuous months and begin to make an appraisal of their results. There has been much of pleasure, much of satisfaction, and just enough annoyance and inconvenience to throw the pleasant part of the journey in relief. Of the pleasant experiences I have said much. Possibly I may be allowed the indulgence of relating a few of the troubles, particularly since, in the present unsettled state of Europe, they are likely to be of interest to people in the States.

SIR HENRY MAYBURY, K.C.M.G., C.B.
Director General of Roads,
Ministry of Transport, United Kingdom

Finally, it would not be fitting to close these notes without a word of thanks to those who have facilitated my work.

Passports and Visés—Outstanding among the annoyances which the traveler experiences in Europe today is that of the passport. This is an evil inheritance of the war. It is a minor one, it is true, but after one has stood in line for many an hour, at frontier stations and at visé offices, he is apt to chafe under it. Whether its continuance is warranted it hardly befits an American to say. Certainly, there is much radical propaganda in Europe, and the passport system may help to keep fomenters in their home lands. In any event, the system is here and must be endured.

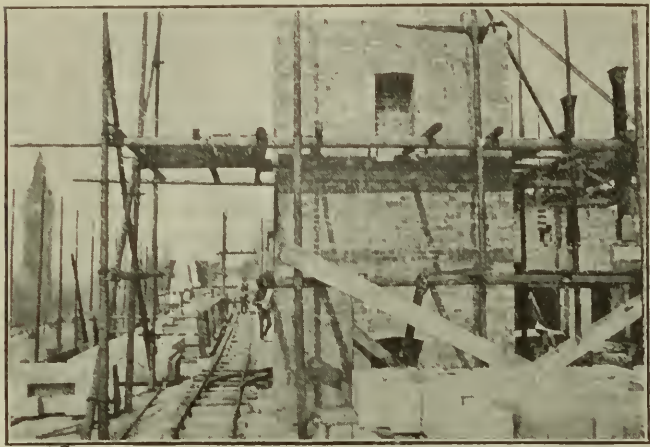
As is well known, the traveler must get a passport from his own Government and must have it viséd by a passport or consular official of every country that he proposes to enter. These passports are always examined at the frontier. There is much difference in the efficiency with which examinations are made, both with respect to customs and the passport. Entering England and Belgium the work was quickly done. At some Continental points, however, there was great delay. As a rule, if one passes by train from one country to another, it is necessary at two points, close together, one on either side of the international border, to remove all of the luggage from the train and have it inspected. Passports are examined at the same time. Necessarily the passengers must stand in line and wait their turns—not a welcome incident at the end of a long fatiguing journey in midsummer in a hot, stuffy room.

Temporarily, too, there is an additional annoyance, in the limitation of the amount of money one may take out of certain countries. For example, at the time I left France one could take out currency, no matter of what country, to the total value of only 1,000 francs. The limit on silver was 10 francs, while the exportation of gold was prohibited entirely.

DR. J. H. T. TUDSBERY
Secretary,
Institution of Civil Engineers, London

At Bellegarde, on the way to Switzerland, the various frontier formalities caused a delay of 1 hr. 20 min., during which the passports were examined four times, the passengers quizzed twice (very sharply regarding the amount of money in their possession), and the baggage searched with rather more thoroughness than is customary, with a view to the discovery of hidden gold, silver, and bank notes. Arrived in Geneva, about an hour after leaving Bellegarde, there were, necessarily, the Swiss examinations. They were made with fair expedition, but the annoyances at Bellegarde are such that previous travelers had unburdened themselves, while waiting at the final barrier in Geneva, by scribbling their thoughts on the unpainted pine-board partitions. An Englishman had written, "The last barrier to freedom"; an Italian, "Ye who enter here leave all hope behind," while an Argentinian had described the formalities as "Two hours in Purgatory."

The passage from France to Switzerland, I must admit, was annoying, but it was duplicated in going from Germany to Holland, via Bentheim-Oldenzaal. Here the examination was more thorough, and if the passenger was unfortunate enough to have silver, he was mulcted out of it at the German station, Bentheim.



ROUND SCAFFOLDING TIMBERS ON LONDON BUILDING

AMERICAN STEAM SHOVEL IN HEART OF LONDON

At the left of the first illustration may be seen the clock tower of the House of Parliament—the steam shovel in the other picture is excavating the foundation of Bush House, on the Strand, being built by Irving T. Bush, of New York, as a sales center, similar to his sales center on West 42d St., New York City.

In fact, I experienced at Bentheim the only real injustice of my entire trip. Though I had but 2½ guldens, it grates yet, particularly because I have met a fellow-American here in London who had an experience similar to mine, thus assuring me that my case was not peculiar. He had about 10 guldens in silver. I had bought the Dutch silver the day before in Berlin, being ignorant of the fact that no silver whatsoever may be taken out of Germany. At Bentheim I was informed that it could not be taken out. Upon inquiring as to what could be done with them I was referred to an adjacent inclosure, and there calmly informed that, though the 2½ guildens had the day before cost 37½ marks they would give me only 20 marks for them. Protests were of no avail and there was nothing to do but accept the 20 marks. As a further evidence of the unfairness of the procedure they refused to give one a 2½-gulden note in exchange for the silver pieces. In other words, they had the travelers at their mercy and robbed them—robbed them with official sanction, since German officials stood alongside the cage and shrugged their shoulders at the travelers' protests. The banking booth had on it a sign, "Barmer Bank Verein, Hinsberg, Fischer & Co." I have since made inquiry as to the standing of the Barmer Bank Verein and learn that it is a strong institution, with a high standing. Evidently, however, it is placing no check upon its agents—Hinsberg, Fischer & Co.—and does not realize that they are forever discrediting the name of the Barmer Bank Verein with those who fall into their hands. At the time I passed through Bentheim they were, by paying 20 marks for silver pieces that were selling in Berlin for 37½ marks each, making a profit of 87½ per cent.

It is needless to say that travelers imposed upon believe that the robbery was due to connivance between the agents of the Barmer Bank Verein and petty German officials, and that the matter would be promptly stopped if it could be brought to the attention of the proper officials in Berlin.

But to return to the visé. As a rule an American finds little difficulty in getting a visé—other than the annoyance of waiting in an anteroom for two or three hours in order to get to the proper official. However, one does strike a snag in case he desires to go into Bavaria, one of the states of the German Empire.

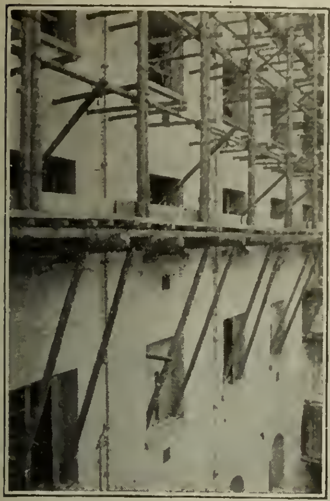
It appears that in 1919 the report gained currency in Prussia and other parts of Central Europe that Bavaria was better supplied with food than its neighbors. Consequently there was a great rush of visitors, with the result of a rapid consumption of the really limited Bavarian food supply. To prevent a repetition the Bavarian Government decided that no one would be allowed to cross the frontier without securing in advance a police permit from Munich. These permits are issued only for good reasons, the prospect of opening business relations in Bavaria being, as a rule, not sufficient to secure permission to enter.

In London I had taken the precaution of calling at the German Consulate and presenting my papers to learn whether there would be any difficulty in securing a permit to enter. I was told that there would be no difficulty. Apparently, however, I failed to make clear that I desired to go not merely to Prussia, but to Bavaria as well. Upon reaching Berne the German officials informed me that they would be unable to give me a visé to go to Munich, though they would at once visé my passport to go to any other part of Germany. The officials at Berne were most gracious and wired the proper ministry in Berlin, explaining the case and urging that my Berlin references be looked up, and if found satisfactory that efforts be made to secure for me the necessary permission to go to Munich. The routine in Berlin caused delay and after three or four days of waiting I tried independently, through connections in Munich, to get the coveted police permit, and in that proved successful. In all, there was a week's delay.

Even though one recognizes the reasonableness of restrictions, one cannot help but feel uneasy and annoyed at the loss of time. I felt in that mood myself, until, calling at the American Consulate in Zurich, I heard a colloquy between the official in charge and a young German business man who desired to secure a visé in order to visit the United States. He was told that it would take four months to get the visé if the matter were handled by mail, but that it could be done in five to six weeks by cable, at a cost to himself of about 100 francs. He had no letters from the United States, but wanted to study American conditions, with the idea of establishing business connections there. After hearing the colloquy I not merely felt thankful that my delay had been no longer than a week, but marveled that the Germans should admit us so freely when we place such

barriers in the way of their visiting the United States. The arrangements seem hardly to be reciprocal.

Of all the annoying visé offices I visited that of the American Commission in Berlin was the worst. Both Americans and Europeans complained about it. Not even the simple expedient of giving numbers to applicants as they came in—a universal practice in visé offices—was in vogue. Everybody crowded around the counter and made efforts regardless of time of arrival to attract the attention of the single clerk who was trying to take care of a large crowd.


ANOTHER VIEW SHOWING ROUND SCAFFOLDING TIMBERS

Before sailing for Europe I was warned that I could expect great inconvenience in traveling accommodations. Such, however, did not prove to be the case. Apparently there was a material difference between conditions in 1919 and 1920. It is true that there were fewer trains than before the war; on the long runs there are now, as a rule, only two trains a day, one leaving in the morning and one in the evening. The trains are slower than they were before, but, except in the third class, the accommodations are ample, while on all of the long day runs dining cars are carried. While one lacked on the Continent the ease and comfort that are found on American and English railroads, the conditions are not such as should discourage travel.

Acknowledgment of Courtesies

But if one must put up with inconvenience, there is more than ample compensation in the pleasant hours one spends among European scenes and in the company of cultured Europeans. My time was spent, as was to be expected, largely with engineers, and I found that the bond which binds us together in the United States has international strength as well. The mere fact that I was an engineer was a sufficient introduction everywhere. Not only did each individual make accessible to me the information at his command, but offered suggestions as to other sources of information. Such suggestions frequently materialized in letters of introduction which passed me on from one engineer to the other, until my wishes in the particular direction were gratified.

To acknowledge by name all of those to whom I was indebted would exceed the reasonable bounds of space. I will be pardoned, though, if I put down the names of a few whose courtesies were of an unusual order: M. Paul Le Gavrian, ingenieur en chef des ponts et Chaussées, in Paris; Prof. A. Rhon of the Zurich Polytechnicum; Dr. Ing. Oskar von Miller, Munich; Prof. C. Matschoss, of the Verein Deutscher Ingenieure, in Berlin; Heer G. J. van den Broek, engineer of the North Sea Canal, Amsterdam, and Mr. J. S. Killick, chief engineer of the roads department of the Ministry of Transport, London.

Two other gentlemen I have left for special mention, not merely because of the assistance rendered to me, but because they and their work are so well known in the United States; I refer to Sir Henry Maybury, K.C.M.G., C.B., director-general of roads, Ministry of Transport, London, and Dr. J. H. T. Tudsbery, secretary of the Institution of Civil Engineers, London.

As those who know him would expect, Sir Henry bears his dignities and his heavy responsibilities well. Backed by a long professional experience, in railroad work, in public-works construction, and in the management of municipal works (as engineer, surveyor, and general manager of important local boards and district and county councils), he came to the position of chief engineer of the Road Board in 1913, richly endowed for the work. During the war he became director of roads in France, responsible for the maintenance of some 4,000 miles of highway, of vital importance in the transportation of troops and supplies to the firing line. Some 330 officers and 13,600 men, all skilled road and quarry troops, were under his command, while, in addition, unskilled detachments to a total of 30,000 men were almost constantly under his direction. In recognition of his great service, he was knighted at the close of the war. Upon the formation of the Ministry of Transport he was made director-general of roads, and has recently been honored by election to the vice-presidency of the Institute of Transport, a new organization formed to further the interests of transport generally, whether by water, road or rail. Under his guidance the road work of the United Kingdom is receiving that careful consideration demanded by the very rapid increase in the number and weight of motor vehicles. He commands the confidence, as I found everywhere, of the road engineers and surveyors of the United Kingdom. They recognize in him a worthy leader—an engineer of high professional attainments, a man of sincerity, purpose and ability, with a character and personality that have commanded universal admiration.

Dr. Tudsbery carries well his sixty-one years. He would be taken for a much younger man. His secretaryship of the institution dates back to 1896. During the period of his executive administration he has seen the great institution grow and broaden, go from one fine house to a greater one, in order to meet its needs making more secure year after year its place as the leader among engineering societies. I found him affable and desirous of doing everything he could to smooth my way. He spoke charmingly of his American friends and showed a very great interest in what we are doing on our side of the water. He sees larger opportunities for the functioning of the institution and enlarged upon the plans now under consideration, which were reported in these notes some months back.

Help from Home.—In paying a tribute to the engineers in Europe who helped me, I must not forget that my way was much smoothed by letters that I brought from our side. Not only did those letters help me, but I was constantly under obligations to American engineers for what they had previously done for Europeans visiting in America. More than once when I protested at the fullness of courtesies being extended my host would rejoin that he was merely trying to repay, through the medium of my humble self, some of the debts of hospitality that he himself had contracted when visiting America.

All of which goes again to emphasize what I said

before, that the fellowship of engineering is international. The bonds can be much strengthened by an interchange of experiences such as is involved in a foreign trip. Though we may not always see the connection and though the war may make us doubt as to the value of any attempts at international amity, I do believe that we engineers in our intercourse with our fellows in other lands are playing a part in the great international drama of trying to get the nations to live and work harmoniously with each other.

While my mission has, I hope, had some effect in this direction, it was, of course, essentially journalistic—an effort not merely, through these notes, to lay some thoughts on European engineering developments and European engineering thinking before the readers of *Engineering News-Record* but to arrange by the renewal of our connections abroad (connections disturbed by the war) for a flow to our readers of what is best in engineering work in Great Britain and on the Continent. As to the flow of material, time must be the test, but I have high hopes that my mission will result in giving American engineers a near or a bird's-eye view, as the particular conditions warrant, of the best in European engineering thinking.

London, Aug. 12, 1920.

(This article concludes Mr. Mehren's notes on his European trip.—EDITOR.)

Heavy Spans To Be Rolled and Jacked in Difficult Bridge Reconstruction

New Double-Track Structure of Increased Load Capacity Provides Wider Channel Openings and Greater Clearance Height—Erection Under Traffic—Will Shift Track to Higher Elevation in One Day

RECONSTRUCTION of the Allegheny River crossing of the Baltimore & Ohio R. R. at 33rd St., Pittsburgh, Pa., which has been actively under way during the present season and is now nearing completion, represents a series of replacement operations of exceptional complexity and difficulty. The renewal of the bridge was necessary not only to provide capacity for modern loading, but also to adapt the crossing to the new requirements of the War Department with respect to channel widths and navigation clearance. The latter requirement involved new pier locations, longer spans, and a higher elevation of the structure. Under these circumstances the replacement of the old structure with a new one on the same alignment became highly complicated.

The Allegheny River bridge, forming part of the Pittsburgh Junction R. R. of the Baltimore & Ohio system, is perhaps the most important structure on the latter's line between New York and Chicago, and is the limiting structure from the standpoint of motive power. The old bridge, designed by Theodore Cooper, was completed in 1884. Its river portion consisted of four through-truss double-track spans varying in length from 167 to 250 ft. It was necessary that the new structure be so designed as to give a 400-ft. channel, which, in view of the 75° skew, demanded a channel span of 436 ft. 9 in. center to center of piers. The outlines of both old and new bridges are given by Fig. 1. The new structure is designed for double-track E60 loading.

Several years ago the approach to the bridge on the line of 33rd St., Pittsburgh, was reconstructed, the new viaduct being designed for E60 loading and so detailed as to be capable of having its grade reduced from 1.5 per cent to 0.3 per cent, descending westward, with a view to raising the elevation of base of rail 12 ft. at the east bank of the Allegheny River. This was in preparation for the subsequent reconstruction of the river crossing at higher level in accordance with the

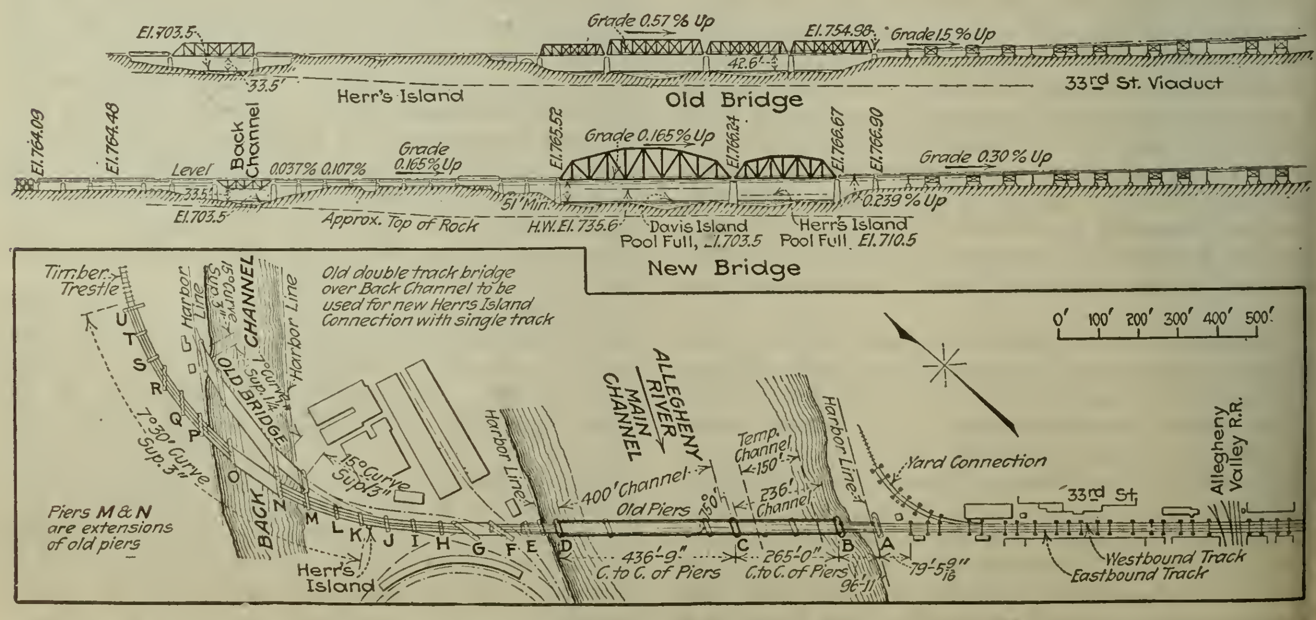


FIG. 1. RELATION OF OLD AND NEW ALLEGHENY RIVER BRIDGES, PITTSBURGH JUNCTION R.R. (BALTIMORE & OHIO R.R.) AT 33RD ST., PITTSBURGH

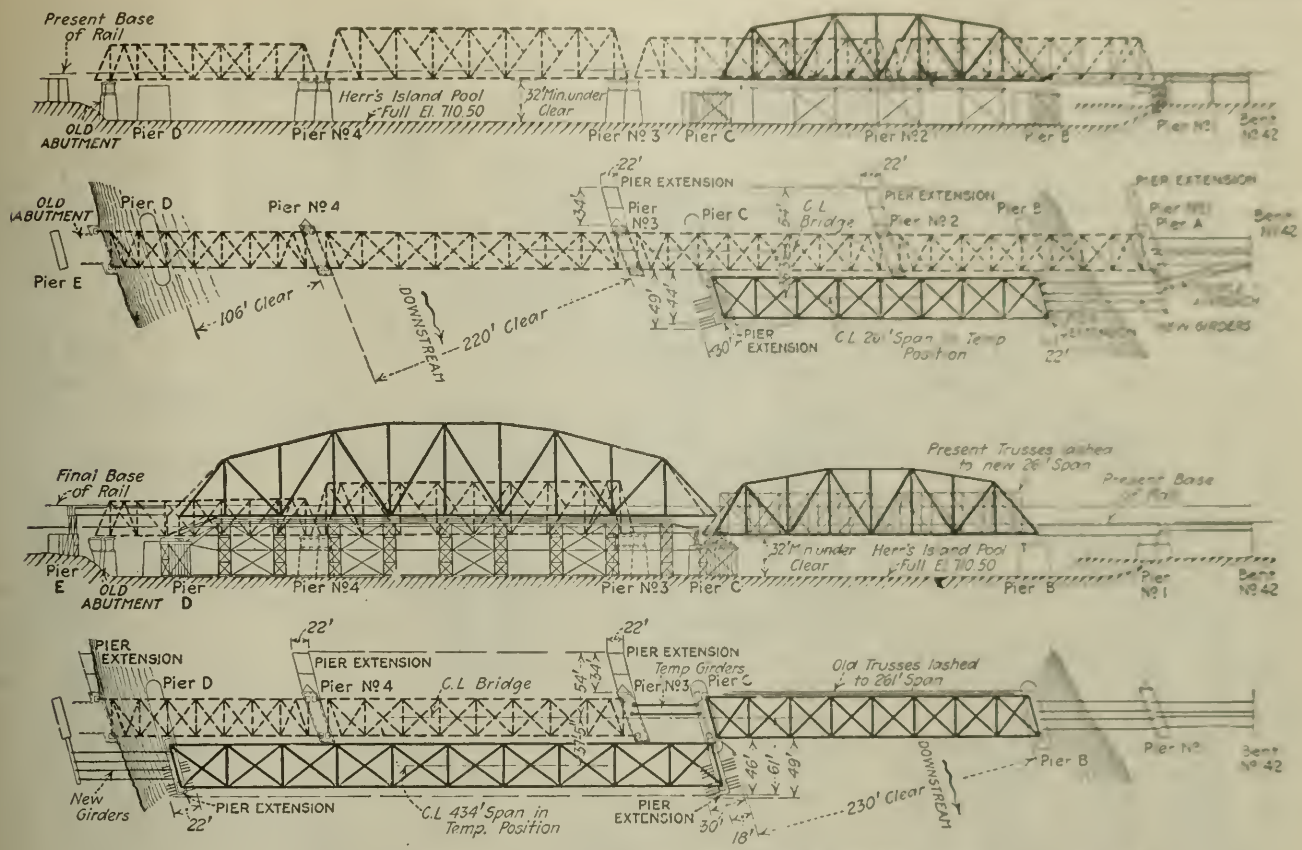


FIG. 2. CHARACTERISTIC STAGES OF ERECTION AND REPLACEMENT OF 33RD ST. BRIDGE

final decision of the government authorities in the matter of the navigation clearances to be provided at the various structures spanning the river.

The new bridge comprises two truss spans over the river, one 261 ft. and the other 434 ft. in length center to center of end bearings, a 147-ft. deck truss over the back channel, and a series of girder spans, so that the structure has a total length of 2,122 ft. The line of the new structure diverges from that of the old in its westerly portion, near the back channel, and here the old structure will be retained and adapted to single-track operation. This involves the placing of a new floor system in the present truss span over the back channel. The altered structure will be capable of carrying E50 loading.

Erection was begun in June, 1920, the work being started at both ends of the bridge. At the east bank of the river the two spans from pier A to pier C, comprising a 97-ft. plate-girder span and the 261-ft. truss span, were erected on falsework just downstream from the old structure (upper sketch in Fig. 2), and were then rolled into place, and simultaneously the two easterly spans of the old bridge were rolled out on timber pier extensions upstream, constructed for the purpose. This operation was carried out on Sept. 1, 1920. Immediately after the rolling, a 50-ft. girder span was temporarily placed between the end of the new span (on pier C) and the old pier 3, restoring traffic connection. At the same time the viaduct spans on the west end, beginning at abutment U, were erected up to the skew span G-F. As the new structure interferes with the old structure, a temporary single-track detour was constructed along the upstream side, connecting with the old line near pier M and making connection by reverse curve with the westbound track on the river bridge.

The viaduct at the west end has been erected at final track elevation. The spans at the east bank of the river, however, were erected at the grade of the old track and rolled at that level, and at present carry traffic at the original grade, in conjunction with the two westerly spans of the old bridge. The change in elevation is to be made at the time of placing the main channel span and the three connecting girder spans on the west bank of the channel.

Falsework is now being placed for the erection of the 434-ft. span. This, like the 261-ft. span, is to be erected immediately downstream from the present bridge, but it will be built at the new or *high* elevation. As it was necessary to restrict the new piers to the elevation established by the clearance of the old bridge, this span will have to be supported on steel end bents footing on the new piers at their present level; the bearing of the span is to be transferred to permanent shoes at the final coping level of the piers later on. These end bents will also serve as track shoes for the rolling of the span from erection position to its final place on Piers C and D.

When the channel span is ready to roll into final position, traffic will be abandoned, the two remaining old truss spans will be rolled out on upstream temporary pier extensions, the new channel span moving on its temporary supporting bents will be rolled to place, and at the same time the two previously placed new spans will be jacked up to their final elevation.

Preparatory to this movement the eastbound track on the 33rd St. viaduct (on the south bank) will have been raised to the final track elevation, so that it will make connection with the main channel structure as soon as the latter is jacked up. The two remaining girder spans on the north bank of the main channel will be placed at the time of the final rolling and jacking operations,

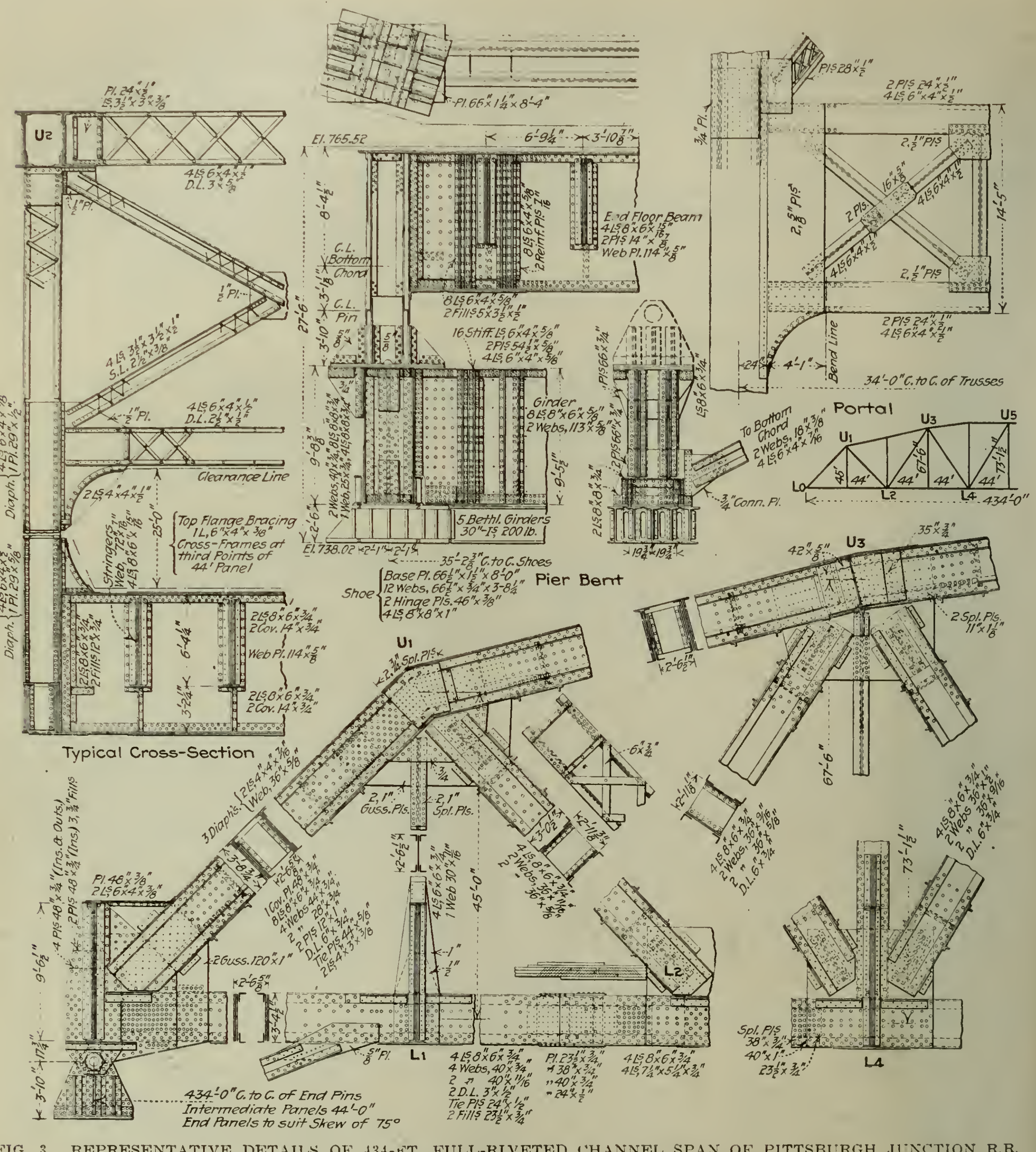


FIG. 3. REPRESENTATIVE DETAILS OF 434-FT. FULL-RIVETED CHANNEL SPAN OF PITTSBURGH JUNCTION R.R. BRIDGE OVER ALLEGHENY RIVER, WITH TEMPORARY PIER BENTS

and with this completed the eastbound track will be opened for traffic at its final elevation, and the channel spans and the north viaduct will be completely ready for service.

River traffic was passed under the third span of the old structure, counting from the east bank of the river, while the 261-ft. truss span was being erected. After the rolling of this span, the old pier below it, which carried the adjoining ends of the first and second old spans, was taken down and a channel dredged under the new 261-ft. span. River traffic was then diverted and caused to pass under this span, whereupon falsework for the large channel span was erected. This manner of dealing with the barge traffic on the river made it possible to erect both truss spans on falsework and obtain a riveted structure.

With regard to the design of the new structure, in general 1-in. rivets are used for the shop riveting throughout. In the field connections of the two large spans, 1⅛-in. rivets are being used.

Attention is called to the fact that rather long panels are used in the large truss span, namely 44 ft., and that this span does not have subdivided panels. By these means secondary stresses are, to a large extent, eliminated. The longest member in this span is the middle section of the bottom chord, which is approximately 104 ft. in length. The longest web member is about 85 ft. in length.

The total cost of reconstruction of the bridge will be about $2,200,000. The work is being carried out under the supervision of H. A. Lane, chief engineer, Baltimore & Ohio R. R., Baltimore. The preliminary stages were under the direction of W. S. Bouton, engineer of bridges; the actual design, fabrication and erection work have been handled under the direction of P. G. Lang, Jr., assistant engineer of bridges. The work in the field is under the supervision of A. C. Clarke, district engineer. The American Bridge Co. contracted for the fabrication and erection of the new steel work, while the substructure was built by the Vang Construction Co., of Cumberland, Md.

Algae Cause Odors from Monona Lake at Madison, Wisconsin

Sewage Effluent, Industrial Wastes and Other Causes Negligible—Prevention by Copper Sulphate Treatment

ALGÆ growth and decay has been determined as the cause of extremely offensive odors coming from Lake Monona, at Madison, Wis., other contributory causes being insignificant. To prevent the recurrence of this condition, instead of waiting to cure it after it has arisen, the recommendation is made that the water be kept under constant biological observation during the early spring and summer of each year and that copper sulphate be applied when necessary to check an increasing growth of algæ. This conclusion and recommendation are the important points of a detailed report submitted to the city in May, 1920, by Alvord & Burdick, consulting engineers, who had been engaged to make a thorough investigation. Collaborating with them in this report were Dean H. L. Russell, of the Agricultural College and Prof. Chancey Juday of the Department of Biology, both of the University of Wisconsin. An abstract of a preliminary report on the subject by John W. Alvord was given in *Engineering News-Record*, Sept. 4, 1919, p. 469.

Three matters which have been thought by the public to be the most likely causes of the unpleasant odors are effluent from the Madison sewage-works (see *Engineering News-Record*, Sept. 11, 1919, p. 510), washings from a beet sugar factory and algæ in the lake water. In 1918, when the conditions were very bad, the odors prevailed all over and around the lake and were not localized as they probably would have been if caused at some one point. At the same time there was an abundant growth of algæ in the water.

Public opinion has placed the responsibility largely upon the sewage effluent, and some years ago a resident brought suit against the city for causing a nuisance by permitting sewage pollution of the lake. As a result of this feeling there has been a popular suggestion that the effluent should be pumped five miles to the outlet of the lake or twenty miles to the Wisconsin River. The report shows that these projects would involve investment costs of $433,000 and $1,330,000 respectively, to say nothing of operating costs, but the money would be wasted since it would not result in abating the odors from the lake.

The offensive growth consists of the so-called blue-green algæ, mainly anabœna, clathrocystis and cœlosphærium, all of which give out odors when living. The algæ are present to some extent every year. Detached masses are driven by the wind upon the shore and beaches, where they decay and cause concentrated odors in addition to those coming from the decaying matter on the surface of the lake. The odor was most offensive and widespread in 1882, 18[illegible]8, 1913 and 1918, but it is more or less noticeable nearly every year. It is said to resemble that from a very foul pigpen.

A strong argument supporting the conclusions of the report and refuting the sewage pollution theory is that the offensive odors were a marked source of annoyance and complaint in 1882, before the city had a sewerage system. The trouble was investigated at that time by Prof. William Trelease, of the University of Wisconsin, who explained the condition of the water and showed that masses of decaying algæ were the cause of the objectionable odors in that year. In 1918 and 1919 the conditions at the sewage-works, sugar plant and other suspected sources were practically identical, but algæ and odors were much in evidence in the former season and noticeably absent in the latter season.

In 1918, about four tons of copper sulphate was used in Lake Monona, being applied from time to time at troublesome points. Although this treatment was effective locally, its general effect was nullified by the fact that the entire lake was covered with decomposing algæ. In 1919, about 5½ tons were used, but the lake was admittedly free from unusual growth. This treatment was made in the usual way by towing bags filled with the chemical, but the report states that the work was not under laboratory control and that the quantities used were far below those found effective in waterworks practice. Further, it states that there is no precedent for the application of this treatment to so large a body of water as Lake Monona, which has an area of 5.45 sq.mi., a shore line of 13.2 miles (of which four miles are closely built up), a depth of 27½ to 74 ft. and a volume of 4,195,000,000 cu.ft. or over 31,000,000,000 gallons.

Effluent from the sewage-works during 1919 was found to have a uniform stability of 95 per cent, which, the report explains, represents a high degree of effective purification and is incapable of producing nuisance by odors. Fish life and dissolved oxygen are abundant at the outlet of the effluent discharge into the Yahara River just above the entrance into the lake. The beet sugar factory operates late in the fall, after the period when the lake odors are most offensive, and its wastes do not produce distinctively sewage odors, although they do produce unsightly conditions. Storm waters and industrial wastes are considered insignificant as causes of pollution and trouble. Further, the report states that neither the sewage effluent nor the sugar factory wastes are important causes of stimulating algæ growth, as such growth occurs even in waters where there is no pollution.

In explanation of this opinion as to the effect of the sewage effluent, the report points out that the present flow of this effluent in the Yahara River, about 6 cu.ft. per second, is less than 4 per cent of the average flow of the river. With this effluent and other sources it is estimated that the river annually delivers to the lake about 108 tons of organic nitrogen and 18 tons of nitrates and nitrites.

Nitrates do not appear to be a direct measure of plant or algæ growth, according to the report. Although nitrates which the sewage effluent introduces into the lake in considerable quantity are an indispensable food

for plant life, it has been shown by experiment and observation that some other factor than inorganic food supply determines the extent to which these growths will flourish. There is some evidence that this factor is an organic substance and may be a waste product of certain organic life of the complex environment in which the algæ grow. At present, however, the physiology of fresh water algæ is not well understood even by specialists.

Copper Sulphate Treatment Recommended

To prevent recurrence of the objectionable conditions it is recommended that during each spring and summer the lake water should be kept under constant biological observation. When early symptoms of algæ growth are observed, particularly in abnormal amounts, copper sulphate should be applied under the direction of the biologist, in order to stop the growth and thus prevent the odors resulting from its death and decay in great quantities. The annual cost of the laboratory and control work is estimated at $4,000 to $5,000, but in occasional years, when large amounts of copper sulphate are required, this may be 50 per cent larger.

As spent sediment and harmless fungi passing into the lake with the sewage effluent make an unsightly condition and cause a popular erroneous judgment as to the source of odors, it is recommended that the effluent be carried out into the lake by a submerged wooden box conduit about 1,000 to 1,200 ft. long. This will also give better diffusion of the effluent with the dissolved oxygen of the lake water. The cost of this outlet is estimated at $12,000 to $15,000. An auxiliary recommendation is the dredging of a strip of shallow shore on the city front to prevent the nuisance arising from weed growth in shallow water, the excavated material being utilized for lake-front park development.

In a review and opinion endorsing the report, which has been added by Dean H. L. Russell and Prof. Chancey Juday, it is suggested that the outlet of the effluent conduit should not be submerged more than 20 ft., owing to the effects of temperature changes on oxygen content in the water. As to the proposed shore line dredging, it is suggested that weed growths will develop abundantly in 12 to 15 ft. of water and will facilitate the accumulation of organic matter which produces odors from decomposition. Thus a considerable depth would be necessary to effect the object sought by the proposed dredging.

Aspirators for Water Ozonization Plants

Tests of aspirators for uniting water and ozone or air in ozone plants for water disinfection are described by A. E. Walden, superintendent and chief engineer, Baltimore County (Md.) Water & Electric Co., in the October number of *Mechanical Engineering*. Of various forms of aspirators, siphons, jets and nozzles found available for trial, the best results were obtained from the Knowles spirojector, but this device "did not function at low heads any better than other types" and is "difficult to construct in either tile or enameled iron." Finally there was designed a cast-iron aspirator, enameled with white porcelain "but even this is subject to deterioration, due to high ozone concentration." The paper mentioned shows the forms of the various aspirators used, and gives tabular and graphical data of results obtained.

Letters to the Editor

Pavement Type Nomenclature

Sir—A not infrequent error in pavement type nomenclature would seem to justify the attention of writers upon highway subjects and others whose duties make conciseness not only a virtue but a practical necessity. I refer to the use of the word "concrete" without any other qualifying designation.

The definition as given by the Century Dictionary reads: "A compact mass of sand, gravel, coarse pebbles or stone chippings cemented together by hydraulic or other mortar, or by asphalt or refuse tar." This definition has been supported and substantiated by court decisions from which it is found that concrete aggregates may consist of crushed stone, gravel, sand, cinders, furnace slag or a combination of these, and the cementing material may be portland or natural cement, asphalt or tar. Correctly speaking a "concrete" pavement may, therefore, be any one of a score of designs, including asphaltic concrete, portland cement concrete, or bituminous concrete cemented with tar.

To be reasonably definite qualifying adjectives such as "portland cement" or "asphaltic" should always precede a reference to "concrete" pavements, and where further accuracy is desired the kind of aggregate should be indicated.

I believe this is a matter of sufficient importance to justify placing before your readers.

J. E. Pennybacker,
Secretary of The Asphalt Association.
New York City, Oct. 22.

[We question the soundness of Mr. Pennybacker's position. Usage, and not the dictionary, usually makes work-a-day definitions. The engineer and the contractor think of "concrete" as an artificial stone composed of fine and coarse aggregate, water and hydraulic cement. Why not accept that and call a mixed asphalt road "mixed-asphalt" road, and a penetration job a "penetration" road. The matter merits discussion and the opinion of engineers and contractors is invited.—Editor.]

Once More the Concrete Foreman

Sir—The editorial in *Engineering News-Record*, Aug. 19, p. 338, entitled "Educate the Concrete Foreman," made very agreeable reading. It expressed a thought which I have had for some time.

For about two years I have been doing concrete work in this city and I have had trouble, annoyance and bilious days. I looked for outside advice, since I could not get it here and from several sources in the States, notably from the Building Code prepared for the National Board of Fire Underwriters by Ira H. Woolson, I learned a number of things. I think I know now how to avoid troubles in concrete—but not completely if I have to rely on foremen.

The violation of the fundamental requirements of a first-class concrete structure is the universal rule. The fundamentals are very simple, but very necessary to be attended to. However, they are not and the cause of the violation is the foreman. A foreman who has had an experience in work for ten or twelve years believes himself superior to all engineers; he is hurt at the simplest remark made at his work. He knows everything, and a man that knows everything does not want advice or remarks from any other man. He believes the engineer and the contractor much below himself.

For the work of proportioning, mixing and placing concrete he appoints any of his men, generally one of his pets; it is no importance to him that the mixing is done in a muddy place, or where waves of dust are continuous or the sun burns; he does not care if the water is full of vegetable matter or if the men are smoking and drop pieces of cigarettes or cigars into the mixture. Sometimes at 3 o'clock he tells the men to make a large quantity of concrete in order to have enough till 5 o'clock. If one tells

him that the forms are leaking he answers: "that has no importance; I will plaster it." He will laugh contemptuously at the man that tells him that there are certain physical and chemical forces at work that have to be taken into consideration in order to have a good construction.

We have had English, American and German foremen here and all are affected by the same defects. It would be better to have illiterate men who would obey orders than foremen who know everything.

The ideas expressed in the editorial referred to are very much to the point. Concrete engineering (or concrete work) is a remarkable exception in its development compared with the other industries, arts and sciences. Gun manufacture, bridge building, ship and locomotive building, surveying, physics, chemistry, medicine, all were born in very humble places, in the shops, the camps and other places and took centuries or thousands of years of work and experience to reach their present stage. And theory and practice were and, in some cases, are in disagreement.

With concrete the case has been very different, for experimental stations have reduced the thousands of years that were necessary in the other arts, to a few years, and so theory and practice have gone hand in hand. Consequently the pretensions of foremen should be put down without any consideration. There is but one way of thinking in this matter, and that is to follow or be guided by the results or knowledge derived from thousands of conscientious and careful experiments.

ANSELMO MIERES Y LLERA.

Guatemala City, Oct. 1.

Should Report and Consolidate All Rainfall and Run-Off Records

Sir—In many engineering investigations it becomes of great value to have as large a number of rainfall and stream-flow records as possible. For the State of New York there are at present published something like eighty records of precipitation in the climatological data of the Weather Bureau. There are many rainfall stations maintained by private and public interests which do not report to the Weather Bureau.

It has been the idea of the writer for some time that the publication of all available rainfall data, as well as stream-flow data, in a single bulletin or other publication would be of very great value. Having this in mind a letter was written to Prof. Wilford M. Wilson of Cornell University, head of the U. S. Weather Bureau in New York State, asking if the bureau would be willing to publish such records as are obtainable. Professor Wilson states that the bureau will receive, publish and file all records of rainfall made under proper supervision in the State. The records must be reported on blanks furnished by the bureau.

If the various interests which maintain rainfall stations would turn in monthly reports to the section director at Ithaca they would confer a great benefit on others who might have use for rainfall data and in addition to that would be making the climatological data of more use to themselves, as all the obtainable information for the State would be included in the one publication.

The same applies also to the matter of stream-flow records. It is suggested that additional records of flow might be published either by the State Engineer or the Conservation Commission, or both, in their annual reports and that suitable arrangements be made between the various parties maintaining such stations and one or the other of these authorities for the keeping and publishing of such records. By this means it seems that there might be from two to three times as many records of flow brought together under the covers of one book as are now obtainable from the publications of these two departments.

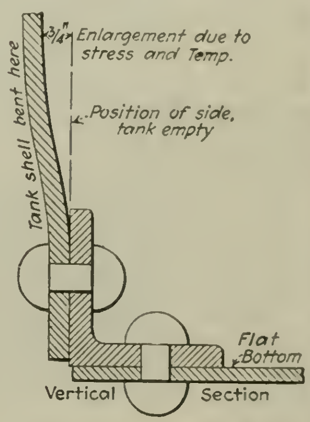
As an extension of this idea the writer would suggest that the American Society of Civil Engineers might well collect, collate and publish the various stream-flow and rainfall records obtainable for past years. It is suggested that this might take the form of a loose-leaf book of standard letter size (8½ x 11 in.) or of small bulletins covering a given stream or stream-flow station which could be punched and inserted in a standard loose-leaf cover. The same system could be applied to rainfall records. The plan suggested would enable interested parties to obtain the particular information without going to the expense of purchasing the entire collection.

BYRON E. WHITE,

Utica, N. Y., Oct. 26. Engineer Utica Gas & Electric Co.

Bending Stress in Tank Shells Due to Restraint of Bottom

Sir — Concerning the collapse of a molasses tank in Boston, the remarkable similarity of this case to the failure of the water reservoir of a gas holder in New York about twenty years ago is notable. In that disaster a number of lives were lost and great property damage occurred, and the owners and their engineers were able to convince a coroner's jury that the failure was caused by dynamite exploded in the tank by persons unknown, which also is the theory advanced in this instance. In each case the cause was undoubtedly the same, and the same danger exists in all flat-bottomed tanks of large size as usually constructed. The practice of following apparently safe precedents, well established as safe for small structures, as the basis for design and detail of much larger structures, has been responsible for some large failures, notably that of the Quebec bridge. The error in the case of flat-bottomed tanks is due to basing the calculation of strength on pure ring stress only, neglecting the misnamed secondary stresses caused by the restraint of the ring by the comparatively unyielding flat bottom. These stresses produce flexure in the side plates near their connection with the bottom. Experience in boiler practice has shown the necessity for properly providing for these stresses, even in case of small diameters, by a curve of sufficient radius to distribute the bending and thereby reduce the stress.



SKETCH OF TANK SHELL NEAR FLAT BOTTOM

As the failure of the molasses tank occurred in January, it is possible that the liquid was warmed to reduce the viscosity. It can be shown that such heating would considerably increase the bending stresses, and that the combined tension and bending stress closely approached the ultimate strength of the material. If the tank had been filled several times before failure, it is probable that even a few repetitions of this great overstress had initiated progressive fatigue cracks, even without the aid of temperature stress. From the published facts the increase in diameter due to ring tension, tank full, would be about 1.25 in.

A small temperature difference would increase this 0.25 in., and the accompanying sketch shows the resulting condition. In view of these conditions and of the published estimate of 1.6 as the factor of safety based on ultimate strength and pure ring tension only, there appears to be no need to search for an outside agency to account for this failure.

GEORGE ROE.

Portland, Ore., Oct. 18.

Unusual Sewerage Conditions in Texas

Of 103 cities in Texas the sewers in 23 are owned by companies, of 70 by cities, while the ownership of 2 is unknown and 8 cities have no sewers. Of the companies 22 of the 23 (one did not report on the subject) charge for the use of sewers. Of the cities 51 charge and 10 supply sewerage service free.

Hints for the Contractor

Traffic Help During Street Obstruction

By UTILIZING part of a wide sidewalk as a roadway the trenching of Michigan Ave. at Randolph St., Chicago, for a footway undercrossing, was effected with a minimum of interference to the extremely heavy automobile traffic on that thoroughfare. The work was done in two sections, so that only half the width of the roadway was blocked at one time. A fence was built along the sidewalk of the side open to traffic, leaving a narrow passage for pedestrians, the gutter being filled in with planks to form a smooth roadway. Automobiles in one direction swung out through this curved widening of the roadway, instead of all vehicles being confined to the half width of the roadway proper. The Nash-Dowdle Co. has the contract for this undercrossing, which will form an approach to the suburban terminal station of the Illinois Central R.R.

Overdriven Piles Form Coal-Like Substance in Gravel Bank

By B. H. Piepmeier

Engineer of Construction, Illinois Division of Highways, Springfield

On THE Illinois state road Project 5, near Chillicothe, the highway crosses seven tracks of the Atchison, Topeka and Santa Fé R.R. at grade. It was decided to make a grade separation at this joint by taking the highway under the railroad. A temporary trestle carried by 30-ft. piles was constructed to support the

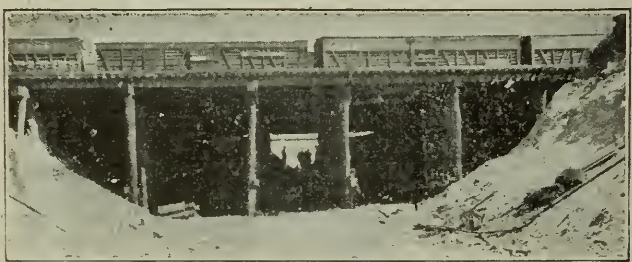


FIG. 1. PILE TRESTLE CARRYING TRACKS DURING CONSTRUCTION OF UNDERCROSSING

tracks during the time the excavation for the under crossing was made and the permanent structure built. The effects of the pile driving, as revealed in the subsequent excavation, were remarkable.

The piles were of oak, standard size and well seasoned. They were pointed with a steel point and capped with the usual ring and plate, then driven with the standard railroad steam piledriver. They were to be driven their full depth through a well graded bank gravel (2-in. pebbles to sand) above water level.

All piles were apparently driven their full depth even though the driving was very difficult. In some instances 24 to 30 hours of constant driving with the large steam hammer were required to sink the piles to the proper depth.

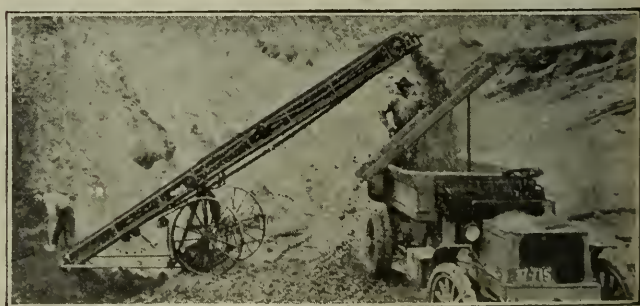
After the trestle was completed the excavated material was removed from beneath the tracks and from

FIG. 2. PILE COMPRESSED TO ONE-FOURTH ITS LENGTH

around the piles. Careful examination showed that over 50 per cent of the piles had failed to penetrate their full depth. Many had buckled and had been compressed into all kinds of shapes. In a number of instances the 30-ft. piles had been merely compressed into a mass of from seven to ten feet in length, and from 18 to 24 in. in thickness. In a few cases 10 to 15 per cent of the compressed mass was apparently pure coal. Over half the piles had to be redriven after the excavated material had been removed.

Pit Sand Rapidly Screened and Loaded Into Auto Trucks

The accompanying illustration shows a novel scoop conveyor installation at the sand pit of Somers & Sons, Wyoming, Pa. The screen was placed in the truck, being supported in the truck by a pole and on the edge of the truck by a small block of wood. The 24-ft. scoop conveyor was then placed so that the ma-



SAND SCREENED AND LOADED

terial, when discharged, would fall near the top of the screen. The screen being set at the proper angle the large lumps rolled off out of the truck while the "fines" fell through.

With this arrangement 5 tons of sand were loaded and screened in 7 min. In addition to money saved on the loading operation, additional revenue was obtained by delivering screened sand.

NEWS OF THE WEEK

New York, November 4, 1920

German Exports Exceed Imports in April and May

(From "Engineering News-Record's" Berlin Correspondent)

For the first time in years the money value of exports from Germany was greater than that of imports during April and May of this year, according to figures just made public. In April, 1920, the balance of exports over imports amounted to 12 per cent and during May, approximately 20 per cent. For the year 1919 the imports were approximately three times the exports. For the first five months of 1920 the exports approximated 83 per cent of the imports.

When studying the attached table of comparisons between pre-war and 1919 and 1920 figures, full account must be taken of the depreciated value of the mark. The increase of imports during the years 1919 and 1920 is partly due to the low purchasing power of the money and partly to the fact that there was practically no control of the imports at the western frontier. The money value of exports has increased considerably, but it is believed that their quantity is below that of the pre-war level.

IMPORTS AND EXPORTS OF GERMANY

1919	Import Mill. Marks	Export Mill. Marks
January	397	161
February	408	195
March	440	292
April	626	270
May	1,468	251
June	2,688	406
July	3,538	570
August	3,817	735
September	4,191	790
October	5,179	1,089
November	4,446	1,284
December	5,178	4,014
Total	32,376	10,057
1920		
January	6,560	3,219
February	5,932	4,262
March	5,683	4,261
April	4,768	5,344
May	5,537	6,647

Pennsylvania Builds 26 Mi. Durable Highways in a Week

The Pennsylvania Highway Department has announced that during the week ending Oct. 14, all Pennsylvania records on road construction were broken. During that week on various construction projects in the state, 26.27 mi. of modern-type highway were put down. During the present construction season and up until Oct. 19, the State Highway Department of Pennsylvania has constructed approximately 320 mi. of modern-typed roadway.

During the season of 1920 the maintenance forces of the highway department have entirely resurfaced approximately 315 mi. of macadam roadway and have oiled approximately 1,300 mi. of road.

Vermont's New Governor Is An Engineer

As the result of the Election Nov. 2, an engineer, James Hartness, of Springfield, Vt., becomes the new Governor of Vermont. Mr. Hartness, the Republican candidate for office, is past-president of the American Society of Mechanical Engineers and was instrumental in organizing the Jones & Lamson Machine Co. at Springfield 30 years ago. His efforts are considered to be responsible in large part for the industrial growth of Springfield.

JAMES HARTNESS, VERMONT'S ENGINEER GOVERNOR

Electrical Engineers Name Federation Representatives

The Board of Directors of the American Institute of Electrical Engineers, at its meeting Oct. 8, appointed the following representatives of the Institute on the American Engineering Council, the governing body of the Federated American Engineering Societies: Comfort A. Adams, Cambridge, Mass.; A. W. Berresford, Milwaukee, Wis.; H. W. Buck, New York, N. Y.; F. L. Hutchinson, New York, N. Y.; W. A. Layman, St. Louis, Mo.; William McClellan, Philadelphia, Pa.; L. F. Morehouse, New York, N. Y.; L. T. Robinson, Schenectady, N. Y.; Charles S. Ruffner, New York, N. Y.; L. B. Stillwell, New York, N. Y.; Calvert Townley, New York, N. Y.

The Florida Engineering Society has appointed L. R. McLain to represent it at the first meeting of the American Engineering Council, Nov. 18 and 19, at Washington, D. C.

Prof. Whipple Speaks of His Work in Europe

Tells Water-Works Men About Activities of Sanitary Department of League of Red Cross Societies

The chief feature of the meeting of the New York Section of the American Water Works Association, Oct. 20, was an address by Prof. George C. Whipple, of Harvard University, who from February until October of this year was chief of the Department of Sanitation of the League of Red Cross Societies, with headquarters at Geneva, Switzerland. Prof. Whipple outlined the work of his department abroad and some of the prospective work of his successor at Geneva, Colonel F. F. Longley.

Among the subjects to which Prof. Whipple gave special attention while in Europe were sanitary surveys, a scheme for which was outlined; water supply studies, and public health education. Colonel Longley, Prof. Whipple said, is now engaged on a glossary of terms used in sanitation and public health. He also stated that the League of Red Cross Societies, working with the Tuberculosis Commission of the Rockefeller Foundation, is carrying on a study of public water supplies in France. It is expected that water supply studies will be made in other European countries, inasmuch as in various parts of Europe the public water supplies are insufficient in quantity and quite unsuitable in quality. Moreover, there are some large cities that have no public water supplies at all.

As an illustration of public water supply needs that have been accentuated by war conditions, Prof. Whipple stated that in Roumania and elsewhere in Continental Europe filter plants and pumps are out of use entirely on account of the lack of some small part which would cost very little, but cannot be secured. The same general condition applies to transportation in Europe.

Incidentally, Prof. Whipple stated that France is planning to enlarge its canals.

PUBLIC HEALTH EDUCATION

As to public health education in Europe, Prof. Whipple said that outside of England there is very little education in public health. Some instruction in the subject is given in medical schools, but this is by doctors and is quite inadequate, especially along sanitary lines. Prof. Whipple spent two or three months visiting European universities, particularly in Switzerland. He was well received and the indications are that before long a school of

public health will be established in Switzerland. This may be a Swiss government school or it is possible that it will become international in character, depending on whether or not arrangements are made under which the school will be supported by the League of Red Cross Societies. Prof. Whipple has been asked to make a survey of health education in Europe.

A question remaining to be settled is how far the League of Red Cross Societies, which is made up of representatives of societies in some thirty countries of the world, shall go in public health work. Prof. Whipple expressed the opinion that it was important to remember that public health is largely a governmental function and that in this field the Red Cross Societies should not encroach. Earlier, it was thought that the League of Red Cross Societies should go extensively into public health and sanitation, but the feeling is growing that the work should be taken up instead by an International Department of Public Health, under the League of Nations, confining the Red Cross efforts to educational work and emergency relief activities.

The next meeting of the New York Section of the American Water Works Association will be on Dec. 1, when a trip will be made to New Milford, N. J., to visit the works of the Hackensack Water Co.

Shipping Board To Sell Housing Projects

The United States Shipping Board is to dispose of all the housing projects in which it owns capital stock. When its housing program was inaugurated money was advanced to local realty companies or housing companies organized by the shipbuilder concerned. The builder constructed the houses on the land owned by them and the Shipping Board took back from the local realty companies mortgages covering the amount of the houses in each case. The board also became the owner of various housing projects by the acquisition of the capital stock of a number of realty companies.

The board now plans to dispose of such projects. The plan for the disposition contemplates selling these projects to manufacturing and business concerns of a substantial character or disposing of the houses by individual units.

In order that local conditions may be considered and fair terms arranged, it is provided that each project shall be passed upon by competent local appraisers who shall report the value of the buildings, the lots and parcels of land and the most advantageous methods and terms of sale. Such a plan enables the appraiser to present the local conditions which the board will consider in offering the various projects for sale.

The projects affected by this announcement are located at Wilmington, Del.; Camden, N. J.; Chester, Pa.; Loraine, Ohio; Wyandotte, Mich.; Jacksonville, Fla.; Groton, Conn., and Dundalk, Md.

Substantial Salary Increase for New York Engineers

(By Arthur S. Tuttle, Chairman, Engineering Council's Committee on Classification and Compensation of Engineers)

Under a recent general readjustment of salaries of municipal employees in the City of New York the compensation for all positions carrying a salary of less than $7,500 per annum has been increased. In the case of salaries of less than $1,500 the increase is at the rate of 22 per cent with a minimum of $200. In the case of salaries ranging from $1,500 to $2,500 per annum the increase is 20 per cent. To salaries upwards of $2,500 per annum $500 has been added, but salaries plus increases have been limited to a maximum of $7,500.

Position	Number of Employees	Average Salary July 1, 1915	Average Salary After Aug. 20/20	Per Cent Increase
Chief Engineer (including Deputy Chief Engineer)	20	$7,270	$7,450	2
Engineer	50	3,850	4,470	16
Senior Assistant Engineer	86	2,850	3,420	20
Assistant Engineer	171	2,180	2,760	27
Junior Assistant Engineer	56	1,630	2,370	45
Senior Aid (Chief Instrumentman and Chief Draftsman)	64	1,700	2,440	44
Aid (Instrumentman and Draftsman)	285	1,500	2,180	45
Junior Aid (Junior Draftsman and Rodman)	150	1,030	1,720	67

The effect of these increases upon the compensation of the engineering force of the city as organized near the close of last year is shown in the accompanying table, which also gives a comparison with the average compensation for the same positions as fixed before the shrinkage in the value of the dollar became pronounced. All of the positions are classified on the basis recommended by Engineering Council's Committee on Classification and Compensation.

Comparing the present average compensation with the compensation schedule proposed by the committee, it will be seen that the average pay of junior aids and junior assistant engineers under this scale is substantially greater than that tentatively recommended; that the average compensation for aid is practically the same as that proposed by the committee; that the average compensation for senior aid and assistant engineer is very close to the committee's minimum; and that for the grades senior assistant engineer, engineer and chief engineer the average salary, after the allowed increases have been added and notwithstanding the appreciable betterment in the lower grades, is still approximately $650 to $1,500 per annum below the minimum proposed by the committee.

Health Officers to Discuss Housing at Detroit

A national conference of health officers to consider housing questions will open at Detroit, Mich., on Nov. 30, according to an announcement made by Dr. Henry F. Vaughan, health commissioner of Detroit.

Proposed Engineers and Architects Registration Bill for Ohio

The Association of Ohio Technical Societies has prepared a combined engineers and architects registration bill. Every technical organization in the state is asked to give consideration to the present draft, endorse or submit suggestions. When these suggestions are received a meeting of delegates will be called prior to Dec. 1, for final action on the bill and the adoption of a plan of campaign for its passage.

The bill is of the blanket or omnibus nature, following the medical and legal practice of giving uniform certificates for all branches. A long definition of the practice of engineering and architecture is given because it is the opinion of the committee drafting the bill that the first attempt to enforce the bill would inevitably lead to a definition proposed by persons much less competent to do so than the members of the technical professions.

Provisions of Bill

Only citizens of the United States and Canada or those who have made a declaration of the intention of becoming a citizen are eligible to receive a certificate. The usual reciprocity clause is included. The fee of applicant for consideration without examination is $10 and for examination $25. No renewal of certificates is required. Violation of the law in practicing professional engineering, architecture or surveying without a certificate is denominated a misdemeanor and the punishment is a fine of from $5 to $100 or imprisonment of from 30 days to 1 year. A heavier fine, $100 to $1,000, is to be levied on any person who fraudulently impersonates a registered engineer, architect or surveyor.

The bill is a compromise drawn up by a committee, originally appointed in January by C. L. Rood, president of the Ohio Engineering Society. The committee was later adopted by the Association of Ohio Technical Societies and endorsed by the Ohio Assembly of the American Association of Engineers. It was submitted in preliminary form July 9 to a committee of delegates representing most of the technical societies of the state and the Ohio Association of the American Institute of Architects. The personnel of the committee is as follows: E. A. Lawrence, W. A. Stinchcomb, R. E. Hempel, E. G. Bradbury, chairman, and F. P. Obee, secretary.

Military Engineers Discuss Army Reorganization Bill

The general plan of administration of the army reorganization bill as contemplated by the General Staff, War Department, as well plans for the administration of the various technical services, was the main subject of discussion by members of the New York Post, Society of American Military Engineers, at its first fall meeting Oct. 26 at the Engineering Societies Building, New York City. The meeting began a series of discussions which are to be held throughout the year, to be participated in by both officers now in the military establishment and those in civilan practice. It is hoped, by these meetings, to create a close co operation between civilian and military engineers.

General features of the reorganization bill were explained by Leiut.-Col. John W. Gulick, War Plans Division, General Staff; plans for the technical services were discussed by Major Donald H. Connolly, General Staff. The third principal speaker was Col. William Barclay Parsons, chairman of the Post's military affairs committee, who outlined a plan providing for the interchange of civil and military engineers whereby the civilian engineer would be assigned to troops for a certain period during the year and the military engineer would replace him in his civilian capacity.

One of the details of the reorganization bill as explained to the military engineers was the plan whereby all reserve officers, in case of an emergency, could be immediately given definite assignments. Not only would the bill retain divisional organization of engineer troops, but corps, army and general headquarters units, so that in emergencies long periods of unassignment of reserve officers would be obviated. It was also pointed out that reserve officers, with their consent, may be called upon to assist the Corps of Engineers in river and harbor work.

Most of the program for the entire year's meeting has been arranged. The next meeting of the New York Post will be Dec. 14. Colonel Roger D. Black, formerly Corps of Engineers, U. S. A., will discuss the "Relations Between Staff and Services." The annual dinner is to be held some date in January. The other meetings and the subjects to be discussed are as follows: Feb. 10, "Functional Organizations of Engineers," by Major George R. Spalding, Corps of Engineers, U. S. A.; April 13, "Military and Engineering Defense of New York. A trip to West Point will be made in May.

Burlington, N. J., May Buy Out Private Sewer Company

After lengthy negotiations an agreement has been reached between the city authorities and the Burlington Sewerage Co. under which the city will buy the sewerage system of the company. The council has passed an ordinance appropriating $85,000 of bonds to pay for the system.

May Cross Toronto Harbor by Bridge or Tunnel

Projects for a bridge or a tunnel to cross the "western gap" of the harbor at Toronto are being studied by the Department of Public Works, it has just been announced. A bascule bridge was investigated some time ago; its cost at present prices would be at least $700,000. Such a structure would probably reduce the available channel width for navigation, however, and a tunnel is being studied by the department as an alternative. The construction cost of a tunnel is believed to be greater than that of a bridge, but land damages and maintenance are expected to be lower. Decision on proceeding with one or the other type of crossing is likely to be made by next season, as the Dominion Government and the Board of Harbor Commissioners have an agreement that a crossing shall be provided.

Entire Staff Resigns as Protest Against Chief's Defeat

As a protest against the defeat of Lloyd Aldrich, county engineer of Sonoma County, Cal., at the election Aug. 31, the entire county engineering organization, numbering 41 men, has resigned. This action is said to be the result of the attitude of certain public officials and politicians toward Mr. Aldrich and the lack of support of the people of Sonoma County. The members of the county engineer's staff state their refusal to subordinate themselves to the new administration resulting from the September election. There follows a copy of a resolution passed recently and signed by the 41 members of Mr. Aldrich's staff:

Whereas, the outcome of the county election of Aug. 31, 1920, is an indication that the efforts of our chief and ourselves to honestly and efficiently conduct the engineering work of Sonoma County have not received public appreciation, and

Whereas, We know the great difficulty that will attend any attempt on our part to maintain an equally high standard of engineering and efficiency under the proposed new administration, now therefore be it

Resolved, That we, the engineering organization of Lloyd Aldrich, County Engineer of Sonoma County, do hereby express our great confidence in the ability and integrity of our chief, and our refusal to subordinate ourselves to authority governed by ideas which we believe are not in accord with the public welfare and the best engineering practice, by making our resignation from the service of Sonoma County coincident with his own.

New Jersey Highway Department Plans Winter Conference

A two-day convention of the staff of the New Jersey State Highway Department will be held in Trenton during the coming winter to co-ordinate activities and develop an *esprit de corps*. No date for the conference has yet been set. It is planned to have a collection of road building materials on exhibition at the laboratory of the department in Trenton. The participants will include division engineers, assistant engineers, road inspectors, foremen, heads of various departments, members of field parties and all others connected with the department.

Non-Partisan Political Meeting of New York Engineers

To carry out its primary purpose of dealing with public matters involving engineering, the New York chapter of the American Association of Engineers held a non-partisan political meeting at the Engineering Societies Building on Oct. 12, 1920. The two major national parties had been asked to send official representatives to deal with the question, "Which party makes the strongest appeal to the engineer?" United States Senator J. T. Robinson, former Governor of Arkansas, was present as the Democratic representative, and Elon H Hooker, president of the Electro Chemical Co., of Niagara Falls, and long a leading figure in state politics, represented the Republicans. In addition to the addresses of these speakers, answers of candidates for President and Governor to a series of questions of engineering importance were presented to the meeting.

Of the national questions (see our issue of Sept. 23, p. 624), that asking support of a movement for a department of public works was perhaps the most important. Governor Cox (Democratic) answered this and all the other questions with specific affirmatives. Senator Harding (Republican) replied by general statements with an apparently affirmative import. As to state issues, Governor A. E. Smith (Democratic) and Judge N. L. Miller (Republican) were asked the following questions:

Questions Asked

(1) Are you in favor of the establishment of a budget system for all state expenditures? (2) Are you in favor of the establishment of a bureau of public works, under efficient engineering direction? (3) Are you in favor of placing the planning, construction and maintenance of a comprehensive and modern highway system under such a bureau? (4) Are you in favor of the appointment of competent engineers as part of the membership of public service commissions and other bodies supervising work largely of an engineering nature? (5) Are you in favor of aggressively seeking a solution of the problems involved in making New York City the foremost port of the world?

Affirmative answers to all these questions were given by both candidates. It was emphasized at the meeting that these declarations by the leading candidates give the association means for following up the reforms covered by the questions.

In discussing national issues of particular appeal to engineers, Senator Robinson reviewed the questions addressed to the presidential candidates, and emphasized Governor Cox's categorical support of the measures outlined, at the same time denouncing the qualifications contained in the replies of Senator Harding. His address was interpreted as putting the Democratic party clearly on record in support of

the public works department and other measures dealt with in the inquiry.

Mr. Hooker emphasized the record of the Republican party in constructive legislation as an assurance of its performance in the same direction during the next Congress, and severely arraigned the inefficiency and lack of sound business methods of the Democratic administration, an arraignment which he illustrated very effectively by citing his personal experiences with the War Department. Speaking as an engineer to engineers, Mr. Hooker dwelt on their responsibility to the public, and urged them to use their influence to bring about increased efficiency in government.

Hearings on New York-Delaware Intercoastal Waterway Planned

In accordance with a provision of the latest Rivers and Harbors Act, hearings are to be held by the Corps of Engineers, U. S. A., looking into the feasibility and desirability of a proposed intercoastal waterway from New York Bay to the Delaware River. These will be in the Army Building, 39 Whitehall St., New York City, Nov. 11, 1920, at 11:15 a.m. and in the Mayor's Reception Room, City Hall, Philadelphia, at 11:15 a.m., Nov. 12.

Transformer Explosion Kills Twelve

Shortly after starting two new transformers in a substation of the Niagara Falls Power Co. at North Tonawanda, N. Y., on Oct. 31, an explosion occurred in the substation which resulted in the death of twelve men from oil burns. Press reports state that the transformers burst, apparently because of an internal short-circuit.

Early Reissue of Road Materials Shipping Permits Probable

Issuance of permits authorizing the use of open-top railroad cars for road-building materials for urgent requirements probably will be resumed in the near future. When in the early part of October it became necessary to find 2,000 additional cars daily to speed up coal distribution in the Middle West, the Interstate Commerce Commission declined to renew any of the outstanding permits for the transportation of road material or other urgently needed freight in open-top cars. The suspension of the priority order covering coal for shipment on the Great Lakes will release a great many cars, but as coal distribution has been held up in the Middle West and in the East while the Northwest was being given its supply, there is some uncertainty as to the number of cars it will be possible to release from the coal trade. A definite policy in this connection probably will be worked out within the next few days.

Two More Societies Join Engineering Federation

Two more societies have become charter members of the Federated American Engineering Societies, in addition to the fourteen listed in the Oct. 21 issue of this journal, p. 817, thus making the total sixteen. The Engineering Society of York, Pa., voted in favor of joining the federation at its meeting Oct. 18, while the Washington Society of Engineers took affirmative action Oct. 20.

Conference on Employment and Vocational Education

On the tentative program of the conference on employment and vocational education, to be held Nov. 12 at the Congress Hotel, Chicago, are scheduled eleven papers, four group meetings and a discussion in the general meeting of the group findings. The conference, which is sponsored by the American Association of Engineers, will consider the problems of employment which are confronted by non-commercial employment bureaus and the relation between employment service and education.

"Placing the Graduate in His First Position" is the subject of an address to be delivered by A. B. Crawford, director of the bureau of appointments of Yale University. The attitude of the employer toward the man placed in his employ by the employment bureau will be outlined by Frank D. Chase, president of Frank D. Chase, Inc., of Chicago. Employment office administration will be discussed by George P. Hambrecht, chairman of the Industrial Commission of Wisconsin. The relation between education and industry will be explained by John B. Densmore, director-general of the Employ-Service. One of the important addresses is that to be delivered by James P. Munroe, vice-chairman of the Federal Board for Vocational Education, on "Vocational Advisement as a Prime Function of Vocational Education." J. H. Libberton, manager of the service bureau, Universal Portland Cement Co., will speak on "Fitting College Students for Success."

Bankers Endorse Federal Aid Highway Work

A continuance of federal aid highway work and the reclamation of arid lands are recommended in one of the resolutions adopted by the American Bankers' Association at its meeting in Washington last week. The resolution reads:

"The association favors the present arrangement of co-operation between the Federal and State Governments in the construction of national highways as the best system available, considers that a five-year building program for the national highways will prove most satisfactory, adequate appropriations being made. We favor such Federal assistance as is possible toward the continued reclamation of irrigable arid lands."

Industrial Information Bureau in China Organized

The Government Institute of Technology at Shanghai, China, will open next February a Bureau of Information for alumni. The school is under Chinese government support and prepares engineers and railway administration men with a technical education. These men often are located away from the port cities and when they desire information regarding equipment find it difficult to obtain. To meet this need the school is about to open the bureau.

Manufacturers who are interested are invited to send catalogs, specifications, designing data, approximate costs, samples or models. No sales will be made nor attempted. Impartial information alone will be offered. A member of the faculty (H. A. Vanderbeek, 5 Cammann Place, Somerville, N. J., until December, 1920, and Box 951, U. S. P. O., Shanghai, China, after that date) is now in America on leave and will be glad to communicate further with any who desire information regarding the China field.

Pennsylvania Highway Contractors Form Organization

At a meeting of the Pennsylvania highway contractors, held at Harrisburg recently, a temporary organization was appointed to draft a constitution and by-laws and arrange other details for an organization to be known as Associated Pennsylvania Highway Contractors. H. H. Wilson of Winston & Co. has been made chairman of the temporary organization and E. J. Harding, of the Associated General Contractors of America, has been loaned by that organization to assist in perfecting the permanent organization of the new association.

A general meeting and banquet for the purpose of arranging a permanent association will be held at Harrisburg in the near future. Sixty contractors engaged in constructing state roads in Pennsylvania attended the preliminary meetings.

Board of Purification of Waters Begins Work in Rhode Island

Under a recent legislative act "to prohibit and regulate the pollution of the waters of the state," a Board of Purification of Waters assumes control of water pollution other than that affecting the purity of waters for drinking purposes and ice supply, which are under control of the State Board of Health. The board consists of Dr. Thomas H. Connolly of Warren, Giles W. Easterbrooks of Pawtucket, and Harold T. Merriman of Providence. The board is authorized to investigate on complaint or its own motion any alleged cases of pollution, and after hearings to give orders for the cessation of the same. Specific jurisdiction is given over the discharge from steamers or other vessels of petroleum, gasoline, kerosene, tar, oil, or any product or mixture thereof into state waters.

Railway Bridge Builders Hold Meeting at Atlanta

The American Railway Bridge and Building Association held its thirtieth annual meeting at Atlanta, Ga., Oct. 26-28, attended by 250 members. A paper on "The Use of Electricity for Pumping Water" was presented by C. R. Knowles, superintendent water service Illinois Central R.R. Mars Johnson, assistant engineer Illinois Central R.R., presented a paper on "The Erection of the St. Charles Air Line Bridge at Chicago," illustrating it with motion pictures. Other motion pictures of various bridge work on the Illinois Central were shown by J. K. Melton, official photographer of that road. A paper on housing and boarding the maintenance employees was presented by Hunter McDonald, chief engineer, Nashville, Chattanooga & St. Louis Ry. H. C. Boyden, Portland Cement Association, presented a paper on the proportioning of concrete mixtures.

Committee Reports

Committee reports and discussions included the following subjects: Abuse of treated material; repair and maintenance of tank hoops; spray painting; maintenance of timber docks; maintenance of bridges during filling, and maintenance and repair of freighthouse floors.

Mr. Knowles, of the Illinois Central, briefly reviewed the development of electric pumping at railway water stations, as electric power has become more generally available. Now the cost of electric power for pumping is usually lower than the cost of fuel that would be required for a steam plant, and an electric pumping plant will require a building of approximately one-third the size of that required for a steam plant of the same capacity.

Following the report on the abuse of treated material, Hunter McDonald, chief engineer Nashville, Chattanooga & St. Louis Ry., described the satisfactory results secured on that road during a period of twenty years in the use of galvanized iron sheets over caps and stringers to protect them against decay. In connection with the report on repair and maintenance of tank hoops, the discussion brought out a preference for round hoops on grounds of decreased breakage and less injury to timber. The report on spray painting stated that the results depend on the skill of the operator, and in the discussion which followed it was stated that spray painting is economical with experienced operators, the waste paint being offset by the reduction in labor.

Research in Hollow Tile

The hollow clay tile manufacturers association has appointed H. D. Foster as research associate to work at the Bureau of Standards on problems of interest to the membership of this association.

Hoover Sees Opportunity for Profession in Federation

Commenting upon the Federated American Engineering Societies, Herbert C. Hoover, president of the American Institute of Mining and Metallurgical Engineers, in a recent statement given out by the Joint Conference Committee, said, in part:

"The Federated American Engineering Societies is of such portent that it seems to me real co-operation can be accomplished in full measure only by membership in it and that only through such combined action can we secure the measure of public service we all desire. The object of this organization, as stated in the constitution, is to further the public welfare wherever technical knowledge and engineering experience are involved, and to consider and act upon matters of common concern to the engineering and allied technical professions. Here is the opportunity for the engineering profession to show its solidarity and accept this opportunity of performing its duty to the nation, which rests upon the profession as a whole and cannot be performed by any component part in an individualistic effort."

Delegates to Federation Meeting

D. J. Sterrett has been appointed a delegate to represent the Detroit Engineering Society at the first meeting of the American Engineering Council in Washington, D. C., Nov. 18-19.

W. B. Powell will be the delegate of the Buffalo Engineering Society at this meeting.

Second Span of Key Bridge Is Placed

A second temporary steel span has been successfully placed in the course of the construction of the Key bridge at Washington. This span, which is 187 ft. in length, was successfully placed, like its larger predecessor, by floating it into position on barges and allowing it to settle into place with the outgo of the tide.

New British Cement Specification

The British standard specification for portland cement which was first issued in 1904 has been recently revised. The new edition, just issued, supersedes that published in 1915. In the revised specification no cement to which slag has been added or which is a mixture of portland cement and slag will comply with the specification. The specific gravity test and the aeration of cement before testing for setting time have both been eliminated. Other modifications refer to the sampling of cement stored in deep bins, the calculation of the lime ratio, setting times, and the supplying of certificate by the seller. The specification can be obtained from the British Engineering Standards Association, 28 Victoria St., London. S. W. 1.

Concrete Ship Lost in Collision

On the night of Oct. 29 the concrete ship *Cape Fear*, which was built by the United States Shipping Board at Wilmington, N. C., was sunk in the deepest part of Narragansett Bay in a collision with the Savannah Line steamer *City of Atlanta*. The *Cape Fear* was bound south out of Providence in ballast and the *City of Atlanta* north for Providence with a cargo of pig iron. How the accident happened has not been definitely determined. It is reported that the weather was clear and only a light sea running.

The *City of Atlanta* apparently hit the *Cape Fear* head on amidships, and the concrete ship remained above water only a few minutes. Twenty-three of the thirty-four men of the crew of the sunken vessel were rescued, but the remaining eleven are at present unaccounted for.

The *Cape Fear* was built by the Liberty Shipbuilding Co. at Wilmington, N. C., during the war. She is 282 ft. long overall, 46 ft. beam, 28 ft. depth, having a full cargo displacement of 6,175 tons, a deadweight of 3,257 tons. The vessel was described in *Engineering News-Record* July 4, 1918, p. 17.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY CIVIL ENGINEERS, New York City, Jan. 19, 1921.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. 25-27.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Washington, D. C., Dec. 13-16.

FEDERATED AMERICAN ENGINEERING SOCIETIES, New York; Washington, D. C., Nov. 15-19.

NATIONAL DRAINAGE CONGRESS, Chicago; Atlanta, Ga., Nov. 1[illegible]-1[illegible].

The Rochester (N. Y.) Engineering Society, on Oct. 26, was addressed by Edwin A. Fisher, consulting engineer and superintendent of city planning, on "City Planning and Zoning of Rochester."

The Engineering Society of Western Mass., at its meeting, Nov. 11, at Westfield, Mass. will be addressed by Prof. L. P. Breckenridge, Yale University, on "The Evolution of the Cast-Iron Heating Boiler as relating to the Problem of Power and Fuel."

The Western Society of Engineers' noon-day luncheon meetings have been resumed. The following speakers have been announced: Nov. 12, E. J. Mehren, editor, *Engineering News-Record* on "An Engineer's Observations in Europe." Dec. 11, Dr. George E. Vincent president of the Rockefeller Foundation.

The Western Society of Engineers' technical meetings for November include the following addresses: Nov. 8, Charles Evan Fowler, consulting engineer, N. Y., on "The Evolution of Bridge Design;" Nov. 10, S. W. Parr, professor of applied chemistry, University of Illinois on "Fuels of the Future." The Young Mens' Forum is sponsor for three meetings to be held soon. W. H. Fogerty of the Alexander Hamilton Institute will speak Nov. 13, Saturday afternoon, on "Mental Training;" G. R. McDermott, mechanical engineer, Illinois Steel Co. and F. H. Wilcox, mechanical engineer, Freyer-Brassert Co., Nov. 15 on "Waste Heat Utilization," and C. W. Gennet, Jr., engineer, Robert W. Hunt Co., Nov. 18, on "Steel Rails."

Personal Notes

W. H. FRANKLIN, for four years manager of the James Black Masonry and Contracting Company, Chicago, has entered the employ of the Morava Construction Company, Chicago.

C. H. BIRDSEYE, chief geographer of the U. S. Geological Survey, completed arrangements with the district engineer of the Corps of Engineers at Chattanooga for co-operative work between the Geological Survey and the Corps of Engineers on the survey which is to be made of the Tennessee River basin.

IRA ROGERS, recently identified with road projects in Lynn County, Kan., has been appointed resident engineer on Federal Aid Project 60, Kansas Highway Commission, with headquarters at Garnett.

PAGE GOLSAN, formerly assistant-to-the-president Great Western Power Company, consulting engineer for the Fleishhacker interests and of the Western office of C. B. Peters Co., Inc., exporters, has resigned these positions to be with the firm of Ford, Bacon & Davis, engineers, New York City.

G. R. KENNY, until recently statistician and valuation engineer for the San Joaquin Light & Power Corporation, is now with Ford, Bacon & Davis in valuation, report and special investigation work. Prior to his connection with the San Joaquin Light & Power Co. he was assistant engineer for the Railroad Commission of California.

COLONEL H. W. HUDSON, formerly engineer of construction, Transportation Deaprtment, A. E. F., has been appointed chief engineer of the Interstate Railroad Co., with headquarters at Norton, Va.

CHARLES W. SHERMAN of Metcalf & Eddy, Boston, Mass., has been nominated for the presidency of the New England Water Works Association for 1921.

H. WILSON, engineer maintenance of way of the eastern division, Chicago Great Western R.R., with headquarters at Chicago, has resigned to become trainmaster, Denver & Rio Grande R.R., Denver, Col.

Obituary

A. S. MARKLEY, for some time superintendent of bridges and buildings, Chicago & Eastern Illinois R.R., died Oct. 14 at Danville, Ill.

JAMES H. SHERMAN, president of the Sherman Engineering Co., Kansas City, Mo., died in that city, Oct. 2. He was 36 years old. Previous to opening his office in Kansas City he was in the Engineer Corps of the army and had been connected with the Truscon Steel Co., Lehrack Engineering and Contracting Co., and Burrell Engineering Co. at Oklahoma City.

GEORGE M. INGRAM, vice-president Warren Brothers Co., Boston, Mass, died Oct. 28 at Nashville, Tenn. Prior to his association with Warren Brothers Co., which began in 1902, he had organized the Nashville Roofing & Paving Company.

LOUIS B. JONES, on the engineering staff of the Maine Highway Commission, was the victim of an elevator accident which caused his death on Oct. 12 at Portsmouth, N. H., where he was attending a conference on the new interstate bridge. Mr. Jones was 48 years old and a graduate of the United States Naval Academy, class of 1894.

WILLIAM MARRIGAN, contractor, died Oct. 18 at Port Arthur, Canada. He was born in Beauce County, Quebec, 1861, and had been in the contracting business since 1883. Since that time he had been engaged in the following works: Ballasting operations on sections of the Bangor Aroostook Ry. in Maine and the construction of railways, bridges and canals in Canada.

PHILIP A. MORLEY PARKER, one of the leading engineers in the Federated Malay States, died at Kuala Lumpur Aug. 4. For several years he was in the service of the Punjab Irrigation Depot. He then entered private practice in London and later went to Australia in charge of the Sydney underground railway. About two and a half years ago he went to Malaya and, until his death, was connected with J. A. Russell & Co., Kuala Lumpur. He specialized in hydraulic engineering and was the author of the book "The Control of Water."

MICHAEL H. FOLEY, pioneer lumberman and railroad contractor, of St. Paul, Minn., died in Los Angeles, Cal., Oct. 20. He was born in Lanmark County, Ontario, Canada, in 1845. He went to Minnesota in 1879 and, with his two brothers, established the firm of Foley Brothers. His firm was largely interested in building nearly all the railroad systems of the Northwest. The ocean terminal at Halifax is one of the more recent projects of the firm.

Business Notes

W. L. SAUNDERS, formerly in the engineering department, Concrete Steel Co., New York, has been transferred to the Washington office as district engineer.

THE AMERICAN ENGINEERING CO., Philadelphia, has opened a new office in Cincinnati for the purpose of extending Taylor stoker representation and service. M. M. Masson is in charge of this office.

J. J. ARNSFIELD, formerly advertising manager of Fairbanks, Morse & Co., has been elected president of the Engineering Advertisers' Association of Chicago to succeed A. H. Hopkins, resigned.

FREYN, BRASSERT & CO., engineers, Chicago, have been appointed consulting engineers for the Royal Netherlands Blast Furnace and Steel Works Company, The Hague, Holland.

W. J. CLUFF of Toronto has been nominated director of the King Edward Construction Co., Toronto.

JANS & DREW COMPANY, engineers and contractors, representing the Hydraulic Steel Craft Company, Cleveland, have opened offices at 1806 Main St., Dallas, Tex. They will specialize in the construction of hydraulic steel factory and warehouse buildings.

C. W. HUNT ENGINEERING CORPORATION has been organized in the interests of the Hunt products and all engineering services previously performed by the C. W. Hunt Co., Inc., New York.

THE HUNTER MACHINERY CO., Milwaukee, Wis., formerly Kern-Hunter Co., announces a service department under the charge of G. N. Spiess, formerly with George F. Smith Co., St. Louis.

THE AMERICAN WOOD PIPE CO., Tacoma, Wash., announces the appointment of Anton J. Berger as district manager of its recently established Chicago office in the Marquette Building.

G. SCHIRMER has resigned as sales engineer Whiting Foundry Equipment Co. to become associated with W. C. Bennett, industrial engineer, Chicago, engaging in all branches of foundry and industrial engineering, designing, superintending and equipping of complete installations.

A Consolidation of Engineering News and Engineering Record
McGraw-Hill Company, Inc.—James H. McGraw, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. M[illegible], Editor

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Flood Tide Again

RESULTS of city and state bond elections, Nov. 2, are most encouraging. Returns so far received (see the news pages of this issue), indicate a flood tide of votes for public improvements. This striking contrast with the bond election results for several years past seems to reflect a wide and deep change in the mental attitude of the mass of the people. Our own interpretation is that while accumulated deficits in needed construction work are largely responsible for the favorable votes on scores of millions of dollars in bond issues the country over, the main cause for the change is rapidly reviving confidence in the fundamental soundness of American industry today. This newly awakened faith in the future is an encouragement and an inspiration.

Victory of a New Idea

QUITE distinct from all other votes of money for public works at last week's election, the New Jersey referendum on a bond issue for interstate tunnel and bridge construction represents the victory of a new conception—new in the consciousness of the voting public. That conception is one which we have set forth time and again in these columns: the inherent unity of adjoining states and their highway systems, now cut apart at nearly every frontier. Few states are so thoroughly isolated as New Jersey, bounded by water on east, south and west, and having only primitive facilities for crossing its bordering rivers, the Hudson and the Delaware. Doubtless this is the reason why the proposal to issue bonds for building a bridge over the Delaware at Philadelphia and a tunnel under the Hudson at New York carried by a large majority, in the face of other heavy demands on the state's resources. New Jersey people have learned—at last—that a highway network within the state alone is only half a loaf, and that unless they provide for as free communication across the borders of the state as within the state the interests of its own people will be strangled. This is a new truth so far as popular recognition is concerned, and willingness to spend money for its realization is a new spirit among taxpayers. But we may predict, quite safely, that in a very few years indeed this truth will hold sway from ocean to ocean

Federation Decisively Defeated

THE result of the American Society of Civil Engineers' referendum on joining the Federated American Societies has been announced: The federation proposal has been defeated, by a large margin. Not only does the negative plurality reach almost one thousand votes in a record total of 5,608 but every quarter of the country contributes to the total (see news section). Only the Pennsylvania-Ohio region, the north central states and the far southwest cast an affirmative majority. The verdict is decisive. No doubts as to the society's attitude can remain such as were left after the close vote on the development committee questionnaire last spring. Whatever one's individual wish may have been, all, we feel sure, will concede that the outcome of the referendum is clear-cut. It marks the end of the debates and contests that have agitated the society for the past year or two, and clears the way for united effort on other matters.

A Bold Irrigation Project

FOR a single state to conceive and make extensive studies and estimates for an irrigation project designed to serve 1,753,000 acres with 20,000-sec.-ft. of water at an outlay of $300,000,000 is unprecedented. That is what has been done by the Columbia Basin Survey Commission with a state appropriation of $100,000. In fact, the project is unprecedented as a whole as also are some of its elements compared with irrigation works heretofore executed, while in point of cost and general magnitude it is second to but few public works projects either carried out or planned. The main features of the project are given on p. 944. The daily capacity of the main canal and other trunk-line conduits is 1,728,000,000 cu.ft., or 12,725,000,000 gal., which is 25 times the carrying capacity of the Catskill aqueduct. The state of Washington deserves great credit for its courage in undertaking such a study.

Labor Recruiting

DISCUSSIONS are under way in Philadelphia between the building-trades council and the Industrial Relations Committee of the Chamber of Commerce, looking toward co-operation of employers and employees in the bettering of building conditions in the city (a situation, by the way, quite at variance with the unsavory condition being disclosed at New York). There is now no organization of building-trade employers at Philadelphia. In urging such an organization, in order that there may be a representative body to deal with, the unions urge, among other points, one that deserves strong emphasis, namely, that the employers should share with the employees the responsibility of bringing desirable young men into the building trade, and, that having assisted in their induction, the employees should help in the systematic training of the men. The idea is a thoroughly sound one, even if it could have no other effect than to provide a continuous supply of competent workers. But the scheme would have a very wide influence. Entered into sincerely by the employers, they could not, if they had one speck of humanity, fail to see that conditions had to be such as would allow them, in conscience, to invite men into the trades. It may sound foolishly altruistic to talk about conscience in the relationships of a trade where strife has seemed to dull all but combative instincts, but we do not believe that it is so. There would be those who would hold back, but.

if the plan be successful, it would be because broad-visioned men were supporting it—and they could be relied upon to bring the recalcitrants to task. The proposed responsibility, once accepted, would cause a broad study to be made of every phase of the labor problem by every participating employer. In this he would be helped by the necessary studies of the group officials or representatives. Altogether the idea is pregnant of much good. It is still in the early-discussion stage, and is involved with other—and very touchy—questions. Nothing may come of it at Philadelphia, but it is well worth passing on to other localities.

Moving Platforms

IN THE REPORT on the comprehensive rapid transit plan for New York City during the next twenty-five years, outlined in this journal, Oct. 14, p. 754, Mr. Turner's advocacy of moving platforms east and west, across Manhattan Island, again brings up a subject which has received considerable study by the Transit Construction Commission. Except for the execrable subway shuttle "service" between Times Square and Grand Central Station, involving excessively long walks at either end, there is no means of traveling across town except on surface cars. On them the trip is constantly becoming more slow and unsatisfactory, due to the long delays at the crossing of the very busy north-and-south thoroughfares. In the underground moving platforms is seen a satisfactory solution of the cross-town traffic problem. Mr. Turner summarized their advantages over shuttle trains in a report rendered a year ago, as follows: The elimination of long walks at transfer points, of one waiting period, and of platform congestion; a saving in time in making transfers, and vastly increased capacity, insuring seats for all passengers. Regarding capacity, it is estimated that a three-speed platform across 42nd St., running at 3, 6 and 9 miles per hour, could handle 31,680 passengers per hour in each direction, whereas the maximum of the present shuttle seldom exceeds 9,000 per hour. It is also believed that moving platforms across 14th, 34th or 42nd Sts., could be operated at a profit, even assuming the establishment of transfer privileges between them and the north and south trunk lines, for they would not only invite passengers to these lines, but would receive the large and lucrative short-haul business of the shopping districts. Obviously, it is to be expected that the first platform built will not display the degree of perfection that will obtain in later constructions, but the evidence in hand is convincing as to the feasibility and effectiveness of the system.

Writing Engineering Reports

A READING of Mr. Mead's article, "Hints on the Writing of Engineering Reports," Nov. 4, p. 891, and a discussion of the subject on p. 947 this week by five prominent consulting engineers, should focus attention upon a subject of primary importance in professional work. In recent years the engineering schools have given evidence of a growing appreciation of the value to an engineer of the ability to write and speak clearly, while among men in professional practice the ranks of those who are always "too busy to write" are being slowly but surely depleted. Much educational work, however, still remains to be done. In both the article and the discussion there is striking unanamity of opinion on one feature of report writing: Engineers should present their story in language which the non-technical reader can understand. They generally either fail to place themselves in the position of those who are expected to read what they write or else lack the necessary literary skill to accomplish the result desired. When a project is in its development stage it is of first importance that the bankers should have a clear-cut presentation of the main issues. If the engineer fails to state his case effectively, funds will not be forthcoming. Much depends upon the point of view of the writer of a report. If he considers his task merely as the accumulation of data to be buried in dusty files he might better leave his work undone. If he undertakes the preparation of his report with the conception that it is to be the means of aiding others to make a decision or to acquire information by giving them a vivid mental picture of the situation, he will be on the right road toward producing something worth while. Emphasis can be well placed, also, on a point discusesd by Colonel Wilgus—the perfection of the mechanical features of a report. There is no question as to the soundness of his advice regarding type display, illustrations and other details too frequently ignored. In the case of public works reports engineers may be justly criticized for the long delays in publication. It is common for this journal to receive printed reports of city, state and government departments several *years* after the date on which they are submitted. In such cases lack of timeliness renders them practically worthless. The report is a valuable tool to those who appreciate its uses. A realization of its possibilities is something by which engineers should profit.

The Trend of Highway Development

STATE highway departments and lesser roadbuilding organizations which, during the season now closing, have been confronted by a multiplicity of construction difficulties, and whose 1921 programs are consequently yet unformed, should find material aid in the series of articles upon the trend of highway development beginning in this issue.

Each highway department naturally has its own problems. All, during the past year, have suffered more or less from the same fundamental difficulties. Yet perhaps not in any two states have those difficulties been accentuated to the same degree. *Engineering News-Record*, through this series of staff articles that will reveal individual as well as sectional problems, becomes the clearing house for expositions of the manner in which states of the Middle West, Far West and Atlantic seaboard have surmounted these barriers to ease in highway construction, maintenance and administration.

From among the great roadbuilding organizations of the Middle West, which are just entering their era of greatest highway development, will come articles on how best to expend available moneys for building the foundation of extensive and durable systems. They give newer highway organizations the essentials of successful administration of more or less limited funds. California, upon whom all highway attention is now focussed because of her experiences with a variety of so-called durable types subjected to heavy and intensive vehicular traffic, should offer wise counsel. Eastern states, whose highway departments, in general, have been functioning for more than a decade and whose

systems are definite and well advanced in hardsurfacing should clarify questions concerning the finer points of highway construction, maintenance and administration.

So, whether the reader of these articles has been distressed by any of the general highway problems encountered within the past year or whether special problems in design or economics are sought, this series should prove of benefit.

Efficient River Control for Irrigation

SHOT-GUN control of irrigation headgates by the individual owner has long since gone out of date. In most of the irrigated areas it is the function of the state to provide the machinery for an equitable distribution in accordance with priority rights or decrees as determined by court decisions. The engineer plays no small part in this machinery, particularly when the appropriations approach or exceed the available supply, for upon his shoulders falls the responsibility of determining daily the aggregate of individual needs and then meeting this with just enough natural flow plus storage water, since any waste by the lowest gate is of course irretrievably lost. When natural flow and stored water belong to different rights, as they usually do, the problem becomes complicated, and acutely so, from the human interest standpoint, when storage water must be transmitted for 300 miles past half a hundred yawning headgates, owners of which are entitled to natural flow only. That was the situation on the Snake River basin noted on page 927 during the season of 1919, the driest year of record.

As to the success of the described single-headed plan of operation, the records indicate that almost a complete utilization of Snake River water was effected in 1919. At the Milner dam, the lowest point on the river from which gravity diversions for irrigation are possible on any large scale, the flow from June 5 to Sept. 30 was limited to leakage past the dam, ranging from 13 to 50 sec.-ft., depending on the head maintained and averaging 26.6 sec.ft. This quantity indicates the wastage from the entire upper river and to some extent is a measure of the efficiency of the distribution. To a representative of *Engineering News-Record* who inspected the Milner dam in August, the quantity appeared small indeed. The famous Twin Falls 25 miles below the dam presented a most dismal naked appearance.

Practically the same methods were used in 1920 but the distribution was even more difficult and required more care since Lake Walcott was eliminated as a catch basin and reservoir, due to the desire of the Reclamation Service to maintain the lake at its maximum for the purpose of developing the needed amount of power at the Minidoka dam. During the entire period from July 9 to Sept. 20, when regulation was necessary, water was wasted through the Milner dam in excess of the unavoidable leakage *on parts of two days only.*

Special attention is directed to the centralized control which the water users brought about by arranging for a combination of the stream measurement work of the U. S. Geological Survey and the distribution functions of the State. The method has distinct advantages to the valley as a whole and may well be studied by those in charge of water distribution in other states.

Shelf-Hardware Filter Details Far Off

FILTER details of the shelf-hardware type have not yet been developed, so one will conclude, after reading the filter-problem symposium on p. 934. Many things work well but with nowhere near 100 per cent efficiency and it is distinctly the province and duty of the designer to make each new design better, profiting from the experience gained in the operation of previous designs. It has been said that the discovery of an inexpensive method of disinfection has put off by at least twenty years the construction of many hundreds of filter plants and it might also be added that it has also thereby retarded the development to a more nearly perfect state those parts of a filter which have to do directly with the filtering medium. Experimental plants have been all too few in the last ten years. All of the things necessary to a filter plant have not been discovered, and while much can be learned from actual operation there is usually not sufficient flexibility to obtain limits of various factors.

Proper sand size and the most effective depths have long been well established and fairly well agred to, but there is no unanimity of opinion on most of the surrounding mechanism. That some kind of a supporting gravel layer is necessary is agreed to but the depth used varies from 6 to 18 in., with the preponderance of opinion in favor of the greater depths. Methods of admitting the water to the filter are as varied almost as the number of designers. Definite principles on which to base the design seem still to require much careful consideration and much experimentation. Elaborate tests have been made at Sacramento on the size and spacing of perforated-pipe laterals and openings in these laterals under varying conditions of water inflow. However, only one depth of gravel bed, 18 in., was used. Someone ought to experiment with a range of gravel depths so as to define the limits as well as to learn the best size of the different layers to use. The symposium indicates that many combinations work but there must be some depth beyond which it is unnecessary to go for efficient distribution and below which difficulties arise.

The mud-ball situation seems to require quite an extensive country-wide series of experiments to learn what character of turbidity is prejudicial to their formation. Although Mr. Ellms has operated the Cincinnati plant, which is supplied by the turbid Ohio River water, he has had no experience with mud balls, while a little farther down the river, at Louisville, a variety of difficulties are recounted by Mr. Lovejoy. Here is a fertile field for a physico-chemical investigation similar to that undertaken by Messrs. Wolman and Powell on the under-water shrinkage of sand beds (*Engineering News-Record*, July 29, 1920, p. 210; discussion, Sept. 2, 1920, p. 438), since it is more than likely colloids are a decisive factor. When the extent of the distribution of colloidal turbidities is established gutter spacing will become a more scientific procedure, as will also the necessity for the use of an air-wash.

Even with these few examples of undetermined factors in filtration practice in mind one hesitates measurably to predict an early decline in the necessity for expert service in determining local conditions and filter designs to meet them. In fact, there is no reason to suppose that such service will not always be a profitable investment.

Trend of Highway Development—A Survey

Practice in Wisconsin and Michigan

THIS IS THE FIRST *of a series of staff articles on the highway situation. It relates to practice in Wisconsin and Michigan. The outstanding features of Wisconsin's practice are the use of one-season contracts, construction by force account, utilization of local materials and the extent of maintenance work. Michigan's practice is notable for the use of gravel for trunkline construction, the conservative character of the hard-surfacing program and the intensive service secured from surplus war materials.*

The second article will appear in the next issue.—EDITOR.

WISCONSIN leads the Mississippi Valley states in mileage of force-account concrete road construction and incidentally in the development and equipment of local gravel pits for supplying aggregate for concrete roads. This position in force-account operations is the result of a definite policy of the State highway department (1) to determine costs and prices for estimating purposes and for appraising the reasonableness of bidding prices and (2) to be prepared with experience and equipment to undertake construction whenever contract and material prices appear excessive or contractors do not seek the work. Contract construction of roads will not be discouraged; it will, on the contrary, be employed as far as possible, *but not regardless of costs.*

Local pit development has made good progress. Its purpose is (1) to demonstrate the possibility of economically utilizing roadside gravel deposits and (2) to determine the practicability of attaining independence of commercial producers and of congested transportation agencies. Commercial materials will not be discarded; they will be employed generally, *but not regardless of price and slow deliveries.*

Wisconsin's great wealth of gravel beds gives the state an enviable opportunity for developing roadside material supplies. Gravel is abundant almost everywhere in the state and it is universally of excellent quality There are 7,500 miles in the state's highway system. Of this mileage approximately three-fifths are earth roads; one-fifth, gravel roads and the remainder, macadam and miscellaneous types and concrete, the ratio of concrete to the other types being about as three to seven. Extension of gravel surfacing on the earth-road mileage makes the first demand for multiplication of local supplies, but the more exacting demand comes from the planned extension of concrete roads. The 1920 development of gravel supplies has been in connection with concrete paving and, therefore, has required comprehensive pit plants.

Construction Policies—Highway contracting policies in Wisconsin express definitely the purpose of keeping costs and values, in their broad sense, always a deciding factor. It is not the policy generally to contract for more mileage in any season than can be constructed in that season. This policy applies to individual contracts as well as to the construction program as a whole. Hold-over contracts are shunned. The shortage of materials in 1920 will compel infraction of this rule in some instances, but on the whole the projects under way will be finished before cold weather. Short-term contracts, it is believed, reduce the risk due to unsettled wages and prices and uncertain transportation conditions, and the reduction is reflected in closer bidding prices.

As a further step toward this objective of closer and more safe bidding, active studies are being carried on with local contractors' organizations in stabilizing cost estimates. Out of this work are coming standard estimate forms and depreciation charges, as described in *Engineering News-Record*, April 1, 1920, p. 663. Finality in a study of this character is not easy to attain, but as the work has proceeded it has brought appreciable results in uniformity of bidding practice, and, what is perhaps quite as important, a heightened cordiality between state highway engineers and the contracting industry.

Labor Employment

A second established contracting policy is not to undertake work in such volume in any locality that its performance will disturb the labor market. As formally announced early in the season: "No work will be done or no prices will be paid for contract work which will unduly inflate the wages of men and teams and thus upset the labor standards existing in any neighborhood." In brief, while the state officials feel very deeply the importance of highway improvement they also feel that highways can be made to cost too much not only in the price of work itself but by causing an undue increase in the cost of other production.

Observation of half a score of paving operations, including both force account and contract work, discloses no radical departure from familiar methods nor much evidence that practice is approaching a standard. About all the plant arrangements and construction procedures which are commonly employed can be found on any half-dozen operations visited at random. Despite all the developments in equipment and methods for handling raw materials to paving mixers it is astonishing to note the frequency with which shoveling to

wheelbarrows is chosen, and still more astonishing to have it asserted that in actual construction both last year and this year this so-called antiquated method has turned out more pavement per day per mixer and has used less man power per square yard of concrete than many of the modern outfits.

At the beginning of the year a 400-mile concrete road program was planned, but a survey of the materials and transportation situation led almost immediately to cutting the planned mileage in half. A further curtailment has been brought about by necessity and probably 100 miles is a liberal estimate of what the year's work will be.

Materials Shortage

By all accounts the shortage of concrete materials, due to lack of transportation, has been serious. Cement shipments have not been over 50 per cent of the program requirements, and where the supply of sand and gravel has depended on the railways the shortage has been about as great. This curtailment of the supply of commercial aggregates has led to extra effort (1) in locating and investigating local deposits convenient to planned roads and (2) in developing and equipping pits, particularly on the force-account operations previously mentioned. Three or four survey parties, of one engineer and one geologist, have been in the field for most of the season locating sources of materials. Incidentally it may be noted that, to conserve cars, the highway department is eliminating rejection at the job siding by inspecting all materials at the plants.

Maintenance—With construction conditions as related, the importance of maintenance of the older forms of surfacing has increased. Maintenance, indeed, has been the big task of the year: for the roads came through the winter of 1919-20 in worse condition than usual because of frost, and the rains of spring and early summer were so frequent and heavy as to hinder efficient patrol work. Wisconsin practice, broadly speaking, favors team patrol. This year patrolmen were in some sections difficult to secure, and where this condition prevailed the counties have resorted to motor-truck patrol, placing a truck and the necessary equipment on about 20 miles of trunk highway, and have secured excellent results.

Efficiency of Patrol Maintenance

In general, the evidence is that, despite the difficulties, road maintenance in 1920 excelled that of 1919. This result is credited largely to the patrol system put into operation in 1918. Figures of the 1920 expenditure are only approximate, but in round numbers about $2,000,000 will be spent in maintaining 7,200 miles of trunk-line highways. The lowest amount that any county will receive will be $150 per mile and the highest $275. These expenditures are on trunk-line highways only. Perhaps another $2,000,000 will have been expended on off trunk-line roads.

Enumerated, the outstanding impressions gained of Wisconsin highway practice in 1920 are: (1) A comprehensive experiment in force account-concrete road construction with a correlated development of roadside sources of bulk materials; (2) a contracting policy which discourages holdover contracts and prevents inflation of costs to upset local labor conditions; (3) an intensive development of patrol-maintenance operations; (4) a definite policy not to seek immediate mileage of hard surfacing at costs unjustified by economic values in a broad sense.

Michigan is building this year some hundreds of miles of trunk-line gravel road. This construction is considered sound economics and good engineering. The roads being built, however, are not the gravel-surfaced trails of past years. They are full-width highways, with corrected alignment, permanent grades, culverts and bridges and complete drainage, *as perfect in detail in respect to roadbed structure as they would be made for a hard surfacing of concrete or brick or asphalt.*

With 6,000 miles of trunk-line highway it is held humanly impossible for some years to hard surface all the mileage, even if present traffic warranted hard surfacing throughout at the high prices which prevail. On a large mileage pavement is not required by present traffic, and perhaps will not be required for a long time. Meanwhile a gravel road, well constructed, will give for its life of three to five years, *if well maintained*, a very satisfactory thoroughfare for heavy traffic. And this road is constructed at a cost, for surfacing and surface maintenance for its natural life, about equal to the interest on the investment required for a concrete pavement. On this reasoning is based the claim that gravel-surfaced trunk-line construction is sound economics.

First Operations Permanent

It is good engineering, it is believed, to have permanent grade and structures built well ahead of expensive hard surfacing. Time is given for consolidation and for defects to develop. When the occasion for hard paving arrives there is needed generally only a dressing of the gravel surface and the pavement can be laid. Structurally there is value to any hard pavement in this sub-base of gravel, particularly where the soil is of clay or a clay mixture. In fact, it is wondered if this gravel layer compacted by travel on a grade which time has settled to permanent position is not itself a sufficient base for an asphalt surfacing. Michigan will undertake some experiments to determine the possibilities.

Much care is given to the selection of the gravel for the surface construction. First a *screened* gravel is employed, all large stones being removed, and, second, a *sand* gravel is chosen. A clay gravel, it is considered, does not wear as well and about its only superiority is that it packs more quickly under a roller. But these gravel roads are not rolled; they are left to be compacted by travel. With close attention to surface maintenance from the beginning the traveling public, it is found, does not object to its imposed task of consolidating the surfacing. In two seasons the task is completed. The gravel layer is 7 in. thick.

A word about Michigan gravel-road maintenance is warranted. It is not unusual in method; it simply is continuous. It consists of grader and drag work, with applications of calcium chloride to keep down the dust. Generally the road is treated with 1 lb. of chloride per square yard and later in the season with ½ lb. additional. Incidentally, the high price this season of the granular chloride has proved a rather serious setback to its use. Recently a flake chloride costing about half the cost of the granular product has been tried, and results are being observed. An ordinary fertilizer distributor is used for applying the chloride.

So extensive a program of gravel-road construction does not mean that hard surfacing is being neglected. Indeed, there is in hand an impressive mileage of concrete and of asphalt on concrete base. Progress on these projects has been hampered by slow deliveries of materials, although local producers and emergency methods of transportation have been utilized as far as the conditions would warrant. In some instances cement has been shipped from ports on the southern end of Lake Michigan through the Straits of Mackinac and down Lake Huron to ports on the eastern shore of the state.

Hard-Paving Projects

A survey of specific hard-paving projects discloses little that is unusual in construction methods or equipment. A record worth mention, perhaps, has been made on one project by the outfit described in *Engineering News-Record*, Oct. 2, 1919, p. 658. This year the contractor is using a finishing machine and also stock piles over a tunnel, at his loading yard, but in other respects the equipment has been changed but little. On a record day's run this outfit placed 1,031 ft. of 18-ft., 8-in. slab in one shift. With materials available, a 700-ft. daily run is held normal. As a bonus to increase output the contractor is paying each man on the job 1c. a foot for every foot exceeding 700 ft. in a day's run. Good results have been had with this bonus system.

Because of its heavy construction and its importance as a link in the main Detroit-Chicago route a 25-mile operation between Ann Arbor and Jackson deserves notice. This is an 18-ft. asphalt-on-concrete-base highway through a hilly country and is notable for its heavy earthwork. Local gravel pits are being developed for concrete aggregates and most of the base will be put in by the industrial-railway dry-batch-haulage method. Cement trucked from a local mill and handled in bulk will be used. The construction is by force account. The equipment problem on this job was considerably simplified by the use of surplus war material, particularly locomotives and cars, obtained by the state.

War Equipment—War equipment generally has been managed by the state with the view of obtaining from it the most intensive service practicable. Uses have been devised with considerable ingenuity, for even the most unaccommodating of the articles received. An example is the remodeling of some thousands of steel stakes or posts designed for barbed wire entanglements to serve as standards for highway signs. Two policies have contributed to this intensive service: (1) All equipment is repaired and, if necessary, is reconstructed before it is distributed for road work; (2) distribution has been made on the basis of no profit to the highway department. A county, for example, receives a motor truck for what it has cost to deliver that truck, including an overhead charge.

An old motor-truck factory at Charlotte, Mich., has been rented and fitted up as a repair shop and storehouse. The donated Federal equipment was delivered here, including some 600 motor trucks and automobiles, a large stock of miscellaneous truck parts and a variety of other material. Credit was secured from the State for a revolving fund for financing the plant operations, and a superintendent, with twenty-five or thirty mechanics and helpers, was put in charge.

The major operations at the Charlotte plant have been the repair and reconstruction of motor trucks. A truck upon receipt is inspected and all the work to be done is noted on a card which is attached to the truck when it is delivered to the shop crews. Generally the large items are the replacing of the old body with a horizontal dump body and the painting of the truck. Including the charge for overhead, the counties are getting the revamped trucks at a cost of $800 to $1,000, and are accepting them eagerly.

Excellent gravel-road construction, maintenance and service is the vivid impression of Michigan highway practice in 1920. A conservative hard-surfacing program covering main traffic routes and highways tributary to industrial centers is being developed without seeking extensive mileage and with liberality in types of construction employed.

Relative Economy of Wood, Steel and Concrete for Ore Docks

ORE DOCKS of steel and concrete construction are so much more economical than timber docks in both first cost and subsequent charges that no more docks of this last type are likely to be built on the Great Lakes. This prediction was made by R. C. Young, chief engineer of the Lake Superior & Ishpeming Ry., in a report on maintenance of ore docks, presented at the recent annual meeting of the American Railway Bridge and Building Association and including statements from several engineers.

When this railway was preparing to build a new ore dock in 1910, estimates were made of the first cost and maintenance charges for a period of 30 years for different types of docks, it being assumed that docks of permanent construction might be retired at the end of that period on account of obsolescence. For comparison it was assumed that a second timber dock on a new foundation would be necessary about the fifteenth year, to insure always having a dock ready for operation. This would give a life of about 16 years each for the timber docks. With the first cost of two timber docks taken as 100, the cost for concrete and steel docks would be 70 and 76 per cent respectively. In the same way taking first cost, repairs, interest, insurance and taxes for a term of 30 years as 100 for the two timber docks, the figures for concrete and steel docks would be 56 and 62 per cent respectively.

Mr. Young stated also that the increases in material and labor costs has been so much greater than was estimated in 1910 that the comparison at this time would be even more favorable to the permanent structure. He intimated also that 15 years was not necessarily the limit of life for a timber dock.

A life of considerably more than 15 years for timber docks is given in the same report by L. J. Anderson, supervisor of bridges and buildings, Chicago & Northwestern Ry. Assuming that repairs are made from time to time, in about 15 years it will be necessary to renew the A-frame deck or that part of the dock above the posts, especially if no treated timber has been used. The dock then is good for 10 or 15 years more, with ordinary repairs made during this period. The use of treated timber by this railroad for parts which are expensive and difficult to renew has reduced the maintenance materially, the treatment practically doubling the life of the timbers. Care in detailing may also reduce materially the difficulty and cost of renewing individual parts.

Defects in Current Meters and a New Design

BY SAMUEL FORTIER AND E. J. HOFF
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ALTHOUGH current meters have been in more or less general use in this country for the past thirty years, few modifications in design have been made with a view to obtaining greater capacity and reliability. Perhaps the main reason for continuing to operate these imperfect instruments is that until recently they were mainly used to measure the flow of water in river channels where the velocities were high rather than low and where conditions were such that accurate results could seldom be obtained. In more recent years, however, the use of current meters has been extended to measure the velocity of water in artificial channels of all kinds and more particularly those pertaining to irrigation and drainage systems. The mean velocities of flowing water in these artificial channels vary as a rule from 1 to 4 ft. per sec, and the requirements as to accuracy are usually much more rigid than is the case with river measurements. It is in connection with the measurements of water in these artificial channels, in which the water moves at a relatively slow rate and in which it is often confined to small cross sections, that the defects of the common types of commercial meters are most apparent. The purpose of this brief article is to call attention to some of these defects, to outline the requirements of a meter suitable for irrigation and drainage ditches and to describe some features of a new design of meter which is being developed to meet the requirements of relatively low velocities and small channels. This new design is the result of experiments carried on by the authors of this paper.

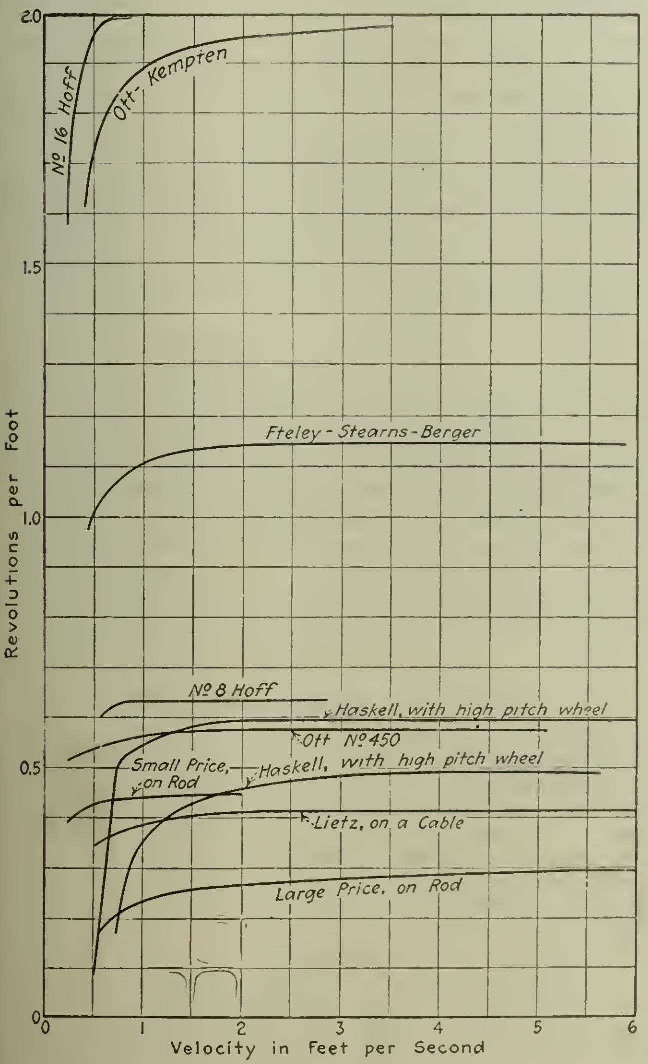


FIG. 1. STARTING-VELOCITY CURVES FOR CURRENT METERS AS AFFECTED BY INERTIA

The curve for the ideal meter would be a horizontal line indicating an identical number of revolutions of the turbine for all velocities.

The fundamental theory of current meters is based on the assumption that the flow of water is parallel to the axis of the channel. Accordingly, in rating a meter, it is moved with a uniform motion through a body of still water for a given distance, and the revolutions of the wheel or propeller recorded. These revolutions and the corresponding velocities, when computed and plotted as coördinates, determine the rating curve. Water, however, rarely moves in the manner assumed by some mathematicians and hydraulicians. Instead of advancing in straight lines, parallel to the direction of flow, the motion of its filaments is in irregular curved lines, the tangents to which form angles of varying degrees with the axis of the channel or stream bed. In the case of artificial channels, the tendency to create revolving motions with cross currents and eddies is augmented by the existence of curves, drops, turnouts and other structures. Thus it is evident that the manner in which water ordinarily flows presents serious difficulties in current meter design, which must be overcome in order to record the axial components of the filaments of water and eliminate all components at right angles to the direction of flow.

Other imperfections of commercial meters are caused by the obstruction they present to water in motion. It is well known that even small obstructions produce eddies and cross currents. As evidence of this fact, a wire 0.06 in. in diameter was placed in a vertical position in the water at a distance of 6 in. in front of a current meter which was being rated. The effect of this small wire introduced an error of 3 per cent in the rating. It would therefore appear that large, bulky meters indicate faulty design, more particularly for the smaller channels, owing to the obstruction which they present and also to the impracticability of measuring bottom currents and the inaccuracies introduced in attempting to measure top currents.

In rating a meter, the meter is rigidly attached to a rod and both moved through a vertical plane. In operating a meter, it may not be held in a vertical position, and in the case of tail meters the impact of moving water may cause a deviation between the axis of the meter and that of the stream. These modifications of the position of the meter when rated constitute another defect. Still another defect in the common types of meters is occasioned by their lack of accuracy and reliability until the influences which retard starting are overcome. Most rating curves of meters may be divided into two parts. From zero to velocities ranging from 1½ to 3 ft. per sec., depending on the type of meter, forms the first part and the second part extends from the end of the first to velocities up to 10 ft. or more per second.

In discussing the requirements of current meters

adapted to relatively low velocities and small channels, chief consideration will be given to ways and means of overcoming existing defects in such instruments. In regard to types, the cup meter possesses several good features. It is simple in design, has a low friction factor and does not readily clog with weeds or other foreign matter. Such a meter would fulfill most of the necessary requirements, providing water flowed in right lines, parallel to the axis of the channel. As has been stated, water seldom, if ever, flows in this manner and since all currents, irrespective of their direction, tend to cause the wheel of the cup meter to revolve, over-registration may vary from a mere trifle to as high as 10 per cent, depending upon the direction of the various filaments of water as they approach the moving part of the meter. There is apparently no way of overcoming this defect in the cup meter and it was regarded as being so objectionable for the conditions under consideration that the propeller type of meter was selected for the new meter. This meter, it will be observed, is acted upon, not by the full force of all currents, as is the case with the cup meter, but only by the axial components of the down-stream currents. This being regarded as an essential requirement in a good meter, this type was used as a foundation on which to construct the new meter. The tendency of the propeller or screw type of meter having a horizontal axis is to under-register. This is due to the readiness with which the axis of the meter may be shifted by its own rotation out of its true position parallel to the channel. A necessary requirement of a reliable meter is that the position of the meter when used to measure water in motion be relatively the same as that when it is being rated.

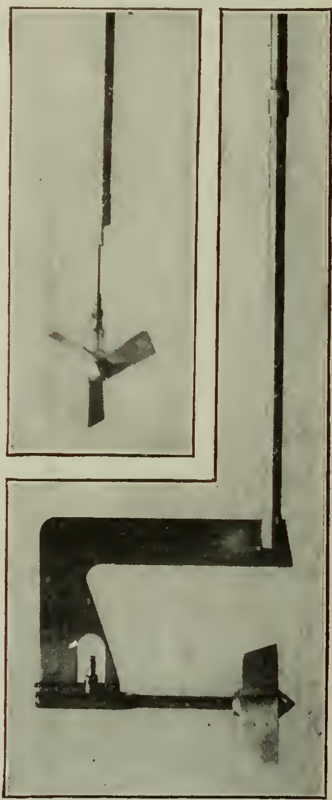


FIG. 2. SIDE AND END ELEVATIONS OF HOFF CURRENT METER

Another requirement calls for a meter of small volume which will present the least obstruction to flowing water. Current meters are often used to measure ditches in which the depth of water is less than one foot and in determining the mean velocity of any vertical section it is important, where accuracy is concerned, to measure top and bottom velocities as well as those between. Furthermore, unless the size of the meter is negligible in comparison with the cross-section of the channel, inaccuracies will result, since the immersion of a large meter in a small stream not only changes the direction of currents but modifies their effects.

To reduce the friction created by the moving parts of a meter to a minimum constitutes still another requirement. Some of the wheels or propellers of meters now on the market move under minimum velocities of about 0.2 ft. per sec. but the motion is erratic and not uniform until velocities ranging from 1.5 to 3.0 ft. per sec., depending on the type of meter, are reached. By constructing a special floatation meter, the eccentricities of the ordinary meter at the lower velocities were determined and these have been plotted on a large scale in Fig. 1.

Starting Velocities

These curves show the starting-velocity curves for various meters, as affected by the inertia of the moving parts. These curves also show that after a certain critical velocity is reached the turbine revolves a given number of times for each foot the meter is drawn through the water, regardless of the velocity. This critical velocity, at which the curve becomes horizontal, approaches zero as the meter approaches the ideal, from an inertia standpoint. The starting-velocity curve is important for the reason that the rating curve of any particular meter on which stream measurement is based becomes erratic and unreliable below the above mentioned critical velocity, the rating curve being closely related to the starting-velocity curve.

As a result of extended tests, the new meter (Hoff meter) shown in Fig. 2 seems to fulfill most of the requirements of an accurrate and reliable instrument adapted to small as well as large channels and to low, medium and high velocities. The instrument is so designed that it will have the least possible eddy-forming parts.

The forces which cause the propeller to revolve are derived solely from the axial components of the down-stream currents. By placing the axis of the meter support directly above the propeller, the errors caused by deviation of the horizontal axis of the meter are eliminated. Instrumental friction, the most serious objection to this type of meter, is reduced to a minimum by the selection of material having a specific gravity equal to that of water. Lastly, the simplicity of the design lessens the first cost of such instruments and tends to maintain a high operating efficiency.

"Acetol" New Gasoline Substitute

In addition to natalite, which is manufactured in Natal from the refuse of the sugar-cane mills and used extensively in propelling motor cars in South Africa, there has recently been produced another motor fuel to meet the shortage and high cost of gasoline in that country. The basis of this new fuel, which is called "acetol," is alcohol and ether, which comprises 90 per cent. The other ingredients are treated as a secret until the patentee receives his patent rights.

It is said that this fuel apparently solves the question of the air-cooled engine. No carbon sediment is formed in the cylinder, and the fuel is claimed to be non-injurious to the carburetor and engine. No special carburetor is required. Acetol mixes with gasoline. The inventor claims that it has a wider explosive range than the ordinary marketed gasoline, *i.e.*, both a weaker and an overrich charge in the cylinder heads will fire when gasoline fritters out or chokes. Tests made with this fuel are said to have produced very satisfactory results.

It is claimed that acetol can be manufactured much more cheaply than the present cost of gasoline in South Africa. The retail selling price of gasoline at the coast ports of this country, which is fixed by the government, is $1.12 per imperial gallon (1¼ American gal.) if purchased in cases of two cans containing 4 gal. each, and $1.22 per gallon if purchased in smaller quantities. Natalite now sells for 60c. per gallon.—*Commerce Reports.*

Sixty-Year-Old Iron Bridge in a New Jersey Village

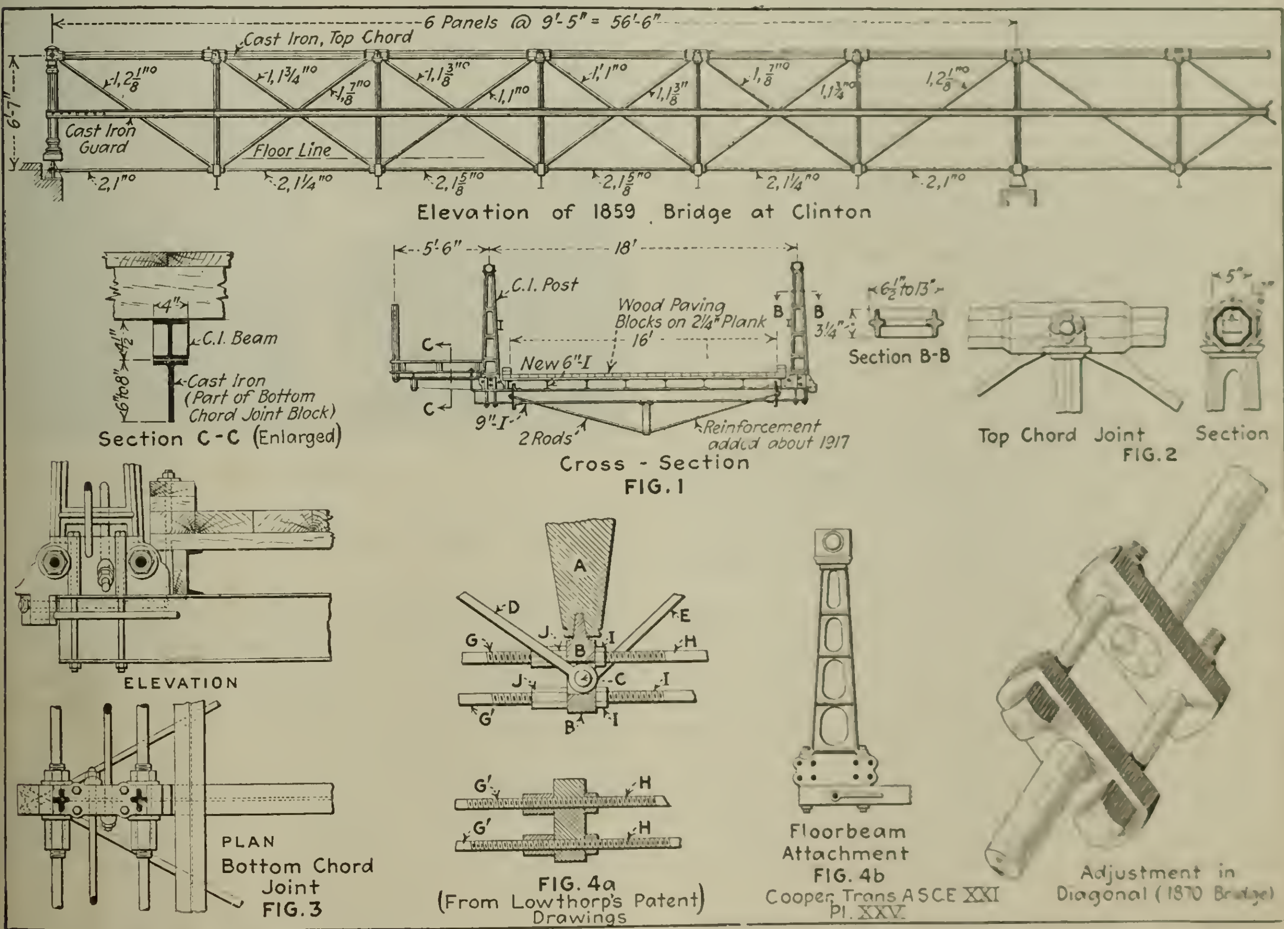
Oldest of Several Lowthorp Truss Highway Crossings of Raritan at Clinton and High Bridge Carries Regular Road Traffic—Floor Recently Strengthened—F. C. Lowthorp a Pioneer Iron Bridge Builder

BY R. FLEMING
American Bridge Co., New York City

IN THE village of Clinton, N. J., are two iron bridges built in 1859 and 1870, respectively, that interest the engineer not only by their age but also by their type. The older of the two, though it has seen full sixty years of service, is still in excellent condition, with no discoverable change of importance except a recent strengthening of the floor system. These structures represent an early type of iron bridge, now long extinct but at one time extensively used; little mention of the type is found in the writings of our standard authorities on bridges, though Francis C. Lowthorp, its originator, was a prominent bridge builder of his day. The type furthermore is an excellent representative of the combination structure of cast and wrought iron which played so large a part in bridge construction about fifty years ago, dominating the field for a time.

Both the bridges mentioned cross the South Branch of the Raritan River; the 1859 bridge consists of three spans of 56½ ft. each, and the 1870 bridge of two 85-ft. spans. Two other Lowthorp bridges over the same stream at High Bridge, some miles distant, bear the dates 1867 and 1868. Most of the illustrations given in the following, however, relate to the older of the two bridges at Clinton.

As shown by the drawing Fig. 1, made from measurements taken at the site by the writer, a Pratt web system is used in the bridge (the Pratt patent was issued in 1844). The compression members (top chord and posts) are of cast iron, while the tension members are of wrought iron. In sections of the top chord is cast the inscription, "Built for Hunterdon County by Wm. & Chas. Cowin, Lambertville, N. J., 1859. Lowthorp's Patent June 30 & Nov. 3, 1857." Because of the increasing traffic loads, the floorbeams were reinforced by kingpost trussing in 1917 or '18, as shown in the cross-section, and steel joists were added. As the road was being macadamized, wood paving blocks were laid on the plank floor. So far as determinable, all the rest of the bridge is old.



FIGS. 1 TO 5. LOWTHORP HIGHWAY BRIDGE OVER SOUTH BRANCH OF RARITAN RIVER AT CLINTON, N. J., BUILT IN 1859

Fig. 2 shows a top-chord joint and Fig. 3 a bottom-chord joint. This same bottom-chord joint is shown in the photograph of an intermediate post, Fig. 6. Mr. Lowthorp's patent of June 30, 1857 was based on a bottom chord joint as shown in Fig. 4a (reproduced

from Patent Office Report, 1857). The claim of the patentee is, "The straining piece B, in combination with the rods G and H, when the latter are connected to the plate substantially in the manner set forth, and when the said plate is arranged to receive the vertical or verticals A and D, E of iron truss frame bridges."

The floor beams are 9-in. wrought iron I's with 4-in. flanges and ½-in. webs, now reinforced by trussing. They are fastened at each end with 4 bolts to the cast iron "straining piece." The beams bear the imprint, "Patented Dec. 1, 1857." The main and counter diagonals have screw adjustment at the lower ends, and the bottom-chord rods are connected longitudinally with screw "swivels" or sleeve nuts at each panel-point. All screw ends are enlarged. The diagonal bracing in the plane of the bottom chord consists of a pair of rods in each panel.

The workmanship of the bridge was excellent. This is evidenced by the fact that it has lasted 60 years and is still in good condition. The bridge presents a much better appearance today than the majority of pony trusses built at a later date. It is, however, frequently overloaded. During the two hours while measurements were being taken there passed over the bridge 35 automobiles, 2 auto-trucks and 2 teams, and later in the day a large moving van from a city 50 miles distant. The writer was told of an auto-truck that crossed a day or two before loaded with 12 tons of cement. Even allowing for exaggeration in this statement, it confirms the writer's opinion that auto-truck loading unless more effectively restricted than at present will result in the failure of this and other old highway bridges.

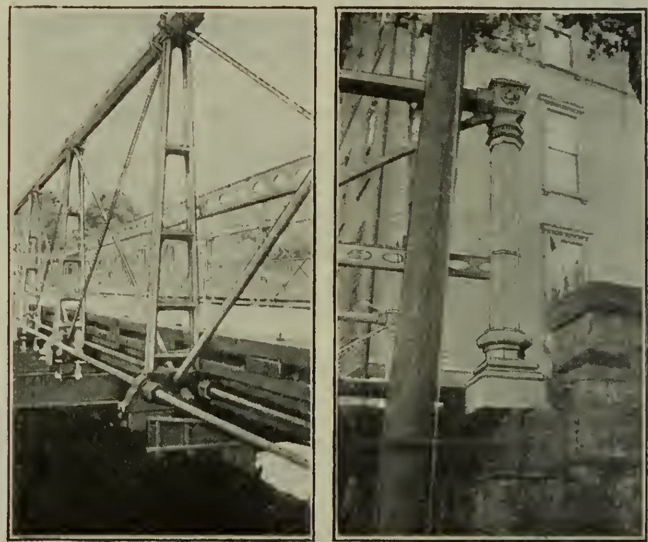
As well as can be judged, the bridge was probably designed to carry a moving load of 50 lb. per sq.ft. on the roadway. The floorbeam reinforcement and the wood paving blocks add 12 or 13 lb. per sq.ft. to the original dead load. Considering the total dead weight of the present bridge to be 900 lb. per lin.ft. (of which 525 lb. is carried by the walk truss) the reader can easily make his own calculations for permissible loading. The heavy moving loads of today were unknown 60 years ago.

The 1870 bridge, "built by Wm. Cowin, Lambertville, N. J.," is of the same type as the 1859 bridge. The truss that was measured is 9 ft. deep center to center of chords and is divided into 8 panels of 10 ft. 7½ in. each. The diagonals in each panel are of two rods instead of one as in the older bridge, and pins are used in bottom as well as top chord. An occasional pair of main diagonals has the adjustment in one rod shown in Fig. 5. Just when this peculiar form of adjustment at irregular intervals throughout the four trusses was made is not clear.

It may be fitting to give some general facts regarding the Lowthorpe bridge, of which type a considerable number were built in the '60s and '70s. They were designed in accordance with correct engineering principles. The type of truss, known as the Lowthorp Trapezoidal Truss, was of either Pratt or Whipple web arrangement, and had counters in all except the end (sometimes the end two) panels. The compression members were of cast iron and the tension members of wrought iron.

Mr. Lowthorp was a firm believer in the merits of cast iron. A paper, "On the Use of Cast Iron for Compressive Members of Iron Bridges," read by him at the second annual convention of the American Society of Civil Engineers, held June, 1870 (*Transactions A. S. C. E.* Vol. 1, page 228) closes with an interesting expression of opinion: "The practical experience of most engineers and builders will justify me in the assertion that there is much more to be feared from defects in wrought iron used for tensile than in cast iron used for compressive purposes."

A commission appointed by the city of Philadelphia (Ashbel Welch, J. Edgar Thompson and John C. Cresson) in 1858 offered a premium for the best design of an iron bridge truss. In awarding the first premium to Mr. Lowthorp it said of his design, "It is well porportioned in all its parts, which are so disposed as to afford a maximum of strength with the smallest amount of material, having such arrangement for adjustment as to give each and every part its proper function to perform, without requiring great experience for its care."



FIGS. 6 AND 7. INTERMEDIATE POST AND ABUTMENT POST

In 1856-7 Mr. Lowthorp designed and built his first railroad bridge. The bridge crossed the valley of Jordan Creek on the line of the Catasauqua & Fogelsville R.R. near Allentown, Pa. It consisted of 11 spans with a total length of 1,120 ft., supported on piers of cast and wrought iron varying in height from 30 to 54 ft. anchored to masonry foundations, making a total height in places of nearly 90 ft. The trusses, of the double-intersection type, 12 panels each, were 16 ft. high and were spaced 10 ft. apart center to center. At the time of its completion this was one of the longest if not the longest of iron bridges in the United States.

An interesting feature in many of the Lowthorp bridges was the hip vertical, where for uniformity in appearance a cast-iron member similar to the posts was used. Inside of this member was placed a wrought-iron rod to take the tensile stress from the floor beam.

While most of the Lowthorp bridges have been replaced as they were outgrown by the traffic loads, a 60-ft. deck span of three trusses, with 34-ft. roadway and two 7-ft. walks, still exists at the Jackson Ave. crossing over the tracks of the Central R.R. of New Jersey in Jersey City. A trolley traverses the bridge, but the trolley tracks, laid long after the bridge was built, are trussed beams extending from abutment to abutment.

In response to a letter of inquiry regarding Mr. Lowthorp and his bridges addressed to his son Francis C. Lowthorp, Counsellor at Law, Trenton, N. J., the latter has given many interesting details. From his letter the following extracts are taken:

My father, born 1810 in New York City, died June 1, 1890. He was a delicate child and was placed under the care of his uncle, the late Dr. John Lilly, of Lambertville, who succeeded in making a rugged man of him, putting him into an outdoor life as a surveyor and engineer. He worked under Ashbel Welch on railroad and canal construction for a time. He went into the service of the Lehigh Coal & Navigation Co. and designed and superintended construction of some locks in its canal with a great lift. Afterwards he became bridge engineer for the Lehigh Valley R.R. Co. Among other bridges he designed the first railroad bridge across the Delaware at Easton, connecting the Lehigh Valley R.R. with the New York Central and the Belvidere & Delaware R.R., a structure carrying tracks on two levels. In 1857, acting as engineer for Cartwright & Co., the contractors for the Catasauqua & Foglesville R.R., he completed the Jordan Creek bridge, not far from Allentown, Pa. This was very adversely criticised by some other engineers, and the prediction was made that it would fall with the first train to attempt its passage. It turned out to be one of the longest-lived bridges he ever built; I think it stood for about fifty years, despite the constantly increasing weight of rolling stock.

Some years after the completion of that bridge my father started into the engineering and contracting business on his own responsibility. He used compressive members of cast iron, as you know, and held to that plan for many years despite the competition of others who used wrought-iron (and afterwards steel) compressive members.

According to the same authority, Mr. Lowthorp designed more than a score of bridges for the Newark & New York R.R. when this was built, and most of the bridges on the New York & Long Branch R.R. These latter included the Raritan Bay crossing, containing a swing span that was probably the longest ever built up to that time. He also built the original Newark Bay draw of the Central R.R. of New Jersey, besides other bridges on that road, and several bridges for the New York, New Haven & Hartford R.R.

Mr. Lowthorp took out patents on his designs of swing bridge centers and turntables; the latter in particular came into wide use, some twelve being furnished to the Union Pacific alone.

While the Raritan Bay draw was replaced after very short use, its removal and replacement by another bridge was not chargeable to any defect in the design or any structural objection to the bridge, but resulted from competitive railroad policy. Immediately after its erection, litigation developed, in the interests of the Pennsylvania R.R., which was engaged in a campaign to obtain an interest in or control over the Long Branch road to secure access to the seashore resorts. The claim was made that the bay crossing constituted an obstruction to navigation. After the success of the campaign, the bridge was replaced by a new structure.

Distribution of Snake River Water During Greatest Drought

Continuous Flow Supercedes Intermittent Flashes —One Man Handles Storage and Natural Flow Like Train Dispatcher

THE Snake River in Idaho is one of the State's greatest resources since it supplies water to a large percentage of the total irrigated area. Policing the stream and distributing the water to the respective users in accordance with their rights is one of the most important duties of the state. From Jackson Lake storage reservoir on the headwaters in Wyoming to the Milner dam, by which the two Twin Falls irrigation companies divert the last of the stored water. the distance is 300 miles. Intervening are more than 50 headgates, which

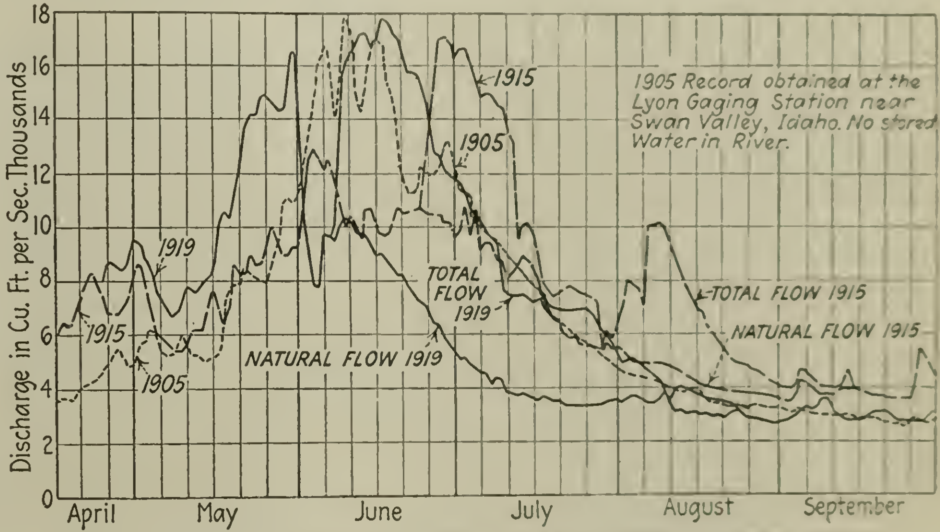


FIG. 1—TOTAL AND NATURAL FLOW OF SNAKE RIVER AT HIESE DURING THREE YEARS OF DROUGHT

by court decrees have priority rights of various dates. To apportion the stored water and natural flow properly to the rightful owners when there is not enough to go around and late decrees must be cut off in successive order is a difficult task. It requires an intimate knowledge of the hydrography of the river, backed up by daily readings at the numerous gaging stations, and necessitates frequent changes of the canal headgates and storage reservoir outlet gates. Like a train dispatcher, the officer in charge of the distribution turns loose in a continuous flow a definite quantity each day and must order the proper number of gates opened to care for it as well as the natural flow, plus or minus the amounts gained or lost in transit. Unlike the train dispatcher, his container as well as cargo must all be delivered at the end of the run.

Only within the last two years has one man been placed in complete control of the whole river but the results have been so satisfactory it is not likely multiple control will again be revived. By a co-operative arrangement effected with the U. S. Geological Survey, it became possible to centralize under the control of one man both the hydrometric or stream measurement work and the distribution. This consolidation of State and Federal functions is a departure from the old method and has a distinct advantage in that there is no lost motion in obtaining the fullest and most complete information concerning all phases of the river work. Another

advantage is the continuance of the same administration from year to year, thereby tending to promote greater efficiency in the handling of the work and to develop better methods each year. W. G. Swendsen, commissioner of reclamation, is charged with the duty of administering the water resources of the state and has designated G. Clyde Baldwin, of the U. S. Geological Survey, a special deputy to handle the Snake River problem as a whole. The latter's annual report for 1919 (not printed) has recently been made available. Since it contains the essential features of how the problem was solved during the dryest year of record, the following abstract has been prepared:

The excess of requirements for irrigation over run-off in the valley during the season of 1905 served to establish the fact that definite determinations of the relative priorities of water rights for the pioneer was essential, and that storage was necessary if water rights throughout the entire irrigation season were to be assured to later developments. Thereupon courts fixed the amount of water allowed and the priority dates of each of these early rights. Construction of storage reservoirs at Jackson Lake and on the Upper Blackfoot River was started in 1906. When the U. S. Reclamation Service completed the first Jackson Lake dam for the use of the Minidoka Project and started to utilize the natural channel, beginning in 1908, the equitable distribution was complicated immeasurably by the necessity of segregating the stored water from the natural flow.

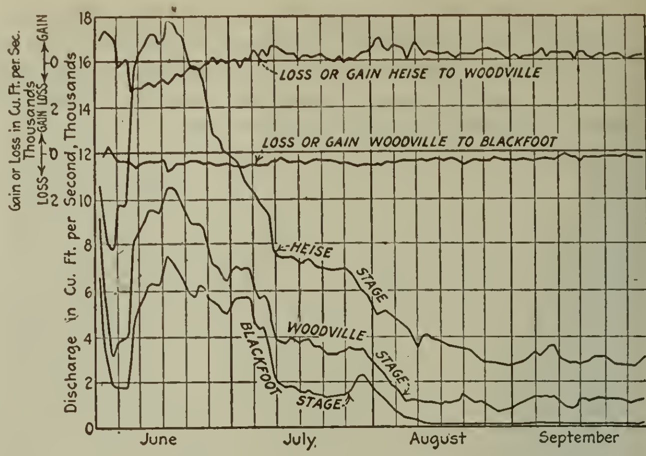


FIG. 3. HIGH RIVER STAGES PRODUCE LOSSES—LOW STAGES BRING GAINS FROM BANK STORAGE

elevations in spite of the normal decrease in the natural flow. Thus storage transmission losses were increased by the extra draft necessary to make up this natural deficiency.

Since 1912 the continuous-flow system has been in use. A steady flow is maintained varying only with the needs of the stored-water users and the limitations as to available supply and outlet capacity at Jackson Lake.

Allowance is made for time of transmission and loss in transit, and the canals having natural flow rights are regulated in accordance with the decrees or to insure proper storage deliveries each day. This plan involves the daily determination and frequent regulation of flow in each canal diverting from the river between Moran, Wyo., and the lowest point of use 300 miles down stream.

Through the U. S. Geological Survey a number of additional river gaging stations have been established to aid in the solution of the problem of transmission losses and return flow.

General Plan of Operation—In the general plan of operations daily reports were made either in person, by telephone or telegraph, for each of the important river stations and for all the canals except those located in the North Fork-Teton area. Each evening the deputy water masters, or river riders, were given any necessary instructions concerning regulation for the following day. A report showing the essential features of each day's deliveries was also mailed to the State Commissioner of Reclamation each evening.

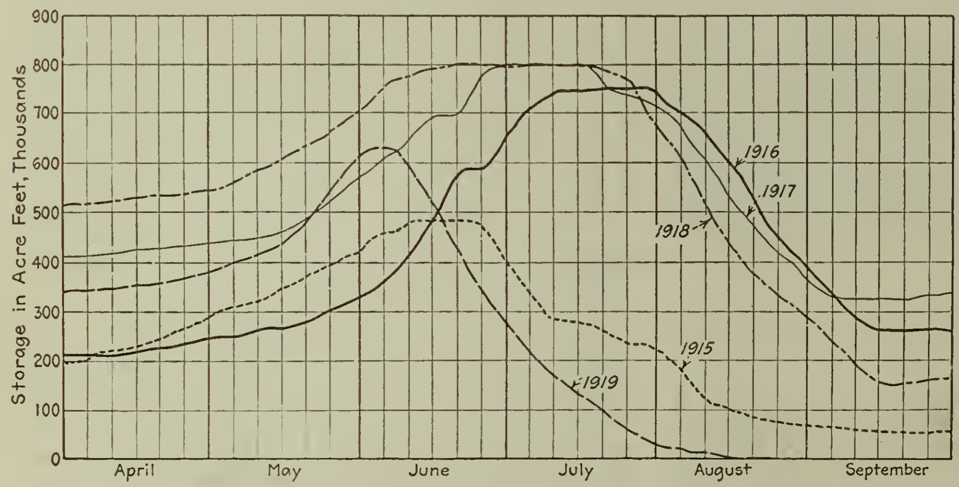


FIG. 2. HYDROGRAPHS FOR JACKSON LAKE SHOWING EARLY DEPLETION IN 1919

Since 1908 Jackson Lake dam has been twice reconstructed to increase its capacity to the present 850,000 acre-feet. Of this amount 102,000 acre-feet has been acquired by 15 different canals in the upper valley and 419,000 acre-feet by the two Twin Falls canals diverting the water at Milner. The remainder belongs to the Minidoka Project of the U. S. Reclamation Service and is diverted from canals leading out of Lake Walcott which acted during the first few years as a catchbasin and equalizing reservoir.

Early operation consisted in transmitting the stored water down the river from Jackson Lake in several flushes or heads with intervening periods during which only the natural flow was allowed to pass. At the end of the period of the flush, canals in the Idaho Falls-Blackfoot section were staked and locked to prevent improper diversion of stored water during the next flush. The plan was unsatisfactory to both the natural-flow and stored-water users. The frequent fluctuations of the river damaged diversion dams and made it difficult, as well as expensive, to maintain anything approaching a constant rate of delivery through many of the canals. On the other hand, during the flushes these canals were maintained at their staked

Outline of distribution—Reports on the precipitation during the previous winter and the available snow in the mountains both indicated that a shortage of water for irrigation would be experienced during the season of 1919 but it was not realized in advance just how great this shortage would be nor how early in the season it would be felt. During the latter part of May the flow in the river increased in a normal manner until about the end of the month when, as a result of unseasonably cold weather, it dropped very rapidly. (The decrease at the Heise gaging station amounting to more than 8,500 sec.-ft. in a period of four days is shown on the hydrograph.) Jackson Lake reservoir still lacked more than 200,000 acre-feet of being filled to capacity, but in order to prevent an immediate shortage of water available to fill the natural-flow rights the outlet gates were raised on the afternoon of June 3 and the level of the water in the reservoir was held stationary until June 6, when the

first storage was released. The release of Jackson Lake stored water was purposely deferred and a heavy draft placed upon Lake Walcott in order to prevent possible wastage of water over Milner dam in the event that rains or a sudden rise in temperature should cause a corresponding increase in the discharge of the river. No material rise in stage accurred, however. In fact, beginning with June 9 (at Heise) there was a steady and, for the first month, very rapid decrease in the natural flow which persisted, except for slight checks due to rains, until the comparatively heavy rains of early September, when a marked increase was noted.

All canals were ordered cut to their decree amounts on June 4 and distribution was maintained on this basis until June 10, when, in order to fill all decreed rights, it became necessary to stop deliveries under licenses and permits. On June 11 decrees having a date of priority subsequent to Jan. 1, 1903, were also cut. Thereafter decreed rights were ordered cut until July 3, when all previous to May 10, 1889, had been included.

Coincident with the constant and rapid drop in the stage of the river, an increase in the return flow entering the stream between the Heise and Woodville gaging stations was noted and about this time what had been a net loss was converted into an appreciable net gain, which by July 5 proved to be of sufficient amount to warrant the restoration of the large right of the Idaho Irrigation District which bears the date of May 11, 1889. On July 8 this right was again cut about one-third, but it was not until July 19 that it was entirely cut off for the second time. Other cuts followed until by July 27 the natural flow was insufficient to supply any of the 1889 decrees. Near the end of the month, however, light rains occurred and these, combined with further decreases in the flow of the river, probably were responsible in part at least for another material increase in the return flow, to the extent that the latter reached its maximum for the season on Aug. 2. A large number of rights were, therefore, restored to good standing.

The storage in Jackson Lake was by this time very much depleted and from July 26 to July 30, and again beginning Aug. 3, all the outlet gates were reported to have been raised clear of the water. The water surface in the lake continued to drop, indicating that storage was still being drawn off, although at a continually decreasing rate because of the limitation of the outlet capacity and the lessening head.

Transmission losses between the Woodville and Blackfoot gaging stations were now very large in proportion to the small discharge of the river and it was soon discovered that the Minidoka canals could expect to benefit little from the small amount of stored water still being released from Jackson Lake. Instructions were therefore received to partially close the gates at the dam on Aug. 21 and thereafter so regulate them as to allow only the natural flow to pass on down the river. In anticipation of this cessation of stored-water delivery an agreement was entered into with the president of the Progressive Irrigation District under which a quantity of storage equivalent to the total of the unused upper valley storage rights was delivered to the canals of this district, to be later repaid, as required, by transfer from natural flow rights. No storage was released from Jackson Lake after Aug. 21 and the work of distribution after that date resolved itself into the problem of so regulating the natural-flow rights of the upper valley in accordance with the decree as to fill all valid rights up to the requirements and still not allow any water to waste past the lowest point of diversion near Blackfoot. This could not always be accomplished exactly, but it was so handled that during the greater part of the remainder of the season (until the end of September) the river was aboslutely dry at a point about four miles below the town of Blackfoot, while at no time during this period did the waste past the last canal exceed about 100 second-feet.

Unusual Natural Run-Off—A brief reference to the extremely low natural flow of the river during the early part of the season and a few comparisons with other low water years will facilitate a clear understanding of the 1919 conditions. Very little snow fell during the early part of the winter of 1918-19 but storms during January, February and March served to accumulate a snow reserve in the mountains of nearly average depth, in so far as this could be determined from the reports available. At the beginning of the irrigation season, therefore, while a deficiency in available run-off was expected, no very alarming shortage was anticipated.

Analysis of the Heise station hydrographs covering the three low run-off years, 1905, 1915 and 1919, indicates that this idea was substantiated in a measure, in that while the natural discharge is materially lower during June and July, 1919, than for the corresponding months of the other years, this deficiency is made up in part by the higher discharge during April and May. In fact, if account is taken of the early run-off during 1919 which was stored in Jackson Lake, it is apparent that the total natural flow was greater for this year than for 1905. Unfortunately, however, the peak period of irrigation use came during the months of greatest comparative deficiency and little benefit was derived from the surplus available during April and May.

FIG. 4. LAKES GIVE UP APPRECIABLE BANK STORAGE AT LOW STAGES—LOSE AT HIGH STAGES

Attention is called to the fact that during most of June and July, 1919, the natural flow was no greater than for dates fully one month later during the other low years, and during the middle of this period the deficiency reached the astounding total of about 5,000 sec.-ft.—an amount equivalent to nearly one-half of all the rights decreed to upper valley canals which divert from the South Fork or main Snake River.

Enforcement of Regulation — In most instances no difficulty was experienced in enforcing orders for the closing of headgates. There were, however, a few exceptions where gates were raised by unauthorized parties after they had been lowered by the water master or by his deputies. In no case was any first hand or eye-witness evidence obtained in regard to infractions of the law. In default of this, prosecutions were not attempted. A number of headgates were fastened with chains and padlocks, but even these were not always effective, so that on three different canals guards had to be employed.

The threatened failure of crops on land under canals which had either been cut under the decree or else were soon likely to be cut naturally aroused much discussion. Meetings of the water users were held at frequent intervals, investigating committees were active and threats were even made to go out and take the water without regard to law. At times this situation appeared to be decidedly threatening and it was materially aggravated by the fact that the bulk of the Jackson Lake storage delivered to the lower valley canals was run down the river during what is normally the flood-water period. Efforts were made, however, fully to explain the existing conditions through

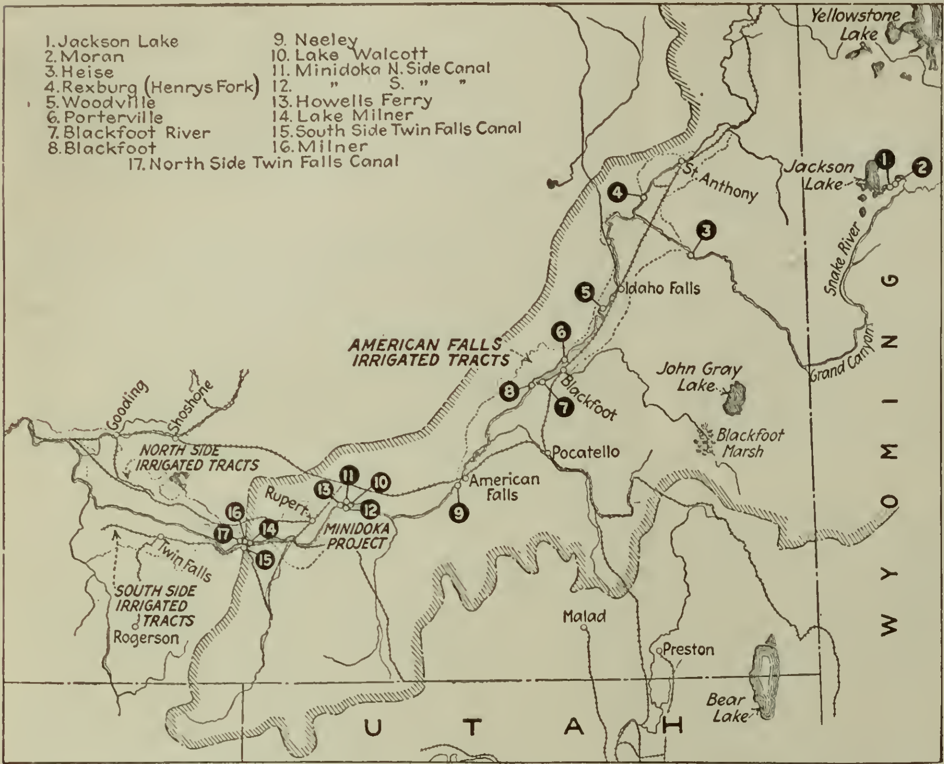


FIG. 5. SNAKE RIVER BASIN SHOWING STORAGE RESERVOIRS, IRRIGATED AREAS AND GAGING STATIONS

the medium of the press, at water users' meetings and by personal conversation with canal company officials. This last means probably was the most effective and although most of the time of the special deputy during ordinary daylight office hours for a period of about six weeks was taken up in furnishing information of this character, and an extra hydrographer had to be employed for a part of the season in consequence, the increased confidence and better feeling which resulted is believed to have afforded ample justification.

Domestic Water—Many of the settlers in the upper valley still depend upon the water in the canals for domestic and stock use; hence, when it appeared that some of these canals, under a strict interpretation of the decree, might be deprived altogether of water, this immediately became a vital issue. In June a general meeting was held at Idaho Falls, where it was explained to the water users that no legal authority for allowing domestic water to otherwise dry canals existed and that to do so would necessarily reduce the quantity available for irrigation use. After some discussion a vote was taken, from which it appeared that public sentiment was unanimously in favor of granting an allowance for domestic use when needed, but no action was taken to provide a specific source from which water for this purpose was to be obtained. Therefore, while domestic heads of water were granted thereafter in accordance with the decision of this meeting, in default of any authority to do otherwise, water for this purpose was taken from the natural flow available in the river. The total natural flow was consequently depleted and it became necessary to cut other rights in the order of their priority in order to make up this deficiency. Under this system, during the latter part of the season in particular, when the natural flow was almost stationary or was decreasing at a lesser rate than at first, the entire domestic allowance was supplied at the expense of the rights of a few canals which otherwise might have enjoyed the use of nearly a full irrigation right. Unquestionably this was unfair to these canals and in future years if domestic water cannot be dispensed with entirely it should be supplied on some other basis.

Temporary Transfers—In order to limit unavoidable crop losses throughout the valley to a minimum the State Commissioner of Reclamation, early in the season, authorized the granting of temporary transfers of water from canals still having valid rights to those in which the flow had been reduced. At first there seemed to be some reluctance to utilize this permission and instead efforts were made to secure an exchange with the stored-water owners whereby repayment could be made from the natural flow late in the season, as was done in 1915. This did not seem practicable, however, and even if arranged would not afford the necessary relief because of the small amount of storage which could be made available. Therefore, after repeated assurance had been given that these temporary transfers would in no way affect the decreed rights of the canals involved, they were very largely adopted and undoubtedly were the means of saving many valuable crops. Between the latter part of June and the end of the irrigation season more than one hundred of these temporary transfers were made. So far as known the water delivered under these transfers was always donated.

In spite of all the good resulting from this temporary transfer system it probably is detrimental to those decreed rights which are just past the dividing line or which would be restored in the event of any increase in the natural flow. The reasons advanced are as follows: (1) If the use of the water was confined to the land to which it had been decreed the ground water level in this section would rise higher and a larger return flow to the river would result than in the case where it is used on land which has been without water for some time. (2) During the latter part of the irrigation season many crops no longer require irrigation and the water requirements of any given right would be allowed to go on down the stream.

Transfers on the 1919 basis, therefore, tend to deprive certain canals of water which might normally be available to them and are probably only justifiable as an emergency measure which promotes a higher water duty.

River Data — Extensive tables were made to summarize the river data in regard to total flow, normal and stored water segregation, diversions, losses and gains for each section of the river between Jackson Lake and Milner. These tables are prepared upon the following time interval basis:

Time from Jackson Lake in Hours	Gaging Station	Period Used for Comparable Daily Means
0	Jackson Lake and Moran	Day ending at 4 a.m.
24	Heise	Day ending at 4 a.m. 1st day following
28	Rexburg	Day ending at 8 a.m. 1st day following
42	Woodville	Day ending at 10 p.m. 1st day following
48	Porterville	Day ending at 4 a.m 2d day following
54	Blackfoot	Day ending at 10 a.m. 2d day following
68	Neeley	Day ending at 12 midnight 3d day following
92	Minidoka	Day ending at 12 midnight 4th day following
116	Milner	Day ending at 12 midnight 5th day following

While no one schedule for time of transmission will apply for all the different stages occurring during the irrigation season, it was thought that any attempt to vary the time interval with changes in stage would only lead to confusion, and as this schedule is fairly representative of average conditions it was used throughout the entire four months' period. On the upper river sections it is more directly applicable at medium and high stages, while below Neeley it apparently coincides better at low stages.

Jackson Lake Storage Deliveries—The amount of stored water released each day from Jackson Lake was measured at the Moran gaging station. The proportion of this total which was storage water was determined from the reservoir capacity tables by noting the quantity corresponding to the daily decrease in stage indicated by the lake gage readings. Interpolations were sometimes necessitated for short periods because of irregularities attributed to wind effect.

Special investigations carried on by the U. S. Geological Survey during the seasons of 1917 and 1918, between Moran and Heise, while not conclusive as to results, indicated that the stored water transmission loss between these two points was very small and probably did not exceed the average of $2\frac{1}{2}$ per cent which has been applied for the last few years. Consequently this percentage was again used throughout the season of 1919. Below the Heise gaging station the former loss schedule of $\frac{1}{2}$ per cent to Woodville and $5\frac{1}{2}$ per cent to Neeley was abandoned in favor of computed losses based upon two-day means. The method of computing the percentage of loss for each day as follows:

$$\frac{U+T-D-L}{\frac{1}{2}(U+T+L)} = \frac{\text{Actual daily loss}}{\text{Approximate average flow in section}} = \text{Percentage loss}$$

Where U equals total flow at upper river station, T equals inflow from tributary streams entering within section, D equals total diversions throughout section, L equals total flow at lower river station.

The percentage actually applied each day to determine the stored water loss in a given section was the mean of the computed percentages for the two preceding days. Whenever a net gain instead of a loss was noted in a section the transmission loss for the stored water was assumed to be $\frac{1}{2}$ per cent, on the theory that the stored water cannot gain in transit. Considering the data for the entire season, it would appear that this plan may have been somewhat detrimental to the storage owners, as under it they participate in any unusual losses but do not benefit from the return flow noted on certain sections of the river during the latter part of the season, even though this return flow may be caused in part by stored water which was dissipated into the ground adjacent to the river during the earlier or heavy loss period.

FIG. 6. RECORDING GAGE HOUSE CABLE AND CAR AT NEELEY IN USE SINCE 1910

Advantage was taken of large rock for foundation and anchorage for house, box type of float well and staff gage.

The original plan contemplated the pooling of all storage losses and their equal assessment between the canals of each group. This plan proved difficult, however, because of the different dates when individual storage rights became exhausted and the consequent uncertainty concerning the final total of the storage loss. Hence approximate total losses of between 6 and 7 per cent to Woodville and between 13 and 14 per cent to Blackfoot were used for the distribution. These percentages were calculated upon the assumption that the accumulated loss to stored water at the Blackfoot station over and above the amount legitimately chargeable (what might be termed the extra loss due to faulty regulation of the natural flow diversions) would be prorated between all storage rights. Few owners received exactly the amount of storage to which they were entitled after making proper deductions for transmission losses. The final discrepancies in most instances are due to computation revisions or to the impracticability of exact regulation to the nearest hour. The only gross error is chargeable to the special deputy who allowed the Harrison Canal to draw storage for one day in excess of its proportion. Summary of the totals shows that 93.7 per cent of the 102,000 acre-feet stored at Jackson Lake for the upper valley canals was actually delivered, while the average delivery to the lower valley canals when proper account is taken of the Lake Walcott exchange amounted to 86.2 per cent of the total credited to them at the reservoir.

FIG. 7. ONLY THIN SHEETS OF WATER PASSED TWIN FALLS—IRRIGATION UPSTREAM CLAIMED ALL FLOW

The flow in the river at the Milner stations which represents the wastage past the Milner dam has been pro-rated and is included in the amounts charged against the two Twin Falls canals. Prior to Aug. 17 this wastage was divided between the two companies in proportion to their relative draft, but thereafter by special agreement [illegible] was charged against the North Side canals and $\frac{6}{10}$ against the South Side Canal, this being in proportion to their relative ownership of the Milner dam.

Review Gains and Losses—A study of graphs showing losses and gains indicates that with a sharp increase in the flow of the river the losses also increase; with a sharp drop in the river the losses decrease or the gains increase. These facts are probably explained by the changes in the ground water which follow each marked variation in the stage of the river. The tendency for the losses to decrease in Lake Walcott with a corresponding drop in the reservoir and the reverse with a rise in the reservoir affords a good illustration of the effect of bank storage. From Aug. 4 to Sept. 30, when there was practically a steady drop in the elevation of Lake Walcott, there was an average daily net gain of 65 sec.-ft., whereas from June 5 to Aug. 3 there was an average daily net loss of 348 sec.-ft. If this latter quantity could be assumed to represent the normal loss in the reservoir which continued during the entire falling stage period the actual inflow attributable to return water or bank storage would average 413 sec.-ft. and would amount to the astounding total of more than 45,000 acre-feet in the last 58 days of record. Such an assumption is undoubtedly not warranted since the normal loss probably decreased with the drop in the water surface elevation, but it serves to indicate the possible extent of the additional supply derived from bank storage.

Eighty Applications for Power Permits

Eighty applications for preliminary permits and licenses have been received by the Federal Commission. The revision of these applications so as to conform with the requirements of the regulations is being carried forward rapidly and many corrected applications are now in the hands of the commission.

Cast-Iron and Wood-Stave Pipe Economically Compared

By J. W. Ledoux
Consulting Engineer, Philadelphia

The cost of cast-iron water mains has been so great the past two years that much attention has been given to substitutes, and many concerns, especially those connected with war activities, have laid immense quantities of wood pipe to be subjected to all ordinary ranges of pressure, both constant and intermittent. It is quite probable that within the next generation some valuable records concerning the useful life of this material will be available. At the present time there is a dearth of reliable information as to its suitability for waterworks purposes. If one were to form a conclusion from a number of important installations he would be justified in condemning its use absolutely. However, he could find at least as many instances to indicate it to be superior to cast-iron pipe in many essential qualities.

Rod-banded continuous wood-stave pipe, properly designed and laid and kept filled with water, should last at least 25 years and be good for working pressures up to 100 lb. per square inch. Cast-iron pipe, when first well laid with lead joints, is practically water-tight, but after some years of service the frequent expansions and contractions due to changes of temperature are sure to cause some dropping leaks, but the total of this leakage is generally not large enough to be a problem. With wood pipe, however, there is almost sure to be a material amount of leakage, and the question is how much is permissible. If water is scarce and precious and the loss due to leakage is not returned to the same drainage area or for any other reason leakage cannot be tolerated, then it will be unwise to use wood pipe at all; but let us suppose that the leakage is recoverable and only causes reduced capacity, or increased cost of pumping, such as would happen if this leakage came back into the drainage area or if the water were pumped from an inexhaustible supply, such as a lake or river.

Let us take an example of 40,000 ft. of 24-in. wood pipe, which, at today's prices, can be laid for about $3.50 per foot. Let us assume the life to be 25 years and the depreciation such as will renew the pipe completely at the end of that time. In order to figure safe, let us take this on a straight-line basis at $5,600 per year. The present worth of $5,600 per year for 25 years is $78,500. The total cost would be therefore $140,000 + $78,500 = $218,500. The cost of cast-iron pipe will be about $6.50 per foot. It will have a life estimated at 80 years and the present worth of the depreciation for 25 years would be about $3,770. The total cost of pipe and depreciation will be therefore $260,000 + $3,770 = $263,770. The difference between this and the cost of the wood pipe is $45,270. If we take the capacity of the pipe as 8,000,000 gal. per 24 hours and the cost of pumping the water 150 ft. high as $20 per million gallons, the cost per million gallons per year would be $7,300. The present worth of $7,300 for 25 years at 5 per cent would be $102,500, so the present worth of $45,270, the difference in the cost of the two pipes, would be equivalent to a pumpage of 442,000 gal. per 24 hours.

During this whole period of 25 years, on account of tuberculation, the friction through a cast-iron pipe will average at least 40 per cent more than that of a wood pipe, corresponding to the increase of head from 150 to 210 ft., or to a reduction of the flow co-efficient to about 85 per cent of that of a new cast-iron or wood pipe. The cost of pumping through the cast-iron pipe will therefore be increased over pumping through the wood pipe from $20 to $28 per million gallons. The difference would be equivalent to pumping an additional 1,400,000 gal. per day through the wood pipe.

Therefore the permissible loss by leakage due to the difference in total investment would be 442,000 gal. per day, and due to the difference in cost of pumpage by tuberculation of the cast-iron pipe would be 1,400,000 gal. per day, making a total of 1,842,000 gal. per day. So if this calculation be correct, one could afford to pump 9,842,000 gal. through wood pipe to obtain a net quantity of 8,000,000 gal. per day, or 1,842,000 gal. per day (over 20 per cent) more than the pumpage through a cast-iron main, and still come out even financially so far as the cost of pumping and fixed charges is concerned. Hence it is seen that when compared with cast-iron the installation of a wood pipe in many important cases is justified from an economical standpoint.

Engineers sometimes are at a loss to know how much leakage it is permissible to use in the specifications for wood pipe and it must be confessed this is a difficult point to decide. Of course, every engineer wants to get as good results as is practicable without imposing upon the contractor undue hardships. Under very favorable conditions it may be possible to obtain results where the leakage will not be greater than 500 gal. per inch in diameter per mile, but the writer suspects that such low results are the exception rather than the rule.

With the best form of joint, pipe and quality of wood a very tight pipe can sometimes be secured. With the ordinary mortise-and-tenon joint under average conditions a considerable amount of leakage is almost unavoidable.

Summarizing, the relative advantages and disadvantages of the two pipes are as follows: Wood-stave pipe has a short life and generally a material leakage. It is low in cost and has a high co-efficient of discharge, and consequently small frictional resistance to the flowing water. Cast-iron pipe is high in cost and after a few years' use has a low co-efficient of discharge and high frictional resistance to flowing water. The leakage is usually negligible. It possesses a very long life and can be easily repaired in case of leakage. On account of the cheapness of wood-stave pipe a material amount of leakage is permissible from an economical standpoint, where the water so leaking can be spared and causes no damage to property.

Cost of Deleware's High Death Rate

Deaths in the State of Delaware in the last four years totaled 3,130 in excess of what would be expected "if Delaware had been up to the average for the country in health and sanitation," according to *Delaware Health News* (State Board of Health, Dover) for October. Assuming a value of $5,000 for each of 3,130 excess deaths the state suffered a loss of $15,650,000, besides an estimated total of $626,000 for nursing, medical care and funerals. The death records of Delaware have but recently been worked up in accordance with the standard system of classification. Chester H. Wells is special health commissioner, sanitary engineer and collaborating epidemiologist for Delaware and Dr. L. S. Connell is executive officer of the State Board of Health and registrar of vital statistics.

Capillary Siphoning of Water Through Soil

CAPILLARY action is capable of lifting water from a source of moisture and carrying it over a rise to discharge it on the other side at a point lower than its origin, according to experiments made by W. W. McLaughlin, senior irrigation engineer, Department of Agriculture, reported in the department's bulletin 835, just issued under the title "Capillary Movement of Soil Moisture." In the main series of experiments a trough or box 10 x 10 in. in cross-section and 10 to 20 ft. long, sloping downward at angles of 15 to 45 deg., and filled with earth, was supplied with water from a tank 4 in. below the bottom of the trough at its upper end, by a closed elbow or gooseneck, also 10 x 10 in. in section, whose lower end, closed with wire mesh, dipped into the water in the tank, the gooseneck being filled with earth in direct contact with that in the trough itself. The top of the trough was open, so that atmospheric pressure existed at all points of the free surface of the absorption water in the soil. In the cast of the 30 deg. trough, moisture drawn up from the tank by the soil in the gooseneck and traveling thence down the column of soil in the trough reached the lower end of the trough in 21 days, and after three or four days more dripped from the end as free water, no longer held by the capillary attraction. Moisture analyses of the soil indicated that at no point in the entire length of the earth mass, except perhaps at the extreme lower end, was the amount of moisture in the soil as great as that of capillary saturation. The experiment showed, in other words, that water could be raised from a body of free water by capillarity and delivered again as free water at a lower level, though transported by unsaturated soil.

In further exploration of this phenomenon, galvanized-iron tubes 7 x 7 in. in cross-sectional area curved to inverted U shape for use as siphons, were filled with soil and placed so that the short leg dipped into a tank of water and the long leg projected downward on the outside of the tank. The top of the horizontal leg of the siphon was open, so as to leave the soil exposed to the air at this point. The earth was retained in the tube by a sheet of fine-mesh gauze over the open end of the short leg, and by a complete closure of the long leg, just above which closure was attached a water-gage glass extending upward along the side of the tubes. The bend of the siphon was 8 in. above the water level of the tank, and the average width of the siphon at the top, center to center of legs, was 12 in. With the long leg of the siphon 6 ft. long below tank water level, sixty days' operation filled the gage glass up to a point within 11 in. of the surface of the water in the tank. Subsequent experiments with the same tube, using different soils, gave similar results, except that the experiments were not run for such a long period. Capillary siphoning was thus confirmed.

That the amount of water delivered is comparatively large was shown in one test of the trough type, as first described. After the water started dripping at the lower end, both the consumption of water from the tank and the discharge at the lower end were measured during a fixed period of time. The quantities were 18 and 8.78 liters respectively, so that the earth siphon delivered nearly half of the water that it took from the tank (the remainder presumably going to increase the saturation).

Special precautions were taken in some of the U-tube tests to guard against the formation of continuous capillary passages or "tubes" through the soil by puddling or other natural action. To this end ventilating pads or drainage wells of flat, compact packages of wire mesh were placed in the vertical part of the short leg, having the effect of ventilating the soil thoroughly. The presence of these pads did not affect the transmission of water, except that a little less water was picked up. In the most extreme case of ventilation the pads were so spaced that no part of the soil in the short leg of the siphon was more than 1½ in. from a pad.

Mr. McLaughlin concludes from his tests that capillary siphons may occur in nature and may in fact be common. Such siphons, he thinks, might cause the swamping of lands. He also suggests that capillary siphoning might develop in a reservoir embankment where the corewall does not extend to the top of the embankment, and the effect might be to saturate the earth on the downstream side.

Research Most Needed as Highway Construction Aid

IN SUPPORT of his contention that research and investigation must form a greater part of highway activities in the future, Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, made the following remarks in the course of a speech, Oct. 20, before the Land Grant College Association, which met at Springfield, Mass.:

For the next quarter of a century improvement of public highways will be the greatest single public activity. It will require such enormous sums of money that these expenditures should and must rest upon the soundest principles of engineering and economics.

There are many agencies interested in these problems. Their efforts should be correlated into one comprehensive program. It is highly important that, while this program should be pre-conceived as a whole, and each undertaking formed as a component part, the working out of the problems should go forward in such a manner that individual initiative will be encouraged and local conditions will be met. It must be recognized that while the improvement of highways in the aggregate is of national concern, and has been so recognized by the Federal government in making available large sums for encouraging road building, the important problems of research and investigations are more or less local. The underlying principles of sound construction or maintenance, or of economics, while remaining the same, are subject to an infinite number of variations dependent upon local conditions of topography, geological formations, population densities, development of industries and such modifying circumstances as to render necessary the proper solution of these problems through a decentralized organization. To bring such a movement into being on a national basis seems properly to be a function of the National Research Council.

Perhaps there is one master problem which should be solved first as a foundation for all others. This problem is that of highway traffic. We would be on a very much sounder basis now with reference to highway legislation, appropriations and organization were this investigation complete. The matter is of such importance as to demand a comprehensive and accurate study in every state and one which, first of all, well might engage the attention of those agencies which are interested in the fundamentals of knowledge necessary to the carrying out of large public undertakings. This problem has become acute in other countries. It is engaging the attention of both the English and French national departments of highways to the extent that detailed and accurate studies are being undertaken of highway traffic.

Filter Underdrain, Sand-Bed and Washwater Experience

Symposium on Current Practice and Operating Success with Various Details of Mechanical or Rapid Water Filtration Plants

[This article is the result of a questionnaire to operators and men intimately connected with 20 typical filter plants. The problems encountered in handling the sand, the medium which does the actual work at a filter plant, have been sought. Experience for 15 years with perforated-pipe underdrains indicates satisfactory service, and the first installment gives the details. Gravel depths seem to have increased to more than a foot in the best practice. Blow-ups, the bug-bear of the operator, are explained and instructions given as to how to prevent them. Mud balls have always existed in nearly all plants but the formation has not been generally understood nor have any but "strong-arm" methods been developed to remove them. How the man at the plant handles them is told succinctly. The second installment will be devoted to experience with various gutter designs, the relation to mud-ball formation, top sand scouring and sand-bed shrinkage.—EDITOR.]

Part I — Perforated-Pipe Underdrains — Gravel Depths—Blow-Ups—Mud Balls and Washing

MOST questions in filter design that were disputed points a dozen years ago should by now be sufficiently answered. In manufacturing, standard practice is desired as soon as possible so that factory methods may be developed and costs reduced. Have we reached that stage in the design of filters? If we have reached satisfactory perfection are we entering on a stage of non-development where the shelf-hardware type of filter may be ordered without detailed engineering design? Has a satisfactory underdrain system been developed? Do we surely know the proper depth and size of gravel layers? Can we control the "blow-up"? Are mud balls still a bug-bear? Have we yet developed a means of scouring the dirty sand at the top of the sand bed? Is gutter design well enough known so that we can get the high-rate wash expected? Do we still lose sand? Is the underwater shrinkage of sand beds well enough understood to apply a remedy? None of these questions relate to anything about a filter far removed from the medium which actually does the work. After all it is on the sand and its handling that reliance must be placed for efficient results. With this in mind an intensive experience study has been undertaken by sending a set of 16 questions relating to the above points to operators and men familiar with about 20 typical plants. The thirteen answers received are collated below:

Perforated-Pipe Underdrains

When the "Symposium on Underdrains" printed in the *Engineering Record*, May 9, 1914, p. 529, was prepared, perforated-pipe underdrains had not been long in use. There has now elapsed the 15-year period which the Harrisburg galvanized-iron pipes were expected to last and in several other plants the system has been adopted. The perforated-plate, ridge-and-valley type then so often employed is still in satisfactory use but the pipe system is so much cheaper and simpler that it is being used more and more. When screens to hold down the gravel are eliminated, deeper gravel layers used and air is replaced by a high-rate wash, any system which will provide sufficient loss of head to distribute the water evenly under the sand layer is satisfactory. As soon as a gravel layer was interposed over the openings in strainers, screen or pipe producing the loss of head no direct jet action on the sand grains was possible leaving only the loss-of-head function to the opening if, indeed, it ever really did serve any other.

Six men answered the two questions asked on perforated-pipe underdrains:

1. What has been your experience with the perforated-pipe type of underdrain?

2. Will it outlive its designed life? What is its present condition? How much more time is it good for? What were the alternatives?

W. G. Clark, consulting engineer, Toledo, O.—The perforated-pipe type has been installed in three plants recently built or revised under the direction of this office. So far they have given satisfactory service. This type has replaced cast-iron laterals and brass strainers in 34 filters at the Toledo plant. All of the laterals of this type which we have installed are provided with a single row of holes on the bottom. The laterals are set so as to give a 1-in. clearance over the filter floor. To avoid having the gravel blanket the openings in the laterals, the bottom layer is made up of gravel none of which is less than 1½ in. in diameter.

It is believed that the life of these laterals will be as great as that of the other parts of the filter equipment. So far as examinations have shown, the laterals are in satisfactory condition. Generally we have used Byer's wrought-iron pipe or cast-iron laterals. In one case we used wrought-iron pipe and after the laterals were made up they were "Sherardized," thus protecting them very fully from corrosion. At present we are installing in 22 new filters for the City of Toledo cast-iron laterals with a single row of holes on the under side, each pair being connected by a tee into a large concrete duct or main under drain.

J. W. Ellms, consulting engineer and in charge of operation of Cleveland filters, Cleveland, O.—The writer's experience with the perforated-pipe system of underdrains for rapid sand filters has been more or less limited. The Division Ave. filtration plant at Cleveland is equipped with this type of underdrain and no trouble has been experienced with it during the 2½ years which it has been in operation. There has been no occasion to dig down into the beds in order to discover in what condition the pipes might be, and, therefore, it is impossible to state at this time what will be the probable life of the system.

Apparently some studies were made of other types of underdrains when designing this plant, such as the trough system with perforated brass plates and the nozzle systems. For the perforated-pipe system adopted, the specifications were quite carefully drawn. For example, the pipes were specified to be of cast-iron, drilled before being coated with a protective tar covering, leaded into the central manifold and properly held in place at their outer ends by a frame securely fastened to the floor of the tank. Moreover, any

openings that had become closed as a result of the dipping of the pipe into the tar mixture were opened carefully so that the metal edges should not become exposed.

Guy Eldredge, consulting chemist and bacteriologist, formerly in charge of operation, Fort Worth filters, Fort Worth, Tex.—Four new filter units of the Fort Worth plant are equipped with the perforated-pipe type of underdrain, but I have no further data. A 3,000,000-gal. plant constructed by the U. S. Army at St. Nazaire, France, was put in operation and operated by the writer for a little over six months. Two-inch galvanized pipe was used, laid 2 in. above a flat concrete floor. Perforations were as usual. The wash water distribution was good and no clogging or blow-outs occurred.

Prof. Charles Gilman Hyde, consulting engineer, Berkeley, Cal., (after consultation with staff of Filtration Division, Sacramento, Cal., C. G. Gillespie, resident engineer; H. B. Foster, assistant hydraulic and filtration engineer; H. N. Jenks, special assistant engineer; W. F. Langelier, special chemist and bacteriologist).—In addition to its use at Harrisburg, this type of underdrain has been employed in the Panama-Pacific exposition plant (1915) under the writer's design and in a small plant at the University of California by Mr. Foster. All of these experiences have been eminently satisfactory. The system is cheap, relatively, in construction, easy to install and it gives, under proper design, a most satisfactory distribution of both air and water without disturbance of the gravel. It has a long life and practically no maintenance costs.

At Harrisburg the filters were built in 1905 and placed in service late in that year. I have carefully reviewed all of the annual reports in which repairs and renewals are explicitly described and I find no reference to any trouble whatsoever with the underdrain system. No renewals have been necessary and no cost of maintenance has been incurred. It was expected that the pipe underdrains at Harrisburg would last at least fifteen years if of galvanized iron against a possibly greater life if made of copper. With fifteen years of life it was estimated to be cheaper to use galvanized iron than copper with, say, twenty-five years of life. Therefore, galvanized-iron pipes were employed with no treatment of the holes to prevent or delay corrosion. There is no evidence that the pipes require renewals and the distribution of air-and-water wash appears still to be perfect, as witnessed by the writer in December, 1919. No other type of underdrain was contemplated at Harrisburg. It would appear that a considerably greater life than fifteen years may be expected.

Mr. Jenks has made some notable experiments on pipe underdrains, 3, 3½ and 4 in. in diameter and 12 feet long. As a result of his convincing studies, it is proposed to use 3-in. standard wrought-iron pipes, 12 ft. long, net, between walls of the Sacramento filters. The pipes will be spaced 12 in. c. to c., with 7/16-in. diameter holes on the underside 6 in. c. to c. The bottoms (outside) of the pipes will be placed 1 to 1.2 in. above the concrete floor. They will successfully handle all rates of water wash (through 18-in. depth of gravel in four layers) from 12-in. to 36-in. vertical rise per minute and will give perfect distribution of air applied at the rate of 4 cu.ft. per sq.ft. per minute.

Mr. Jenks' experiments demonstrate that with a 4-in. pipe, a length of at least 20 ft. can be successfully employed 12 in. c. to c., or possibly 16 in. c. to c., if an 18-in. gravel depth is used. In general his conclusions are: (a) That the holes may have a total area of 50 per cent of the cross-sectional area of the pipe, but not more than that. (b) That there may or should be from 0.3 to 0.4 sq.in. of hole area per sq.ft. of filter floor area. (c) That 3-in. pipes may be spaced as far apart as 12 in. c. to c. with holes 6 in. apart.

F. H. Waring, assistant engineer, Ohio State Board of Health—The department has been giving close study to the design of water filters proposed for use in this state, particularly for the last few years. It has been our practice to keep in close touch with the many plants in service about the state, noting the results obtained from the various types of designs in use. The first filter plant of fairly recent construction to adopt the Harrisburg perforated-pipe type of underdrain in Ohio is the one at Napoleon, placed in service in 1916. Four years' experience has demonstrated that this type has proved satisfactory.

A modification of the false bottom, cast-iron manifold and lateral type of underdrain was designed for the filters at Lima, by W. G. Clark, and placed in service in 1917. The wash water is admitted below the filter bottom in a concrete conduit extending across the center of the units and of such size as to limit the velocity of wash water to a low point, approximately 2½ ft. per second. Connecting with the conduit through the bottom of the filter are 3 x 2½-in. tees placed 6 in. c. to c., extending up above the floor of the filter and to which are connected 2½-in. laterals having ¼-in. holes 3-in. c. to c. on the under side.

R. S. Buzzell, chief chemist, Filter Plant, Flint, Mich.—Our strainers are of the type designed by the Pittsburg Filter & Manufacturing Co. type. They have given practically no trouble during the seven years in use.

Gravel Depths

Gravel depths have materially increased since the first thin layers were used at Little Falls, N. J. More and thicker grades have been added. Since the holding-down screens have been eliminated the depth in high-rate wash plants has been increased two or three times. With the perforated-pipe systems the practice of pointing the perforations downward has eliminated entirely any jet action which might cause shifting directly, but depths have increased just the same with the idea of obtaining a better distribution and less shifting. Twelve men answered the one question on this subject.

3. What are the gravel depths and grades finally found best suited to support the sand?

Charles P. Hoover, chemist, Columbus purification plant, Columbus, O.—We are at present rebuilding our filters and contemplate making some changes. The normal carbonates, calcium and magnesium with which a softening plant has to deal tend to incrust or form a coating on the sand. The holes in the strainer plates have become partly plugged with this incrustation, so that at the present time it is not possible to wash the filter with a vertical rise of more than 12 in. This rate of wash is not entirely satisfactory so we are taking out the strainer plates and drilling four ¼-in. holes through each plate. We expect to cover the strainer plates with 18 in. of gravel of the following grades:

5 in. between 2½ in. and 1½ in.
3 in. between 1½ in. and 1 in.
2 in. between 1 in. and ½ in.
2 in. between ½ in. and ¼ in.
1½ in. between ¼ in. and ⅛ in.
2½ in. fine pea gravel.

The depth of the sand will be 24 in. We are not going to buy regular filter sand but will use local bank sand.

Walter A. Sperry, chemist, filtration plant, Grand Rapids, Mich.—Originally our sands were supported on 8 in. of quartz gravel tied in between ridge blocks with a brass screen on top secured to the top of the ridge blocks. The gravel was supported on the strainer plates and consisted of the following:

3 in. between 1 in. and ⅝ in.
2 in. between ⅝ in. and ⅜ in.
1¾ in. between ⅜ in. and 3/16 in.
1¼ in. between 3/16 in. and No. 10 mesh screen.

Later, due to the problems introduced by after-deposits resulting from our lime-softening operations, we removed the screen and increased our gravel layers to a total thickness of 14 in. by filling in the space between the ridge blocks with gravel grading between 2 in. and 1 in. and adding gravel thereon as follows:

7.5 in. between 2 in. and 1 in.
1.3 in. between 1 in. and ⅝ in.
1.1 in. between ⅝ in. and ⅜ in.
1.1 in. between ⅜ in. and 3/16 in.
3.0 in. between 3/16 in. and No. 10 mesh screen.

This gave gravel layers that were not disturbed or displaced by the wash water when applied without the sand and has worked well for four or five years.

W. R. Gelston, superintendent, Water-Works Commission, Quincy, Ill.—My experience has all been with the New York-Continental-Jewel Filtration Co. strainer system. Our six filters, 12 x 34 ft. in area, are equipped with 9 in. of graded gravel and 30 in. of sand. We have had no trouble with mud balls but we do have trouble due to shifting of the gravel. When the air wash begins the filter breaks first immediately over the large pipe and seems to throw the gravel out of position and pile it up a short distance on each side of the large pipe.

Mr. Clark, Toledo—It is felt that approximately 17 in. of gravel is desirable. In the reconstruction of the Toledo filters, on account of limited depth, $15\frac{1}{2}$ in. was used. This depth was made up of a $3\frac{1}{2}$ in. layer under four 3-in. layers. Where a depth of 17 in. of gravel is possible we would use a 5-in. layer at the bottom and four 3-in. layers above it. Our experience indicates that the sizes given in the table below are satisfactory:

5 in. between $2\frac{1}{2}$ in. and $1\frac{1}{4}$ in.
3 in. between $1\frac{1}{4}$ in. and $\frac{3}{4}$ in.
3 in. between $\frac{3}{4}$ in. and $\frac{3}{8}$ in.
3 in. between $\frac{3}{8}$ in. and $\frac{3}{16}$ in.
3 in. between $\frac{3}{16}$ in. and 10 mesh screen.

Lewis I. Birdsall, superintendent, Purification Division, Minneapolis, Minn. — After the screens installed in the twelve original Minneapolis filters were removed, the gravel in these filters was increased in size and depth as follows:

4 in. between $1\frac{1}{2}$ in. and 1 in.
4 in. between 1 in. and $\frac{5}{8}$ in.
2 in. between $\frac{5}{8}$ in. and $\frac{3}{8}$ in.
$1\frac{3}{4}$ in. between $\frac{3}{8}$ in. and $\frac{5}{16}$ in.
$1\frac{1}{2}$ in. between $\frac{5}{16}$ in. and 10 mesh screen.

The twelve additional filters installed since 1914 have the following sizes and depths of gravel:

$2\frac{3}{4}$ in. between 2 in. and $1\frac{1}{2}$ in.
3 in. between $1\frac{1}{2}$ in. and 1 in.
3 in. between 1 in and $\frac{5}{8}$ in.
$2\frac{1}{4}$ in. between $\frac{5}{8}$ in. and $\frac{3}{8}$ in.
2 in. between $\frac{3}{8}$ in. and $\frac{5}{16}$ in.
2 in. between $\frac{5}{16}$ in. and 10 mesh screen.

The 15 in. of gravel graded as above permits of a vertical rise of wash water of 24 in. per minute without displacement of the gravel and has been entirely satisfactory.

Mr. Ellms, Cleveland—The depth of the gravel layer in the Division Ave. plant is 22 in., of which about 16 in. lie above the center of the lateral pipes. The bed is well graded from coarse to fine as regards its gravel, and properly supports the sand bed. The sand bed is about 27 in. deep and is rather coarse (0.45-mm. effective size) for the most effective filtration.

It is the writer's belief that where the high velocity method of washing is used the character of the gravel bed is of the greatest importance. Not only must the bed be of the right depth, but also it must be uniformly graded from coarse to fine. The gravel in upper layers should be only a little larger than the coarsest portion of the sand. The ideal filter bed consists of as nearly as possible uniformly decreasing sizes of gravel and sand. The gravel bed is a distributor for the wash water after leaving the strainer system, and its importance in this respect cannot be too strongly emphasized.

For safety and for the best effects it is believed that between 12 and 18 in. of properly graded gravel will generally be found satisfactory. The writer has operated a large sand filter bed successfully with only 8 in. of gravel, and failed to observe any marked difference between the efficiency of washing of this bed and those which contained 14 in. of gravel. Nevertheless, as a factor of safety, it is thought that at least 12 in. of graded gravel should intervene between the strainer system and the sand bed.

Mr. Eldredge, Fort Worth—A gravel depth of about 10 in., graded as follows, is used:

2-3 in. between $1\frac{1}{2}$ in. and $\frac{3}{4}$ in.
3-4 in. between $\frac{3}{4}$ in. and $\frac{3}{8}$ in.
remainder between $\frac{3}{8}$ in. and $\frac{3}{16}$ in.

Prof. Hyde, Berkeley—At Harrisburg only 7 in. of gravel was employed. A 4-in. layer around and just above the pipes, of $\frac{3}{4}$ in. to $\frac{1}{4}$ in. gravel; a second layer of 3-in. depth, $\frac{1}{4}$ in. to $\frac{1}{12}$ in. gravel. This depth at Harrisburg seems to be satisfactory with a water-wash rate of from 9 to 12 in. vertical rise per minute and an air-wash rate of 2.5 cu.ft. per sq.ft. per minute, but with greater rates of wash, more layers and greater depths of gravel underdrains should be used.

W. H. Lovejoy, superintendent filtration, Louisville Water Co., Louisville, Ky. — Two different depths of gravel are used. In the old battery of filters we had originally 7 in. of gravel resting on brass strainer plates between concrete ridge blocks, the gravel being held down by a 10-mesh brass screen. This screen rotted out after about eight years' service and we then removed the screen and rebuilt the gravel bed to a depth of 11 in. This new gravel bed is carefully laid in four layers:

4 in. between $1\frac{1}{2}$ in. and $\frac{3}{4}$ in.
3 in. between $\frac{3}{4}$ in. and $\frac{3}{8}$ in.
2 in. between $\frac{3}{8}$ in. and $\frac{3}{16}$ in.
2 in. between $\frac{3}{16}$ in. and 10 mesh screen.

A thicker bed of gravel was preferred here but we were limited to 11 in. by the filter wall height.

In our new battery of filters we have the Pittsburgh strainer cups set in concrete and overlaid with 14 in. of gravel made up as follows:

5 in. between $1\frac{1}{2}$ in. and $\frac{3}{4}$ in.
4 in. between $\frac{3}{4}$ in. and $\frac{3}{8}$ in.
3 in. between $\frac{3}{8}$ in. and $\frac{3}{16}$ in.
2 in. between $\frac{3}{16}$ in. 10 mesh gravel.

I have found that 14 in. of gravel properly graded is nearer the optimum depth than is 11 in.

Mr. Waring, Ohio State Board of Health—A high rate of wash water, say 15 gal. per sq.ft. per minute, is desired, and without the use of air agitation of the sand in filter washing.

The use of a carefully graded gravel to assist in the distribution and in breaking up jet action from several types of underdrain distribution is needed. We feel that the size of gravel should preferably be graded from 2 in. at the largest to at least $\frac{1}{12}$ in. for the smallest size and that the whole depth of gravel should be about 18 in. as a minimum.

It has also been demonstrated that the use of torpedo sand in addition to the gravel, or the use of a coarser sand, to support the filtering sand, is advisable. If the latter is employed, about 12 in. should suffice. This idea has been developed for the most part at the Akron filter plant under J. S. Gettrust. The filtering sand should be limited in size between 0.35-mm. and 0.40-mm. effective size, the uniformity coefficient not to exceed 1.7.

The whole depth of the filter sand should amount to about 30 in. and the distance from the top of the sand to the top of the wash-water troughs should be held to about 27 in.

Mr. Buzzell, Flint, Mich. — Ten inches of gravel seems to give satisfactory results. We are of the opinion that a 4-in. layer of finest gravel is necessary to support the sand.

S. T. Powell, chemist, Baltimore County Water & Electric Co.—In three plants recently designed the following grading has been entirely satisfactory:

6 in. between 2 in. and $1\frac{1}{4}$ in.
4 in. between $1\frac{1}{4}$ in. and $\frac{3}{4}$ in.
4 in. between $\frac{3}{4}$ in. and $\frac{1}{4}$ in.

Recently in removing the filter medium from a 500,000-gal. plant which had an 8-in. gravel bed the gravel was found displaced and piled up in one portion of the bed to a depth of 20 in. In another area sand only remained, packed around the strainers. The condition was attributed entirely to the grading and depth of the gravel.

Blow Ups

In the early use of strainer plates much difficulty was encountered with blow-ups, due largely to insufficient strength in the holding-down arrangements.

Blow-ups occur also in other types due to unequal compacting of the sand bed, uneven distribution of wash water and unusual accumulations of clay in certain areas. Most of the mechanical defects have been eliminated. The use of monel metal holding-down bolts solved the difficulty at Evanston, while the design has been changed considerably at Minneapolis. Nine men answered the two questions relating to blow-ups.

4. When blow-ups have occurred, what has been the cause; air, water, valve manipulation or an attempt to use air and water together?

5. Have repairs been replacements or new designs and what?

Mr. Sperry, Grand Rapids—There have been no blow-ups at this plant. In the beginning there were some few failures of the filter bottoms due either to the breaking of bolts or to the failure of the concrete blocks. These occasions were few in number and in no way serious. After these weak spots were found and corrected, they never recurred. Considering the total number of plates and blocks we have always felt that we had a surprisingly small share of this type of failure. With the exception of the removal of the screen noted above all repairs have been small in extent.

Mr. Clark, Toledo—In the Toledo plant in 1915 a number of blow-ups occurred due to the softening or deterioration of the cast-iron laterals at the points where the brass strainers were screwed in. These defects were so numerous and were appearing so frequently that complete revision of the underdrain system was decided upon. We have experienced no other trouble from blow-ups due to other than improper valve manipulations on the wash-water supply. We have not attempted to use air and water together except where a separate air system is provided. This air system being located just above the gravel does not cause blow-ups. The only extensive repairs in the Toledo plant have been where cast-iron laterals with brass strainers were replaced by wrought-iron laterals.

Mr. Birdsall, Minneapolis — Blow-ups in the filters have been caused entirely by failure of strainer plates and bolts of Tobin bronze, due to cold working of the metal. Annealing after bending or working was necessary. Monel metal gave no difficulty. (See *Journal* American Water Works Association, Dec., 1917, p. 471).

Replacements were made at first, followed by a change in design. Monel metal plates and bolts have been used in all new filters constructed. Cast-iron plates were placed along the side of the ridge blocks to serve as shoulders on which the strainer plates rest. The ridge blocks were made continuous across the entire width of each half of the filters, there being no center passage longitudinally of the filters beneath the strainer plates. Three-inch riser pipes in manifold form were substituted in place of the four 14-in. riser pipes in the original installation. Two 3-in. riser pipes serve as the collecting system for the area between each pair of ridge blocks in each half of the filter.

Mr. Buzzell, Flint, Mich.—While we have never had any trouble due to blow-ups, yet any tendency seems to come from the use of the air and water wash together.

Mr. Powell, Baltimore Co. — In every instance where blow-ups have been observed they have been due to excessive air pressure or to the simultaneous application of water and air. The reckless use of air by the operator is the most serious objection to air agitation of sand beds. Consequently, in small installations where the method of cleaning cannot be carefully controlled the writer believes that a high velocity wash is preferable to air and water.

Mr. Ellms, Cleveland—No difficulties with blow-ups have been experienced with the perforated-pipe type of strainer system. The washing rates used are from 27 to 29 in. per minute. The opening of the hydraulic valve on the wash water line has been carefully adjusted on each filter so that the above rate of washing cannot be exceeded. It is customary to open the wash-water valve slightly at the beginning of the wash and to hold it in this position for about one minute. The valve is then opened the remaining distance for which it is adjusted for the balance of the period of the wash, or from 2 to 2½ min longer. Under these conditions the pipe system is subjected to a minimum shock, and the sand bed is uniformly lifted and washed. It is believed that a well-constructed, perforated-pipe system would be able to withstand a much more violent shock than that to which it may be properly subjected when carefully and intelligently handled. In other words, it offers an ample factor of safety against improper handling.

Mr. Eldredge, Ft. Worth—Blow-ups have occurred with the old cast-iron manifold. In most instances it was due to blowing out of one or more strainers. In one instance, however, it was due to a cracked manifold and this in turn was caused by the settling of the filter floor. No trouble has been experienced with air blow-ups except where the separate air-and-water systems are in use. In such systems I have found air pipes split or worked out of the air manifold. In one plant gaskets were blown out of the joints of the large air manifold. On air-locked filters improper valve manipulation will generally cause blow-ups of rather a serious nature.

With a cast-iron manifold, repairs have consisted of bushing the strainer holes and welding breaks in the main header. No replacements have been made.

Prof. Hyde, Berkeley—There is no evidence of any difficulty from blow-ups or any other causes at Harrisburg, so far as my observation goes, and no repairs have been necessary.

Mr. Lovejoy, Louisville—No air is used and all of our blow-ups have been due, in the old units, with ridge block underdrains, to broken anchor bolts which allowed the strainer plate to drop down. In the new units, with the Pittsburgh strainers, the blow-ups have always been due to the blowing-off of the strainer cups which probably had never been screwed down tightly enough.

When we rebuilt the gravel bed in our old units, we took this opportunity of replacing all of the ½-in. strainer-plate anchor bolts with ⅝-in. rolled brass bolts, as we found that most of the old ½-in. brass bolts were badly eaten and crystallized and would break easily.

Mud Balls and Washing

Just why some kinds of turbidity are more prejudicial to mud-ball formation than others has never been explained. The colloidal theory, so much discussed latterly by the chemists, probably can be applied but improper coagulation, short settlement, insufficient washing and lack of sand scouring all are factors. Eleven men had answers for the four mud-ball questions.

6. Has the top of the sand always kept clean?

7. Have mud balls formed? How are they prevented and removed?

8. Is there a relation between mud-ball formation and rate of wash, or is the formation due to the type of turbidity?

9. Is the horizontal distance that the dirty wash water must travel a definable factor in the formation of mud balls?

Mr. Sperry, Grand Rapids—Our top sand is not clean and we do have mud balls and mud coatings. The condition is local and is caused by the special feature of the lime softening. It occasions us little trouble and does not appear to interfere with the proper functioning of the filters either in the way of clarifying the water or in removing the bacteria. Removal of mud balls is effected by scraping and washing with a second or third scraping as seems necessary two or three times a year.

There is not so much relation of the formation of mud balls to the wash as to the character of the raw water received on the surface of the filters. There is no evidence locally that the horizontal travel of the wash water is a factor. The Grand Rapids filters have troughs spaced 6 ft. c. to c. The troughs are 21 in. wide and the bottom is

V-shaped below vertical sides. It has a fall of 6 in. in 10 ft. toward the central channel into which the troughs discharge. The total depth of the gutter from the outside top to bottom is 18 in. at the back and 24 in. at the connection with the central channel. The filter sand is just high enough to dip into the bottom of the trough at the channel side.

Mr. Clark, Toledo—At times, especially when softening was being done, it has been difficult to keep the top of the sand clean. This has been due in part to deposits containing a considerable percentage of magnesium hydrate. It was found that these deposits were not removed satisfactorily by the use of a wash of approximately 22 in. vertical rise unless air was used.

When the use of air was discontinued mud balls began to form but by the use of air their formation was stopped and the muddy condition of the top of the sand was overcome.

It has been found at the Toledo plant that a relatively high rate of wash is necessary to avoid the formation of mud balls when softening is being done. As low a rate of wash as 12 in. with the use of air has prevented the formation of mud balls.

It is not believed that the distance between wash water troughs is definitely related to the formation of mud balls but it is believed that this distance effects the amount of wash water required to wash the filter properly.

Mr. Buzzell, Flint, Mich.—At certain times of the year it has been necessary to scrape off some foreign material from the sand surface. Mud balls occur at times. When found forming, a strong wash and the operation of running a rake through the bed tends to eliminate them. If mud balls are still present they are usually small, settle on the surface and are scraped off with a trowel. Mud-ball formations here seems to be due to a colloidal type of turbidity. Their formation may be related in a measure to the horizontal distance that the dirty wash water must travel.

Mr. Powell, Baltimore Co.—Mud balls or mud accumulations have occurred on the surface of the sand in every mechanical filter installation that has come under my observation. In some instances these accumulations have formed very slowly and in others rapidly. Accumulation of mud on the surface is caused by no single element, but is the resultant of one or all of the following conditions: (1) Poor distribution of wash water, either from an improper placing of the strainers or from a failure of the wash water distribution system while in service. (2) Too great horizontal flow of the dirty wash water before discharging into the wash water gutter. (3) Insufficient capacity of the wash water trough to carry away the washings. (4) Too short a period of detention of the coagulated water, thereby requiring the bed to receive an excessive amount of suspended matter that has not been completely entrained by the coagulant. (5) Character of the turbidity and suspended matter in the raw water.

By proper design and efficient operation of a filter installation the first four conditions mentioned above can be corrected. The last condition is difficult to correct, if not beyond the control of the engineer. It is for this last reason that so many well designed and efficiently operated systems are confronted by this problem. Mud balls are more prevalent when the raw water carries a high amount of turbidity and suspended matter, either continuously or after storms, and when the particles of suspended matter have a tendency to adhere. Many clays possess this agglomerating characteristic.

It has been the practice of the writer to have the operation of the plants under his supervision drain the plants after they have been thoroughly washed and scrape the mud accumulations from the surface of the sand. After each scraping the filters are again washed and the operation repeated if the mud balls are still present. Frequently it is necessary to repeat this operation three or four times to eliminate the deposits entirely. The filters are inspected every few weeks and are scraped whenever there are any excessive areas of mud balls over the beds. This method is not applicable to large installations but has been followed successfully in a number of small plants for many years.

Mr. Birdsall, Minneapolis—Occasional scraping of the filters is necessary to remove the fine sand and also surface accumulations that do not wash off.

Very little trouble is experienced with mud balls because filters are scraped often enough to prevent their formation. Turbidity at Minneapolis is so slight as not to be a factor in the formation of mud balls. I believe that the rate of wash is a factor in the formation of mud balls as is also the lateral travel between the wash-water troughs. A rate of wash water greater than 18 in. vertical rise per minute is not used in our old filters because we fear that the Tobin bronze strainer plates and bolts may fail. A vertical rise of 24 in. per minute is safely used in the eight new filters having monel metal plates and bolts constructed in 1919. There is very little tendency for mud balls to form in the new filters.

C. M. Daily, engineer in charge, Supply and Purification Section, St. Louis, Mo.—If the filter is washed until the water is clear the distance between gutters will have no effect on the formation of mud balls, but the farther the gutters are apart the more wash water will be required.

Mr. Ellms, Cleveland—The writer has never had any experience with the formation of mud balls in sand filter beds. It is his belief, however, that where they do form the cause lies chiefly in inefficient and imperfect washing, and in the character of the organic and inorganic matter in the water being filtered. It is, therefore, quite possible that primarily the trouble may originate in an improperly designed strainer system and a poorly graded and laid gravel bed.

Mr. Eldredge, Ft. Worth—The top of the sand has not always kept clean. Mud balls have formed. Prevention was sometimes impossible with the old plant. The settling capacity was limited to three hours and the rate of filtration was high with a very turbid water. Removal was accomplished by screening by hand. The horizontal distance the dirty wash water must travel is a definable factor in the formation of mud balls.

There is a relation between mud-ball formation and rate of wash, but the type of turbidity I regard as the main factor in mud-ball formation. Nearly every operator that I have talked to regarding plant operation has reported mud balls forming at certain seasons. The rate of wash, etc., being in these instances a constant factor.

Prof. Hyde, Berkeley — At Harrisburg there has been no difficulty from unclean sand or mud balls.

At Camp Meade, Md., where, in essence this type of underdrain was used in the Roberts' wooden tank filters, great difficulty with mud balls has been experienced. This plant has a high-rate (22 to 24 in.) water wash and no air. Mud balls may have been due to insufficient coagulation (during the period July-November, 1918), to the too-great distance for the water to travel to the troughs and perhaps they may have been due to the character of the water and the contained turbidity.

Under the conditions obtaining while I was camp sanitary engineer (August-November, 1918) there was no apparent way of preventing the formation of these mud balls. The top sand was removed from time to time and washed in a box. A wire screen skimmer on a long handle was employed but without satisfactory results. From time to time the filters were partially drained and the surface scraped with a shovel. From one-fifth to one-third of the sand surfaces in the tanks were frequently found to be coated with mud in small round balls or particles.

At Camp Meade these mud balls formed in spite of what would seem to be a sufficiently high rate of wash (22 to 24 in. vertically per minute). Prof. Langelier suggests that the trouble may be due to poor or insufficient coagulation and this explanation seems to be reasonable. It is also reasonable to suppose that the amount and character of the turbidity has something to do with it. A too-great distance between troughs may be a factor. The Camp Meade plant operated while I was there under all these difficulties. From the center of the tank a small amount of wash water had to travel about 6 ft. 8 in. to the circular gutters on the side

walls, but the major portion of the water traveled less than 4 ft. to the gutters.

Mr. Lovejoy, Louisville—The top of the sand has not always kept clean. Sometimes during the summer for short periods the top layer of 2 or 3 in. of sand shows a dark discoloration which I have always ascribed to organic matter.

We have had frequent occurrences of mud balls. During the summer in the presence of algae we have what might be better termed "sand balls." That is, during washing the sand rolls up into balls of various sizes, being held together firmly by the gelatinous coating of micro-organisms. During other times of the year we have plain mud balls with little or no sand inter-mixed. Both of these types are practically unpreventable by any means so far known. Of course, the sand balls break up and disappear as soon as the micro-organisms die off. The mud balls gradually disappear as the type of turbidity which causes them disappears.

We have tried several means of removing the mud balls, such as raking, scraping and dragging a screen over the sand while washing, but all of these means are slow, laborious and not very effective.

I believe there is more of a relation between mud-ball formation and a certain type of turbidity than with the rate of wash. The mud balls are so heavy that a washing rate that will lift them will also carry away sand.

If the horizontal distance of travel of dirty wash water is so great that this heavy type of mud is not all removed at each washing, then there will be a gradual accumulation that will eventually form mud balls. We have had this exemplified in an extreme way recently. One of our filters was out of service all winter with the inlet valve open, so that the unfiltered water of varying turbidities had access to it for several months. The gradual accumulation of mud that settled on the sand of this filter was found to be ½ in. thick in a solid layer. Four successive washings at increased pressure did no more than break the mud into large lumps that finally had to be shoveled off.

Mr. Waring, Ohio State Board of Health—The wash-water troughs should be of sufficient number to permit of a maximum travel of suspended particles in washing of about 30 in.

(To Be Continued)

Miles-Acid Process Applied to Tannery Wastes

Experiments by E. S. Dorr, engineer of sewer service, Boston, Mass., with the Miles-acid process on heavy tannery wastes indicate that a clear liquid could be obtained in five minutes and a well-settled sludge in half an hour. Mr. Dorr gave this information and that following in a paper presented recently to the American Society for Municipal Improvements. The dark blackish-red color of the tannery wastes was bleached to straw color, the odor completely killed and organic and volatile matter, including suspended solids, was reduced 50 per cent. The SO_2 used was at the rate of 7,167 lb. per million gallons which precipitated 4 tons of sludge (dry) having a grease content of 16.88 per cent. The ammonia content of the sludge was 7.5 per cent before and 9 per cent after degreasing. The total degreased sludge was 6,640 lb. containing 1,360 lb. grease. At present prices the 9 per cent ammonia fertilizer would be worth $67.50 per ton or $222.75 for 3.3 tons, the amount of fertilizer material per million gallons. With grease at 5c. the total value of grease and fertilizer would be $290.75; at 8c. it would be $331.55 per million gallons treated. On the New Haven basis (see *Engineering News-Record*, Dec. 5, 1918, p. 1034, and Jan. 2, 1919, p. 32) the cost of treating the tannery wastes experimented with would be $161.22 per million gallons, leaving a substantial profit, whereas at present Mr. Dorr stated that he is aware of no place where the sludge is not a burden of expense for disposal.

Hydraulic Sluicing for Ochoco Dam in Heavy Material

Preponderance of Rock Governed Method Used on Oregon Irrigation Dam—Water and Power Needs, Quantities and Costs

SLUICING material into the recently completed Ochoco dam near Prineville, Oregon, had to be done with limited power and water, working in material of which a large percentage was rock or hardpan. The difficulties were such that the general contractor abandoned the job in February, 1919, and the irrigation district for which the work was being done then arranged with the sub-contractors to take charge and complete the work.

Prospecting on both sides of the stream indicated that the north side was the more favorable source of

GIANT IN OPERATION—NOTE ROCK CUT 25 FT. DEEP

material and work was concentrated there. However, even then the hard formation was found so well distributed over the available area that sluicing was slow and costly from the start. Beds of good material were known to exist beyond the hard formation but in order to keep the flume down to a grade that would reach them it was often necessary to blast out a channel. In several cases solid rock cuts through ledges were blasted to a depth of 25 ft. The formation was so irregular that it was finally decided to simply cut into the bank with the giant, working in the general direction of the good material.

The usual procedure was to wash down a bank with the giant until only a talus of large rock fragments or a ledge of solid rock remained. Then the giant operators would move to other points while the powder

crew shot the ledges or the larger masses of rock forming the talus. Crews of men by bulldozing and with sledges broke up the larger sizes for the next attack of the giant. By using four giants set up on as many spurs of the pressure pipe line, several separate headings were kept open. Thus crews went from one heading to another, and continuous operation as well as the fullest use of the limited power available was maintained. In fact, the operation of the pumps was practically continuous, averaging month after month between twenty-three and twenty-four hours per day. This was an important factor in the work as the power company limited the energy consumption to 450 hp. at any one time.

For several months the primary purpose of the work was to get the flumes through hard material on the gradient necessary to insure the desired quantity of sluicable earth. During this time material was continuously being sluiced into the dam but not under most ideal conditions. When the flume had been extended on the low elevations to such a distance as to assure tapping sufficient good material to complete the work, the policy was changed and attention was concentrated on avoiding the heavy rock ledges and choosing a line of advance through material carrying the greatest percentage of fines.

The determining factor in the yardage delivered to the dam each month was not the time consumed in blasting and sledging out rock on talus slopes, but rather the material-bearing capacity of the water. Where a large percentage of rock fragments was being handled, the capacity was found to vary directly with the quantity of fines in the water, that is, the more fine material in suspension, the greater the amount of rock which a given quantity of water would carry down the flume. Ultimately, but not until the work was well on toward completion, the flume lines were carried to points where the operators could secure that mixture of broken rock and fines which would carry the largest possible quantity of spoil.

Taking the job as a whole and despite the difficulties, an average of 6.2 per cent of spoil was carried in the water during the year 1919. The cost during this time averaged 75c. per cubic yard. The itemized allotment of this total was as follows:

Power	7.027
Installation and breakout	5.286
Lumber	3.844
Repairs, hardware and tools	3.225
Powder	5.575
Office and general expense	1.447
Rents of plant	7.814
Labor	34.161
Compensation (10%)	6.840
Total	75.219

The excessive proportion of rocky fragments moved not only greatly increased the powder cost, but materially affected the labor cost because of the large crew constantly employed in breaking boulders and the hard formation. The rental included two complete pumping outfits so that the available power could be utilized continuously in case of trouble or breakdown. It also included several thousand feet of wood-stave pipe of various dimensions and other sluicing equipment necessary to maintain the several headings ready for immediate use. Most of the items are estimated as having been two to three times what they would have been before the war. The total volume sluiced was 527,000 cu.yd. The total material placed in the dam, including that deposited from the spillway excavation, was 540,000 cu.yd.

The sub-contractors, who later became the general contractors and carried the work to completion, were the sluicing department of the Puget Sound Bridge & Dredging Co., of Seattle, formerly Lewis, Wiley & Morse, Inc., R. W. Rea is project engineer for the district and J. M. Howells is consulting engineer.

RECORD OF SLUICING OPERATIONS ON OCHOCO DAM BY MONTHS FOR 1919

	Feb.	March	April	May	June	July	August	September	October	November	December
Total hours working giant	223	611	597	293	264	595	671	653	659	637	151
Average giant hours per day	...	19	19	16	12	21	23	23	22	23	5
Average gal. per day's run	1,572,471	2,821,480	2,861,666	2,272,222	1,695,770	3,347,846	3,952,330	3,732,856	3,448,015	3,204,552	1,000,000
Average load in flume water	8%	9%	8%	7.3%	6%	6%	6%	6%	6%	6%	6%
Total yardage	13,209	38,467	35,333	14,442	10,500	28,067	34,260	32,144	27,177	28,901	7,400
Average yardage	629	1,241	1,177	802	500	1,002	1,181	1,148	937	1,070	740
Average horsepower	394	401	419	440	414	412	382	378	377	377	422

Water Solubility a Necessary Property of Wood Preservatives

ANY substance to be an effective wood preservative must be soluble in water at least to the extent of producing a toxic water solution. By a theory now being developed at the U. S. Forest Products Laboratory (explained below) it would seem reasonable to expect that any material which is poisonous enough to kill an organism of any kind must necessarily be soluble in the body fluids of that organism; and the chief body fluid of timber-destroying fungi and wood borers is water. With very poisonous materials this solubility need not be great. In fact, 1 part in 1,000,000 may be sufficient if the material is poisonous enough.

Wood preservatives now in use are of two distinct types—inorganic salts, such as zinc chloride, which are very soluble in water; and oils, such as creosotes, which are generally considered to be insoluble. The solubility of creosote is usually considered so slight as to be neglected, but experiments indicate that certain constituents of creosote are sufficiently soluble in water to make it poisonous for wood destroyers. Creosote oil may, therefore, be considered as consisting of two groups of compounds, one of these being sufficiently soluble in water to render it toxic; the other insoluble in water and hence not toxic. The non-toxic oils act as a reservoir for the toxic oils and feed them slowly to the moisture in the wood.

The difference between oil preservatives and inorganic salt preservatives, as far as this theory is concerned, is in their method of retaining the reserve supply of poison. Zinc chloride has no reserve supply, all the material being soluble in the usual amount of moisture present in air-dry wood. Sodium fluoride may have a reserve supply in the form of solid crystals, if applied in a saturated solution. Creosote oil may have a considerable reserve supply stored in the oil itself, this supply being fed to the wood as needed.

Various Schedules of Fees for Consulting Engineers

Compiled by Edmund I. Mitchell, Assistant Secretary of Committee on Classification and Compensation of Engineers, Engineering Council, New York City, with aid of Engineering Societies' Library.

VARIOUS suggestions as to proper fees for engineering services have been put forth by individual practitioners and by the American Institute of Consulting Engineers (1911), the Connecticut Society of Civil Engineers (1914), the Iowa Engineering Society (1917) and the Mahoning Valley (Ohio) Engineers (1918), for the guidance of both the engineer and his client. The American Institute of Architects also has a schedule of minimum charges (revised 1908). So far as can be determined, however, the four national societies representing civil, mining, mechanical and electrical engineering have never given consideration to this question.

An examination of technical periodicals published during the past decade shows that these schedules make provision for three methods of charging: (A) A percentage of the cost of the completed project; (B) A per diem rate; and (C) A fixed sum. Suggested minimum charges are as follows:

A. PERCENTAGE OF COST OF WORK

American Institute of Consulting Engineers (1911); Connecticut Society of Civil Engineers (1914); Iowa Engineering Society (1917)—(1) For preliminary conferences, studies, estimates and reports: A. I. C. E., 1.5 to 3.0 per cent; Ct. S. C. E., 1.0 to 1.5 per cent; I. E. S., 1.5 per cent.

(2) For services as in (1) and in addition preparation of drawings, specifications, contracts and all work to the letting of the contract: A. I. C. E., 2.5 to 5.0 per cent; Ct. S. C. E., 2.5 to 5.0 per cent; I. E. S., 2.5 per cent.

(3) For services as in (2) and in addition advice in letting contract and general supervision of construction: A. I. C. E., 4.0 to 5.0 per cent; Ct. S. C. E., 4.0 to 8.0 per cent; I. E. S., 5.0 per cent.

(4) For full professional services including complete supervision and inspection of construction: A. I. C. E., 6.0 to 10.0 per cent; Ct. S. C. E., 6.0 to 12.0 per cent; I. E. S., 6.0 per cent.

Mahoning Valley (Ohio) Engineers (1918)—(1) For engineering and supervision for sewer district or system, or disposal plant, per diem rate shall apply when cost of work is less than $3,000: For first $15,000, 8.0 per cent; for second $15,000, 7.5 per cent.

(2) For engineering and supervision on paving work, per diem rate shall apply when cost of work is less than $3,000: For first $15,000, 7.0 per cent; for second $15,000, 6.5 per cent.

Committee of Engineers' Society of St. Paul (1918)—(1) For preparation of preliminary report with a general plan and an estimate of cost, 0.75 per cent of estimated cost but not less than $150.

(2) For complete plans and specifications including preliminary report and survey but exclusive of soundings and borings: Cost of work under $10,000, 3.5 per cent; under $25,000, 3.0 per cent; under $50,000, 2.5 per cent.

Consulting superintendence 2.5 per cent. Number of trips to the work to be stated in contract; per diem rate plus expenses to apply to trips in excess of stipulated number. Extra charges for engaging resident engineer, making alterations after plans have been approved, etc.

Under all these schedules in the preliminary stages cost of work is based on the estimated cost; later, on cost of all labor and materials necessary to complete work plus contractor's profit and expenses.

B. PER DIEM RATE

American Institute of Consulting Engineers—Charges for consultations, reports and opinions should vary according to the character, magnitude and importance of the work or subject involved, and according to the experience and reputation of the individual engineer from $100 per day up. For expert testimony, etc., a retainer from $250 to $1,000 and up should be charged. These charges are exclusive of expenses and of charges for assistants. Six hours of actual work constitutes a day, except that when engineer is called from office 24 hours or fraction thereof shall constitute a day.

Connecticut Society of Civil Engineers—(1) For expert services, reports, consultations, expert testimony, etc., $25 to $100.

(2) In consulting capacity on designs and for more ordinary services, examinations, reports, etc., $15 to $25.

Additional charges for actual expenses and for assistants. Seven hours actual work constitutes a day.

Iowa Engineering Society—(1) For consultations, opinions, expert testimony, preliminary investigations and preliminary reports, $25.

(2) In consulting capacity on design or for services requiring a greater period than for one day, $25 per day.

(3) For examinations or reports of a more extensive nature, $15 per day. Seven hours constitute a day, except that when engineer is called from office 24 hours or fraction thereof shall constitute a day.

Mahoning Valley Engineers—(1) For consultation, expert testimony, preliminary investigation, reports and in consulting capacity upon design, $25.

(2) For extensive examinations or reports covering several days, $15 per day.

Minimum charge for field work, $10 per day.

Charges for assistants as follows: Engineer in charge of field work, $10; instrumentman, $5; rodman, chainman, $3.50; inspector on paving and sewer work, etc., $3.50.

In addition to above charges, a charge to cover actual expenses. Seven hours constitutes a day except that when engineer is called from office 24 hours or fraction thereof shall constitute a day.

C. FIXED SUM

American Institute of Consulting Engineers—May include all items cited under per diem rate.

Connecticut Society of Civil Engineers—Iowa Engineering Society—(1) Fixed sum covering all charges.

(2) Fixed sum covering services only, with additional charge for expenses, both personal and for assistants.

Contracts should set a time limit within which work should be completed, and should contain clauses protecting engineer against unforeseen contingencies, alterations, etc.

These schedules also authorize special charges for difficult and unusual work, at correspondingly higher rates.

Based on bookeeping costs wherein are represented proper profits, overheads, cost of getting business and all legitimate general expenses, W. L. Benham suggests (1920) the following Fee Schedule for Consulting Engineers in the Kansas City District:

A. PERCENTAGE OF COST OF WORK

For Municipal and Valuation Work—(1) Preliminary investigations, report and estimate: $50,000 to $100,000, 1.5 per cent. $101,000 to $500,000, 1 per cent; $501,000 to $1,000,000, 0.75; $1,000,000 and upward, 0.5 per cent.

(2) Plans, specifications, estimates, attending to letting contracts and final inspections and tests. $50,000 to $100,000, 3.5 per cent; $101,000 to $500,000, 3 per cent; $501,000 to $1,000,000, 2.75 per cent; $1,000,000 and upward, 2.5 per cent.

(3) Supervision of construction

$50,000 to $100,000, 2.5 per cent or $250 to $300 per month for each man furnished and an extra fee of $25 per day plus expenses when called from office for inspection.

$101,000 to $500,000, 2 per cent or same monthly charge per man and an extra fee of $35 per day plus expenses when called from office for inspection.

$501,000 to $1,000,000, 1.5 per cent or same monthly charge per man and an extra fee of $50 per day plus expenses when called from office for inspection.

$1,000,000 and upward, no fixed sum or percentage but same monthly and daily charge as for preceding class of work.

(4) Appraisals, including testimony or investigations

$50,000 to $100,000, 3 per cent or $75 per day and expenses up to $300, and $50 per day thereafter. Minimum fee $1,000. Each man furnished at cost plus 50 per cent.

$101,000 to $500,000, 2 per cent or same as above.

$501,000 to $1,000,000, 2 per cent or $100 per day plus expenses up to $5,000 and $75 per day thereafter. Minimum fee, $2,500. Each man furnished at cost plus 30 per cent.

$1,000,000 and upward, 2 per cent or same as above.

(Under (3) and (4) provision should be made in contracts requiring contractor to pay engineer or city a stipulated fee per month for delay in completing work according to contract.)

B. PER DIEM RATE

Reports, investigations, examinations, expert testimony, checking fellow engineers' work, etc. $75 per day plus expenses up to a fee of $2,000, then $50 per day thereafter. Minimum fee, $500. Each man furnished at cost plus 35 per cent.

The American Institute of Architects sanctions a minimum fee of 6 per cent of the total cost of the work complete for architectural services. These services consist of necessary conferences, preparation of preliminary studies, working drawings, specifications, large scale and full size detail drawings, and general direction and supervision of work. Payments are due as follows: Upon completion of preliminary studies, 20 per cent of entire fee; completion of specifications and general working drawings, 40 per cent additional; remainder from time to time. At the annual meeting, May, 1920, a proposition to increase the minimum charge from 6 to 8 per cent was referred back to the chapters for study during the coming year.

Edmund T. Perkins, president Edmund T. Perkins Engineering Co., Chicago, made the following suggestions regarding charges to the Illinois Society of Engineers in 1918.

A. PERCENTAGE OF COST OF WORK:

Service	Cost of Work	Charge, Per Cent
Reconnaissance	Less than $5,000	2.0
	$5,000 to 10,000	1.75
	10,000 to 20,000	1.5
	20,000 to 50,000	1.0
	50,000 to 100,000	0.75
	100,000 to 200,000	0.5
	200,000 to 500,000	0.4
	Over..... 500,000	0.3
Preliminaries	Less than $5,000	1.5
	$5,000 to 10,000	1.0
	10,000 to 20,000	0.8
	20,000 to 50,000	0.6
	50,000 to 100,000	0.5
	100,000 to 200,000	0.4
	200,000 to 500,000	0.3
	Over..... 500,000	0.2
Plans and specifications	Less than $5,000	4.0
	$5,000 to 10,000	3.5
	10,000 to 20,000	3.0
	20,000 to 50,000	2.5
	50,000 to 100,000	2.0
	100,000 to 200,000	1.5
	200,000 to 500,000	1.3
	Over..... 500,000	1.2
Supervision (not charged for when superintendence is charged)	Less than $5,000	2.0
	$5,000 to 10,000	1.8
	10,000 to 20,000	1.5
	20,000 to 50,000	1.3
	50,000 to 100,000	1.1
	100,000 to 200,000	1.0
	200,000 to 500,000	0.8
	Over..... 500,000	0.6
Superintendence	Less than $5,000	5.0
	$5,000 to 10,000	4.5
	10,000 to 20,000	4.0
	20,000 to 50,000	3.5
	50,000 to 100,000	3.3
	100,000 to 200,000	3.0
	200,000 to 500,000	2.8
	Over..... 500,000	2.4
Alterations (relates only to value of work involved in alterations)	Less than $5,000	7.0
	$5,000 to 10,000	6.5
	10,000 to 20,000	6.0
	20,000 to 50,000	5.5
	50,000 to 100,000	5.0
	100,000 to 200,000	4.5
	200,000 to 500,000	4.0
	Over..... 500,000	3.5
Complete charge of work	Less than $5,000	12.5
	$5,000 to 10,000	10.75
	10,000 to 20,000	9.3
	20,000 to 50,000	7.9
	50,000 to 100,000	7.4
	100,000 to 200,000	6.0
	200,000 to 500,000	5.3
	Over..... 500,000	4.2

Percentages to be computed on entire cost of completed work exclusive of engineering. "Cost" refers only to such part of work as engineer may deal with.

Services generally charged for on a percentage basis include reconnaissance, preliminary reports, plans, specifications, details, supervision progress estimates, superintendence, alterations, professional advice, consultation, court work and arbitration.

B. PER DIEM RATE:

Not including expenses. Chief engineer, $500 retaining fee and $100 per day; assistant chief engineer, $50; topographical assistant engineer, and chief of party, $15 to $25; designer, $12.50; instrumentman, draftsman and computer, $7.50; stenographer, chainman and axeman $3.50. Surveying is usually charged for on a per diem basis.

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Mahoning Valley (Ohio) Engineers' Schedule of Fees—*Engineering and Contracting*, Vol. 51, No. 4, Jan. 22, 1919, p. 76.

St. Paul Committee Proposes Minimum Fees for Engineers—*Engineering News-Record*, Vol. 80, No. 4, Jan. 24, 1918, p. 174.

Recommends Specific Fees for Engineering Services (Edmund T. Perkins, Chicago, to the Illinois Society of Engineers)—*Engineering News-Record*, Vol. 80, No. 8, Feb. 21, 1918, p. 365.

Schedule of Charges for Engineering Services (Recommended by Edmund T. Perkins)—*Engineering and Contracting*, Vol. 49, No. 11, March 13, 1918, p. 269.

Fee Schedule for Consulting Engineers (Recommended by W. L. Benham)—*Engineering News-Record*, Vol. 84, No. 18, April 29, 1920, p. 878.

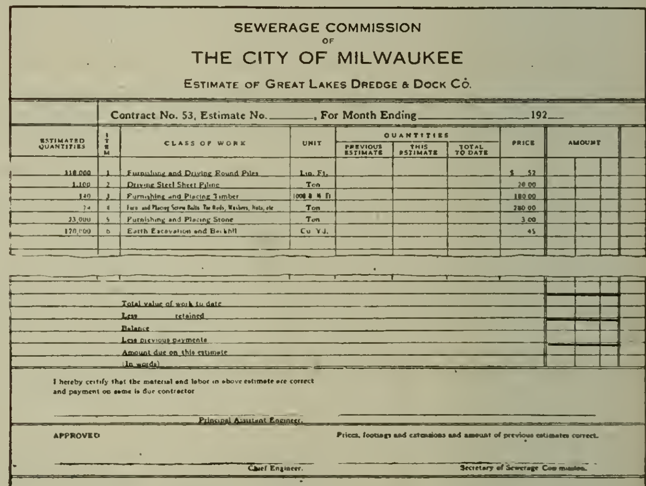
Schedules of Engineering Fees (Abstracts from various proposed schedules compiled by Baar and Cunningham, Consulting Engineers, Portland, Ore.)—*Engineering and Contracting*, Vol. 53, No. 6, Feb. 11, 1920, p. 160, *Canadian Engineer*, Vol. 38, No. 18, April 29, 1920, p. 425.

Canadian Society Fixes Fees for Engineering Service (Fees proposed by Association of Alumni of École Polytechnique of Montreal)—*Engineering News*, Vol. 75, No. 25, June 22, 1916, p. 1,183.

American Institute of Architects' Schedule of Proper Minimum Charges — Kidder's "Architects' and Builders' Pocket Book," 16 Ed., 1916, p. 1,651.

Printed Forms Standardize Monthly Cost Estimates

PRINTED forms for monthly estimates have been found highly convenient for original records of contract operations under the direction of the Sewerage Commission of Milwaukee, Wis. With many contracts in force on a great variety of work a form is printed for each contract. On each form, as the illustration indicates, is printed the estimated quantities, classes of



SEWERAGE COMMISSION
OF
THE CITY OF MILWAUKEE
ESTIMATE OF GREAT LAKES DREDGE & DOCK CO.

Contract No. 53, Estimate No.______, For Month Ending______________192__

Estimated Quantities	Item	Class of Work	Unit	Quantities: Previous Estimate	This Estimate	Total to Date	Price	Amount
118,000	1	Furnishing and Driving Round Piles	Lin. Ft.				$ .52	
1,100	2	Driving Steel Sheet Piling	Ton				20.00	
140	3	Furnishing and Placing Timber	1000 B. M. Ft.				180.00	
74	4	Furn. and Placing Screw Bolts, Tie Rods, Washers, Nuts, etc	Ton				280.00	
23,000	5	Furnishing and Placing Stone	Ton				3.00	
170,000	6	Earth Excavation and Backfill	Cu. Yd.				.45	

Total value of work to date
Less retained
Balance
Less previous payments
Amount due on this estimate
(In words)

I hereby certify that the material and labor in above estimate are correct and payment on same is due contractor

Principal Assistant Engineer.

APPROVED

Prices, footings and extensions and amount of previous estimates correct.

Chief Engineer.

Secretary of Sewerage Commission.

MONTHLY ESTIMATE FORM
The original sheet was 9½ x 12 inches.

work, units of measure and contract prices. By this arrangement the engineer making the estimate or the accountant who checks the estimate is not required to call on his memory or to refer to separate records for any of the constants involved in his task. This reduces the chances of error. When the form is properly completed it gives for any month at a glance the status of the contract in respect to work done and payments authorized. The procedure is not unique in contract work but the form illustrated is convenient and its use is standard on the large construction operations referred to. T. Chalkley Hatton is chief engineer of the Milwaukee Sewerage Commission.

Study of Temperature Stresses in Rigid Pavement Slabs

By C. H. Scholer
Testing Engineer, Kansas State Highway Commission

The Engineering Experiment Station of the Kansas State Agricultural College is conducting an extensive investigation of the stresses induced by expansion due to changes of temperature and moisture conditions in concrete and other rigid types of pavement slabs. The investigation is being made by the road materials testing laboratory of the Experiment Station which is also the official laboratory of the Kansas Highway Commission.

Although the desirability of expansion joints is seriously questioned by many highway engineers, the extreme temperature ranges and climatic variations in Kansas led M. W. Watson, state highway engineer, to request the testing laboratory to make an investigation of these phenomena in various parts of the state. The investigation has just started and it is thought that the methods and apparatus used, together with an outline of the scope of the investigation would be of interest to engineers engaged in highway construction.

The apparatus used is simple and consists of a 20-in. Berry strain gage with Ames dial which will permit the measurement of a change between gage points of 0.0001 in. The assembled gage is shown in the illustration. The frame of the mechanism is of invar steel with a low coefficient of thermal expansion which eliminates errors due to slight temperature changes which might take place during the handling of the instrument.

FIG. 1. STRAIN GAGE AND "ZERO BAR"

The zero bar illustrated in Fig. 1. is a double bar; one bar of steel and one of aluminum which expand and contract independently of each other, but are thoroughly encased in asbestos and paper to insure their being at the same temperature and to prevent rapid changes in temperature. Gage marks on these bars consist of No. 58 drill holes slightly countersunk to prevent burring of the edges. Before wrapping in asbestos the bars were carefully calibrated together at different temperatures and a curve (see Fig. 2) plotted showing the corrections in dial divisions in the length of the steel bar in terms of the difference in length of the two bars. This makes it possible to correct for temperature changes independently of any actual temperature determinations.

Observation has shown that, knowing the difference in readings, the temperature can be computed to within 0.25 deg. C., which is considered sufficiently accurate for the work.

Gage marks are set in the plugs illustrated in Fig. 3. This plug consists of a 3-in. length of [illegible]-in. iron pipe crimped at one end. In the other end a short brass plug is driven leaving about [illegible] in. of pipe projecting beyond the plug. The inside of the plug is then tapped to take the small brass cap which closes the pipe when in place.

A temperature plug, a pipe 4 in. long similar in every respect to the others except that it contains no

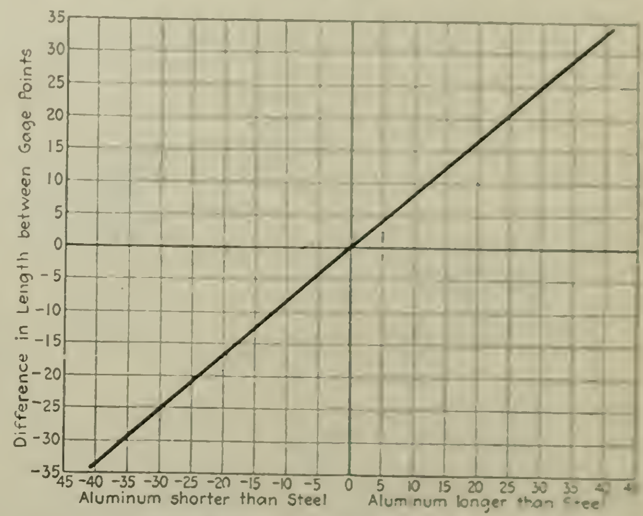


FIG. 2. CURVE SHOWS TEMPERATURE CORRECTION IN LENGTH OF STEEL BAR

brass plug to receive the gage mark, is also set at each station. This is later partly filled with mercury and used as a temperature well to determine the actual temperature in the slab.

Two plugs which are to receive the gage marks are set on the centerline of the pavement approximately 20 in. apart and a third plug is set at right angles to the centerline opposite and 20 in. from one of the other plugs.

The plugs are set slightly below the finished roadway surface and are kept covered with a patch of tar or asphalt filler. The patch is used not only to protect the concrete near the plugs but also to keep meddlers from finding the screw caps and tampering with them.

For two course types like monolithic brick, a set of plugs are placed in the base at the edge of the slab and independent readings secured upon these, to determine if the base tends to expand independently of the top.

Where the plugs are placed in old pavements holes are drilled to receive the plugs which are grouted in place. After the surrounding concrete has set for 24 to 48 hours, the screw caps are removed and gage marks similar to those described in the zero bar are drilled in the brass plugs 20 in. c. to c. and the initial reading secured.

In making the readings the strain gage is assembled and set at zero on the steel member of the zero bar, a reading is then made upon the aluminum member and the difference, plus or minus, recorded; a check is then made upon the steel bar to insure against possible errors in setting or disturbance of the adjustments of the instrument. The readings on the different gage lines are then made and recorded and a check again made upon the steel member of the zero bar, if any change in length is shown the operation is re-

peated. The temperature of the pavement as indicated by the mercury in the temperature plug is also recorded. From these figures the correct distance between gage marks may be computed thus: If the difference between bars gave a + 7 dial divisions by referring to the curve (see Fig. 2) the correction will be found to be + 8.5 dial divisions and the true length of the zero bar will be 20.0017 in. This length is then used as a base and the distance between gage marks is computed.

As yet no conclusions can be drawn from the data secured. The first gage station was set July 12 in

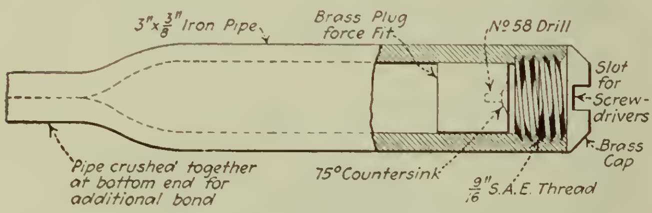


FIG. 3. EXPANSION PLUGS FOR TAKING GAGE MARKS IN PAVEMENT

Geary County, Project 10, a two-course concrete road, and it is expected that readings will be taken every 30 days. Present readings indicate a shortening between gage points. This period covers the setting of the concrete and a change of 2 deg. C. in the temperature of the concrete slab. This might easily account for the contraction noted.

Observation Checks

It is hoped that the difference in change between the transverse and longitudinal gage points may be used as a factor in computing the approximate stress in the slab due to axial forces. The gage marks at right angles to the centerline of the road will be comparatively free from restraint other than the friction on the subgrade, while along the centerline of the roadway there will be the compressive forces due to the tendency to expand and which will decrease the expansion. By noting the difference in change of length the forces can be computed.

As a further check upon this, gage points were set in a small section of slab 12 in. x 30 in., and of the same depth as the center of the pavement, placed at the side of the roadway and poured at the same time the main slab was poured. If high compressive stresses are induced in the main slab it should be possible to detect it by a comparison with this small unrestrained section.

At present stations are set in the following projects and types of construction: Project 10, Geary County, two-course concrete; Project 11, Sedgwick County, two-course concrete; Project 15, Reno County, monolithic brick; Project 26, Rice County, two-course concrete. All of these above projects are now under construction without provision for expansion. A station was also placed on a concrete road on the college campus. This road is about six years old and was provided with expansion joints.

It is expected additional stations will be set covering extreme conditions in subgrade and drainage features, and also stations set at different seasons of the year—during late fall, mid-summer and early spring construction.

Unprecedented Design Involved in Irrigation Project

To Bring Water 130 Miles to 1,753,000-Acre Columbia Basin in Washington—Viaduct, Siphons and Tunnels of Unusual Size

ENGINEERING, agricultural and financial aspects of a plan for irrigating 1,753,000 acres in Washington with water brought from the Pend Oreille River, 130 miles away, are presented in the report of the Columbia Basin Survey Commission just issued. The report contains complete preliminary plans and cost estimates for structures necessary to deliver 20,000 sec.-ft. These include a viaduct across the Spokane River with 100-ft. spans, which would carry a stream 20 ft. deep and 82 ft. wide, 80 miles of tunnels of diameters up to 33 ft., 13 dams, numerous inverted siphons up to 23 ft. in diameter and nearly a thousand miles of main and lateral canals, of which the important sections would be concrete lined. Despite the extensive work involved, to cost about $300,000,000, the area supplied is so large that the cost per acre would be only $171, which the commission finds is well within the amount that can be afforded under the very favorable soil, drainage and weather conditions.

The commission was created by legislative act of the State of Washington in March, 1919, and at the same time an appropriation of $100,000 was made for its work. State officials would like to construct the project as a state undertaking, but it is felt that the state could not finance the plan. Moreover, water rights in other states are involved. It is therefore proposed to secure Federal aid, if possible, in the form of credit guarantees. Previous reference to studies and investigations carried on by the commission appeared in *Engineering News-Record*, Nov. 6, 1919, page 800, and March 4, 1920, page 456.

The area to be irrigated lies between the Snake and Columbia Rivers just above their confluence. Surface and soil classification studies covering 3,000,000 acres showed that 1,753,000 acres which could be irrigated by the proposed gravity system are high-class irrigable land and compare favorably with land in the adjoining Yakima Valley. In this region the normal rainfall is less than 8 in., which occurs mostly in the winter time. As crop production requires 2½ or 3 ft. of water during the growing season, the region is characterized as extremely arid.

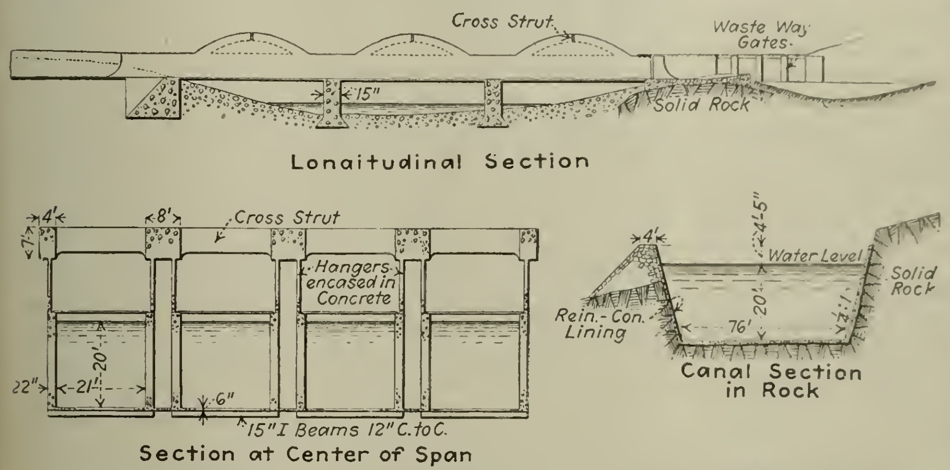
Unlike many arid regions, however, there is nc accumulation of alkali salts. The underlying gravel and sand strata and the numerous deep coulees act as a natural and adequate drainage-way, the commission finds, and will prevent waterlogging. The present value of the sage-brush land is taken at $3 to $5 per acre and the cost of leveling off about $15 per acre, which, with the *pro rata* of the cost of building the irrigation works, will bring the total to $190 per acre as the cost of land and water ready to start farm operations.

The watershed to be drawn upon covers about 24,000 square miles in western Montana and northern Idaho and, with the development of some of the reservoir sites it contains, affords an ample supply for any crops suited to the area. The gross diversion is to be about 6,250,000 acre-ft., taken from the stream at a point where the annual run off varies from 11,000,000 to

29,000,000 acre-ft. An allowance of 19.25 per cent of the diverted flow is made for regulation and seepage losses in canals. The average duty of water for the tract is taken as 33 in. per annum.

A comparison of seasons of maximum irrigation demands with seasons of maximum stream flow gave the storage required in a critical year as 2,686,000 acre-ft. By building a diversion dam at Albany Falls, Pend Oreille Lake could be used to store 1,180,000 acre-ft. at a cost of $1.01 per acre-ft. Flathead Lake in Montana could store 1,506,000 acre-ft. at a cost of $1.39 per acre-ft., and a large amount of additional storage could be created in either lake at reasonable cost if that became necessary.

Of the thirteen dams required on the main supply line ten are to be rock or rock- and earth-filled, because of the large amount of rock available from the tunnel excavations. Alternate designs and estimates were



CROSS-SECTION OF CANAL AND ELEVATION OF SPOKANE RIVER VIADUCT

prepared in each case before deciding upon the most economical plan, and drill tests of foundations were made where the information was not otherwise available. These dams would require a total of about 30,000,000 cu.yd. of material. The largest one, on Latah Creek, would require 4,000,000 cu.yd. of rock and earth and would retain water normally to a depth of 135 ft. with a freeboard of 13 ft. The longest dam, on Deadman Creek, would have a crest length of 3,800 ft. Two of the dams include Stoney gates which, due to the necessity for placing as few piers as possible in the stream would have widths of 47 and 50 ft. respectively. The heads on these gates would be, respectively, 19.5 and 25 ft. Taintor gates are designed for the smaller canals.

In the supply canal and many of the main distributaries the large capacity required is attained partly by the use of a high velocity, 12½ ft. per second being the standard. The cross-section ranges from 1,595 to 1,658 sq.ft., the depth from 20 to 29 ft. A feature of the distributing-system design is that although the irrigation season lasts seven months, it was decided to make possible the delivery in any one month of 20 per cent of the season's requirements.

Reinforced-concrete lining is to be used in all canals of 100 sec.-ft. capacity or larger, enough reinforcing being included to provide for temperature stresses and the extra strain at all transition points. The thickness of the lining ranges from 3 to 8 in. according to the depth of water and character and slope of material. Because of the large amount of concrete lining to be placed (3,285,000 cu.yd., or an area of 23,000,000 sq.yd.) the report recommends a traveling mixer plant operating on a track in the bottom of the canal and the use of steel forms. In planning the work, as well as in that of excavating the canal itself (involving the handling of 57,000,000 cu.yd. in digging canals of capacities exceeding 100 sec.-ft.) the recommendations go into some detail in outlining methods and equipment which will require a minimum of labor.

Owing to the large sum involved in the tunnels (about $120,000,000), the route of each tunnel was examined in the field and a construction program and detailed estimates prepared by an experienced tunnel engineer as a check upon the work of the commission's engineer. On the main supply canal two parallel bores with a total capacity of 20,000 sec.-ft. were decided upon because it was not considered feasible to construct a single bore of large enough capacity to carry the entire flow. Such a bore would require a roof span exceeding 45 ft. By using two bores of more convenient dimensions, construction of the second one could be postponed until the increasing demand on the subject called for the full water supply.

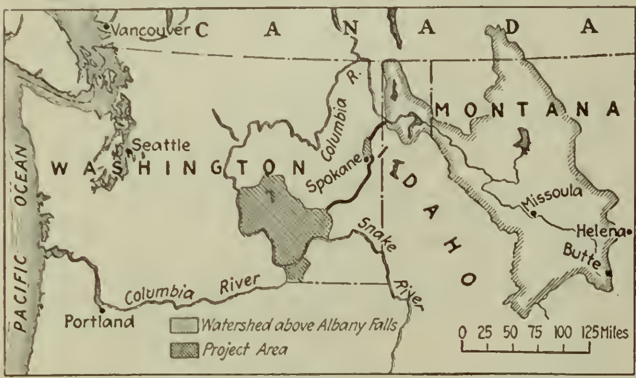
Comparing costs and the construction and operating advantages of different types, it was finally decided that on the main supply canal the first construction should be of a single-bore tunnel, 33 ft. 5 in. in diameter which would, on a grade of 3.96 ft. per mile, carry 10,000 sec.-ft. at a velocity of 12 ft. per second. In such a bore, allowing for the probable overbreak in the basaltic rock and for an average lining thickness of 17.5 in., the required excavation would be 38.53 cu.yd. and the concrete lining 5.81 cu.yd. per lineal foot of tunnel.

All of the tunnels are near railroads and it is planned to carry standard-gage tracks through them so that standard railway equipment may be used during construction. In estimating the cost, a construction program was prepared in detail providing for the driving first of those tunnels whose completion would facilitate work on the others.

The Bonnie Lake tunnel would be the determining factor in the length of time required between the starting of construction and the delivery of water. The completion of the first bore is estimated to require four summers and five winters of continuous work. The plan is to then continue with the construction of the second bore, using the same equipment, provided the rate of settlement of the project indicates that more water than the first tunnel could deliver will be required by the time the second one could be completed. The construction program for the Bonnie Lake tunnel includes three inclined shafts which, with the two portals, would afford eight working faces. A pioneer heading on the center line of the second bore would be driven to facilitate work on the first bore. All told there would be 21 tunnels over 1,000 ft. in length and ranging in diameter from 15 ft. to 33 ft. 5 in. Eight of the

largest tunnels would consist of twin bores. Although there would be some tunneling in earth, by far the greater part would be in basalt and granite.

In crossing the deep coulees with the main supply canal three methods were planned for, namely, diverting the route around the head of the coulee, crossing by means of inverted siphons, or crossing in a pond created by a dam. The avoiding of loss of head and the creation of a small regulation storage in the pond led to the adoption of the dam method wherever this was feasible. Of the thirty-three inverted siphons designed for the main canal and larger laterals, nineteen carry a flow so large that under the high heads necessary it was not considered feasible to make the crossing with one large pipe, hence two, three or four smaller pipes were recommended.



KEY MAP OF COLUMBIA BASIN PROJECT

The crossings at Wassun Creek and Cow Creek on the main canal are under heads of 141 and 121 ft. respectively and require four pipes, each 23 ft. in diameter, in which the velocity is 12 ft. per second. The Snake River crossing, 17,680 ft. in length, requires three pipes, 8 ft. 9 in. in diameter under a maximum head of 690 ft. In these pipes 24,000 tons of steel would be used. In the thirty-three siphons the length of steel pipe required would total 245,000 ft., weigh 188,500 tons and cost about $34,800,000.

The crossing of the Spokane River was found to be such that none of the three methods mentioned in the foregoing was suitable. A steel through-truss bridge was not feasible on account of the limited clearance. The design finally decided upon calls for reinforced-concrete arches from which a reinforced-concrete flume would be suspended by steel hangers extending into the arch rib. Five pairs of arches would support the flume in four sections, each 21 ft. wide by 20 ft. deep with 2 ft. of freeboard and each designed to carry its load independently. A stilling basin and spillway would be built in the upper end of this viaduct to remove the sediment and also to afford means of diverting the entire canal flow into the Spokane River in emergencies. Except for the information given on the accompanying drawing, further details about this viaduct are not given in the report.

The development of seasonal power at drops on the canal line is not included in the estimates of cost but would be feasible at about twenty-five points, varying from a 350-ft. head on a 300-sec.-ft. lateral to a 49-ft. head on a 4.950-sec.-ft. flow. In August about 175.-000 hp. could be generated in this way but only a very little of this could be used to advantage in pumping water to lands above the gravity canals.

The cost estimates which are given in considerable detail include allowances for contingencies and for engineering not as arbitrary percentages but as worked out in detail for each structure. The totals include $17,500,000 for contingencies and $3,800,000 for administration, engineering and legal expense, aside from the cost of engineering design and supervision chargeable to the individual structures. The dams total $14,000,-000 and the open canals, totaling 942 miles in length, $86,600,000. The tunnels figured as a single bore total 80 miles and would cost $119,400,000; inverted siphons $35,000,000; distribution system (below 100 sec.ft. capacity) $26,300,000; wasteways and drainage along the distribution system $2,400,000; lateral head-gates $400,000; and road crossings $450,000. These are the major items in the total cost of $300,475,000.

The possibility of developing a part of the area with water pumped from the Columbia River, or with a supply from Wenatchee Lake, are discussed in detail in the report, but the recommendation is for using the Pend Oreille supply as described in the foregoing.

In the act creating the commission, the state hydraulic engineer was named as chairman and directed to appoint four additional members. The personnel of the commission throughout the work has been as follows: Chairman, Marvin Chase; secretary, O. L. Waller, head of department of civil engineering, State College of Washington; E. F. Benson, state commissioner of agriculture; Peter McGregor, director, Spokane Federal Reserve Bank, and Arthur D. Jones. The engineering staff has been directed by Arthur J. Turner, as chief engineer, with J. C. Ralston, consulting engineer. The United States Reclamation Service assigned D. C. Henny and James Munn as consulting engineers to co-operate with the commission. In addition the following engineers were called in by the commission on special work: A. J. Wiley, on questions of general design, A. C. Dennis, on tunnel construction, F. E. Weymouth, on general methods of procedure, Henry Landes and Dr. Solon Shedd on the geology of dam sites.

Catskill Water Yield Figures

The sources of New York City's Catskill water system, when developed to furnish 500,000,000 gal. of water daily to all boroughs of the city, will have the following features, according to the 1919 annual report of J. Waldo Smith, chief engineer, Board of Water Supply:

Reservoir	Drainage Area, Square Miles	Reservoir Area, Square Miles	Available Storage, Million Gallons	Probable Mean Flow, Million Gallons per Day	Estimated Safe Yield, Million Gallons per Day
Ashokan	257	12.78	127,700	360	250
Schoharie	314	1.83	20,000	400	250
Catskill sources	571	14.61	147,700	760	500
Kensico	22	3.47	29,000	18	18
Catskill system	593	18.08	176,700	778	518

From the foregoing figures it will be seen that the available storage is 298,000,000 gal. per square mile of drainage area; that the probable mean flow per square mile of drainage area is 1,312,000 gal. daily, and that the estimated safe yield is at the rate of 875,000 gal. daily per square mile of drainage area.

Hints on the Writing of Engineering Reports

Discussion of Daniel W. Mead's Article in Last Week's Issue by Maj.-Gen. W. M. Black, Col. W. J. Wilgu[s], Allen Hazen, Prof. G. F. Swain and F. Lavis

Proofs of the article entitled "Hints on the Writing of Engineering Reports," by Daniel W. Mead, published in last week's issue, p. 891, were sent to a dozen prominent consulting engineers with a request for comment on any point which Mr. Mead's discussion might suggest. The replies thus far received are reproduced below.—EDITOR.

By Maj.-Gen. W. M. Black, U. S. A., Retired

CONSULTING ENGINEER, WASHINGTON, D. C., AND FORMERLY CHIEF OF ENGINEERS, U. S. A.

THERE is little to add to the suggestions of Mr. Mead. It is rarely the case that an engineering project can not be expressed in a manner which can be easily understood by any layman. In fact, the formation of such a project usually involves simply an exercise of good judgment and common sense. The technical training of an engineer is useful mainly because his experience and habit of thought has enabled him to know what to look for and how to analyze the conditions so as to arrive at a just conclusion. The strictly technical portion of the work lies mainly in the design of the structures needed to bring about the desired results.

Almost always a report on a project comprises two distinct discussions: First, there is the statement of the ends desired, an analysis of the existing conditions and, in general terms, a description of the work to be done to change those conditions so as to produce the desired results, accompanied by a general estimate of cost. All of this can and should be so clearly expressed as to be understood by anyone. The second part is the technical discussion of the design of the works required. It is this which must be accepted largely on faith by a non-professional reader.

Clarity of expression results from clarity of thinking. If the writer of a report has in his mind a clear conception of the problem, of the attending conditions, and of the steps to be taken to make the required modification of the conditions, he should be able to describe this mental picture clearly and intelligently. If the mental picture be blurred his description will be confused.

In writing a report it is essential that each sentence shall convey but one meaning. To this end sentences should be short. Semicolons and colons should have but a limited use. Too frequently they cause sentences to be involved and the exact meaning obscure. Adjectives should be omitted unless necessary to the sense. Otherwise they weaken a statement.

By Allen Hazen

CONSULTING ENGINEER, NEW YORK CITY

I have read Mr. Mead's article on engineering reports with interest and I heartily commend what he has said. In my experience I should say that a majority of technical matters necessarily brought into reports can be reduced to simple terms and expressed in language that will be understood by intelligent people who do not have engineering training. It is always good policy to make a serious effort to bring all important matters to this degree of simplicity.

Matters that are so intricate that they cannot be treated in this way are usually best handled by being worked up clearly with a memorandum explaining h[ow] the calculations were made and the reasons for the various steps, and either placed in an appendix or more often filed as supporting data, for delivery to the client only in case of need. In a great majority of cases there is no need of ever delivering them; but such filed statements are constantly used as data in studying subsequent problems, to which they are applicable.

By F. Lavis

CONSULTING ENGINEER, AMERICAN INTERNATIONAL CORPORATION, NEW YORK CITY

There seems little to add to what Mr. Mead has said. It may, however, be necessary to emphasize the need of reading his article very carefully because so much of value is said in such a short space.

The essence of a good report is an orderly presentation of the facts, beginning at the beginning and going through, in order, to the end. This may seem a trite saying but nevertheless the lack of appreciation of this fact or inability to accomplish it is the fault of most reports—that is, assuming of course that those who make them have the necessary technical experience and ability themselves to appreciate the situation.

A much discussed point is the question of length. Personally I believe a report should be quite full and complete as to the description of the situation, its analysis, and the writer's conclusions, so that others than the author may analyze the situation if they wish. Appendices covering various matters of relative, but not direct, interest can often be used to advantage; the whole should be made easily available by a good index. A brief summary of the facts and conclusions, which are all that some persons will need or have time to read, should precede the report.

It is surprising how often such details as the name of the writer, the date, and a proper title page, are omitted, also a brief note as to how and when the examination was made, the methods used, etc.

Mr. Mead refers particularly to the need of presenting reports, when necessary, in such a way that non-technical readers or hearers can understand them. This, of course, has been said before, but it can hardly be emphasized too much. The principal trouble with those who fail to accomplish this is that they fail first in ability to put themselves in the state of mind of persons who know nothing of the subject, and then in lack of ability to start at the beginning and go through the story in order to the end. This I mentioned before, but in the very many reports I have occasion to read this seems the greatest fault.

One other point which might well be emphasized for the younger engineers, to whom, as I understand it Mr. Mead's remarks are addressed, is that ability to write or speak to an audience requires practice. If anyone will sit down and attempt to write a description of a piece of work he thinks he is reasonably well or quite familiar with he will be surprised to find how much he doesn't know about it. Practice in writing in this way will soon indicate methods of recording pertinent facts

and develop ability in their orderly presentation. An interesting test for beginners, and even for others, is to set aside what has been written, for a month or more, perhaps for a year or so, and then go back and read it over, noting particularly any phrase or sentence that is not immediately clear at the first glance. After the lapse of a year or so, one will often be more nearly in the position of the uninformed layman and can appreciate better the lack of description which is necessary for the information of those unfamiliar with the subject.

By George F. Swain
PROFESSOR OF CIVIL ENGINEERING, HARVARD UNIVERSITY

I have read Mr. Mead's paper with great interest and entirely agree with everything that he says. It is excellently put.

The main point, in my mind, is for the engineer to state his results in a logical way and in language which is untechnical, so far as possible, and suited for the comprehension of those to whom it is addressed or who may be expected to read it. Technical matters should be placed in appendices.

I think engineers make the great mistake, in general, of using language which is too technical and not suited for the comprehension of those who are to read it.

By Col. William J. Wilgus
CONSULTING ENGINEER, NEW YORK CITY

There is very little that I can add to Mr. Mead's admirable outline of the fundamentals of an engineering report. A thorough digesting of the results of an exhaustive investigation of the matter under consideration is, of course, the first desideratum, coupled often with the drafting of summaries from which information may be taken at will. With a mastery of the subject gained in this manner it is possible briefly to express the findings and recommendations in the foreword or introduction of the report, followed by the details, suitably captioned and arranged in logical sequence, and closing with concise and definite conclusions, all couched in language and terms readily understandable by the lay reader, and supplemented by appendices containing supporting data of a purely technical nature.

The perfecting of the mechanical features of the report is also well worth while. A suitable cover, title-page and table of contents, strict accuracy, neatness of typography and convenient arrangement of maps and illustrations, and uniformity of size of sheets and folded attachments will go far toward creating the desired impression.

With a report framed in this manner those who have not the time or inclination to arrive at an independent judgment, and who prefer to rely solely on that of the engineer, will get all that they require in the first few pages; the less easily convinced reader will go through the report to the end; while the technician, in his desire to verify the conclusions expressed in the report, will even examine each appendix with care. Thus each reader is given as little or as much as he desires in order that he may be satisfied as to the merits of the subject in question.

It is a good rule for the engineer in drafting his report to imagine himself in the place of the prospective reader, and then endeavor to supply the character of simply expressed information that he would himself desire were he a non-engineer and entirely unacquainted with the subject. This attitude will usually aid very materially in bridging the gap, too often left ajar, between the highly technical work of the engineer and the lay mind which, directly or indirectly, will play some part in its consideration.

Sink Holes in Canals Stopped By Swelling of Ground

Former Lake Bed, in Drying, Left Subterranean Cracks—Dynamite or Dirt in Sacks of No Avail—Caving Into Large Holes Held

WITH the first operation of laterals constructed in the silt or "rock meal" soils on the Flathead project of the U. S. Reclamation Service, troubles began from sink holes or break through the bottom of the ditches. C. J. Moody, engineerfor the project, describes in the August *Reclamation Record* the methods of repair used, but he concludes that the only permanent cure is the swelling of the lower earth strata absorbing moisture from the water in the canal. His notes follow:

Some of these holes extended vertically into the ground and apparently had no outlet. Others dropped for a few feet and then found an outlet underground across adjacent fields, causing a caving in of the ditch banks and the topsoil of the fields for varying distances up to several hundred feet. The width and depth of these cave-ins varied from 2 or 3 ft. to a maximum of 15 ft. deep and 30 ft. wide. Where the holes dropped vertically without breaking out in the fields it was found best to allow water to run into the hole for a considerable period, as the hole would generally plug itself and fill up with water, after which necessary repair work consisted in bringing the banks and bottom up to grade with team forces. When the breaks started out across the fields it was necessary to shut out the water from the break to prevent more damage to the lands. In some cases the relocation of the lateral was the most economical solution of the repair work, but generally the break in the bank was trimmed down so that the new dirt was placed against sloping sides and topsoil used in the new bank. Water was kept in the ditch as much as possible during the time of repairing in order that the new material might be well puddled in.

REPAIR METHODS

The repair of these breaks in level country is not a serious matter but for the fact that they are very numerous. It has not been uncommon to have 20 or more in a mile of ditch, breaking in succession as soon as preceding ones are repaired and water again turned in. A more serious type of these appeared in the Camas A canal between miles 8 and 10 where the location is on steep sidehill with light topsoil with the excavation cutting into the stratified subsoil. The first water taken into this canal dropped into cracks in the bottom in a multitude of places, went down vertically from 5 to 15 ft. and came out through the hill below the bank sometimes 40 ft. lower than the canal grade. As the stratified material does not cut badly it was possible to turn out the water in the canal before these holes had assumed much area. A part of the season of 1918 was spent trying to repair these holes by refilling with good material immediately after the break occurred. Shooting the hole with low percentage dynamite and then puddling with good material was also tried. Dirt in sacks in the bottom of the hole with good puddled material on top was another method. None of these expedients proved capable of holding even under a very small head of water. It was ound necessary to allow a considerable head of water to run through the break until a hole 6 or 8 ft. in diameter had been cut through the subsoil and all of the cracks leading into the one which had caused the break were cut out. These holes were generaly at such depth under the can-

bank that the bank did not fail. The first step in the repair work was to trim the sides of the opening to as flat a slope as possible without moving much material. This slope was generally about 1:1. The canal bank, which was largely sandy loam and clay material was caved down into the opening. Sandy loam was available fortunately on the upper side of the canal and was used in filling the break. Water was kept against the new bank during the process of filling and was turned through the canal as soon as the repair work was completed. Up to January, 1920, none of the places repaired in this manner had broken the second time. During the fall of 1918 a large number of breaks were repaired in this manner. In 1919 on this canal there were 12 breaks in April, 6 during May and 1 in July. One new hole showed up in the spring of 1920.

The largest number of sink holes appeared during the first and second year of operation, but are still occurring with less frequency after four years of operation. They also occur in fields where irrigation water is applied.

An explanation of the cause of these holes is that the subsoil which lies in horizontal strata has contracted during the drying-out process following the time when the country was a lake bed, and vertical cracks have been formed. When the light soil covering the stratified material becomes saturated sufficiently, water breaks through into the cracks and carries considerable quantities of the soluble topsoil into the crevices. Some of these must be to a great depth vertically, and others are cut off by a horizontal stratum and are open for a considerable distance parallel to the surface of the ground.

Salinity Effect on Action of Teredoes

A study of the action of marine borers in San Francisco Bay, reported in a zoology paper by Albert L. Barrows, published by the University of California, finds that once established the teredo can withstand for several weeks or perhaps months a reduction of salinity to about ten parts per thousand, though it must have an average of at least thirteen or fourteen parts per thousand in order to thrive. In upper San Francisco Bay waters where the teredo is much more active at the mud line than near the surface, the mud line salinity was found to be consistently greater than at the surface; sometimes as much as 4.28 parts per thousand greater. Another peculiarity is that the teredo was found to be very sensitive to the amount of water in circulation around the place where it settles. By way of explanation the report states: "It is possible that the relation of the teredo to salinity may be only an indirect one and at least partly dependent upon some other cause, such as the presence of certain organisms upon which the teredo may feed to the best advantage, which are in their turn directly dependent upon water of a certain density for flotation or of a certain salinity for their own physiologic well being."

New System of Track Work Records On St. L.-S. F. Ry.

Foremen Report Time and Amount of Work in Detail Classification—Figures Extended to Cover Operating Divisions

As cost records of railway maintenance of way work are becoming of greater importance under present conditions of labor and material, and as such records must be based upon the daily reports of foremen of section gangs and extra gangs, the St. Louis-San Francisco Ry. has established a new system of reports which is designed to give more complete and reliable figures than have been available under former systems. It has been pointed out by F. G. Jonah, chief engineer, that formerly the foreman reported only the amount of time spent on different kinds of work, nothing being said as to the quantity of work done in the stated time (see *Engineering News-Record*, Sept. 30, p. 662.)

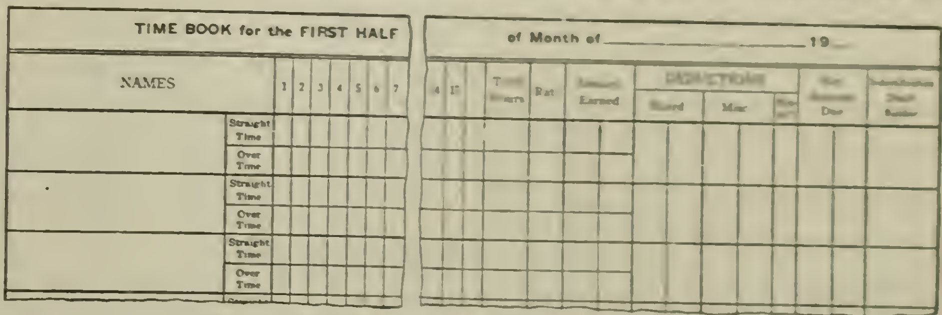


FIG. 1. SECTION FOREMAN'S DAILY TIME REPORT

A form of report which provides for records of time spent and work done is the basis of the new system. In the first place, the foreman is provided each month with a "foreman's pocket time distribution and material book," which he keeps with him on the work and in which he enters the names of the men employed. During the day he notes in his own language what the men are doing and how much they have done. At the close of the day's work, these figures are transferred to the semi-monthly time book. The foreman's pocket time book is 4 x 6¾ in. with stiff fiber-board covers. The first few double pages are ruled as shown in Fig. 1, and it will be noted that separate space is provided for reporting "overtime." Following this are double pages for daily distribution of work, ruled as shown in Fig. 2. In these are recorded the kinds of work, the location, time spent in each

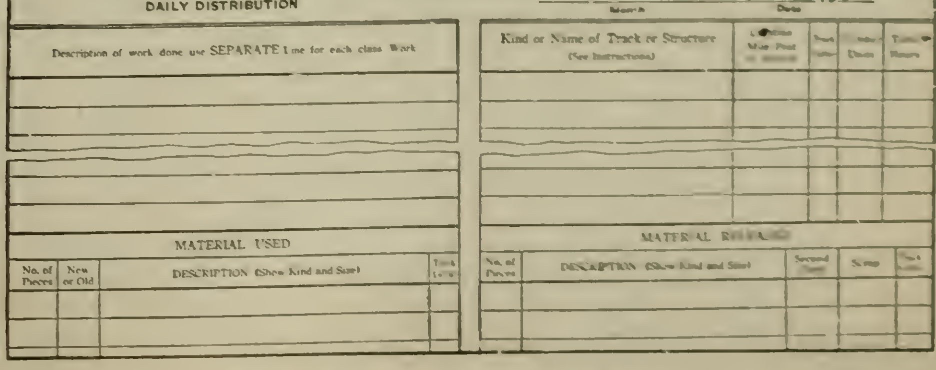


FIG. 2. FOREMAN'S DAILY WORK REPORT

ST. LOUIS-SAN FRANCISCO RAILWAY LINES

Section and Extra Gang Labor—Number of Units and Average Cost per Unit by Kinds of Work
Month of July, 1920
Recapitulation by Divisions; Districts and Total Entire Line

Item No.	Kind of Work	Units and Unit Cost	Eastern	South-Western	Western	Northern	Southern	River & Cape	Total Northern District	Central	Red River	Total Southern District	Texas Lines	Total Item System	No.
1	Cleaning weeds from track...	Trk.ft.	676,386	917,873	1,631,821	1,283,730	635,100	1,499,732	6,644,642	1,113,715	375,957	1,489,672	605,333	8,739,647	1
		Cost	$0.01	$0.01	$0.01	$0.01	$0.02	$0.01	$0.01	$0.02	$0.02	$0.02	$0.02	$0.01	
2	Cleaning ditches in cuts.....	Lin.ft.	150,365	12,190	34,745	92,005	114,591	7,233	411,129	110,530	4,804	115,334	86,402	612,865	2
		Cost	$0.17	$0.06	$0.02	$0.03	$0.09	$0.08	$0.10	$0.06	$0.06	$0.06	$0.05	$0.09	
3	Cleaning surface ditches.....	Lin.ft.	59,422	19,260	5,600	57,521	35,275	1,352	178,430	10,772	2,100	12,872	12,955	204,257	3
		Cost	$0.05	$0.03	$0.02	$0.02	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.08	$0.03	
4	Mowing and burning right of way	Trk.ft.	572,285	356,725	536,805	1,415,316	876,924	779,118	4,537,173	162,672	156,310	318,982	149,916	5,006,071	4
		Cost	$0.005	$0.008	$0.006	$0.006	$0.01	$0.003	$0.007	$0.008	$0.008	$0.008	$0.004	$0.007	
5	Unloading ballast........	Cars	164	84	634	124	250	361	1,617	29	304	333	36	1,986	5
		Cost	$3.67	$4.01	$6.42	$3.42	$3.58	$2.26	$4.42	$4.89	$2.12	$2.36	$6.95	$4.12	
6	Applying chats and gravel ballast..	Trk.ft.	1,775	26,755	19,192	8,660	......	120	56,502	....	1,941	1,941	......	58,443	6
		Cost	$0.06	$0.04	$0.12	$0.04	......	$0.06	$0.07	....	$0.06	$0.06	......	$0.07	
7	Applying slag and rock ballast	Trk.ft.	150	.	3,227	650	9,055	8,296	21,378	....	1,058	1,058	2,020	24,456	7
		Cost	$0.42	...	$0.21	$0.13	$0.08	$0.06	$0.09	....	$0.13	$0.13	$0.15	$0.10	
8	Applying cinder, sand or other ballast........	Trk.ft.	6,755	550	4,402	7,040	12,900	8,170	39,817	5,614	300	5,914	......	45,731	8
		Cost	$0.08	$0.13	$0.06	$0.06	$0.13	$0.10	$0.09	$0.14	$0.09	$0.14	......	$0.10	
9	Inserting ties in chats and gravel ballast ...	Ties	14,225	4,761	2,876	12,282	7,148	4,851	46,143	6,442	378	6,820	4,252	57,215	9
		Cost	$0.44	$0.52	$0.55	$0.44	$0.45	$0.38	$0.45	$0.40	$0.53	$0.41	$0.39	$0.44	
10	Inserting ties in slag and rock ballast.	Ties	5,729	163	17	447	14,263	3,204	23,823	745	4,788	5,533	54	29,410	10
		Cost	$0.43	$0.59	$1.13	$0.57	$0.37	$0.44	$0.40	$0.64	$0.46	$0.48	$0.64	$0.42	
11	Inserting ties in sand, cinders or earth.	Ties	20,430	1,159	11,081	11,534	11,843	24,691	80,738	9,804	3,722	13,526	8,753	103,017	11
		Cost	$0.30	$0.55	$0.32	$0.35	$0.37	$0.37	$0.34	$0.31	$0.55	$0.38	$0.39	$0.35	
12	Surfacing track on chats or gravel...	Trk.ft.	224,152	182,458	79,335	387,831	62,289	85,187	1,021,252	99,359	5,545	104,904	53,729	1,179,885	12
		Cost	$0.07	$0.06	$0.09	$0.05	$0.09	$0.05	$0.06	$0.09	$0.11	$0.09	$0.10	$0.07	
13	Surfacing track on slag or rock..	Trk.ft.	40,950	17,300	594	2,170	137,990	29,110	228,114	14,104	76,815	90,919	2,590	321,623	13
		Cost	$0.07	$0.01	$0.05	$0.04	$0.12	$0.07	$0.10	$0.11	$0.14	$0.14	$0.10	$0.11	
14	Surfacing track on sand, cinders or earth............	Trk.ft.	77,672	23,431	158,751	62,196	104,707	125,065	551,822	74,641	38,447	113,088	47,230	712,140	14
		Cost	$0.10	$0.09	$0.08	$0.08	$0.12	$0.08	$0.09	$0.10	$0.11	$0.10	$0.12	$0.09	
15	Unloading rail............	Lin.ft.	11,049	5,486	18,579	76,245	69,429	147,105	327,893	....	......	....	......	327,893	15
		Cost	$0.01	$0.008	$0.003	$0.007	$0.009	$0.005	$0.007	....	......	....	......	$0.007	
16	Loading rail...............	Lin.ft.	5,916	8,342	8,922	13,450	5,723	36,982	79,335	....	......	....	......	79,335	16
		Cost	$0.01	$0.004	$0.006	$0.01	$0.02	$0.007	$0.009	....	......	....	......	$0.009	
17	Laying rail	Trk.ft.	5,428	2,648	528	9,874	47,390	16,179	82,047	426	110	536	75	82,658	17
		Cost	$0.10	$0.18	$0.09	$0.08	$0.06	$0.15	$0.09	$0.15	$0.35	$0.19	$0.24	$0.09	
18	Lining and gauging track....	Trk.ft.	22,664	44,665	38,467	65,581	90,163	32,847	294,387	39,305	15,745	55,050	26,795	376,232	18
		Cost	$0.06	$0.04	$0.02	$0.04	$0.02	$0.03	$0.03	$0.01	$0.03	$0.02	$0.03	$0.03	
19	Applying rail anchors.......	Number	19	90	....	490	2,950	....	3,549	400	....	400	......	3,949	19
		Cost	$0.12	$0.49	....	$0.05	$0.005	....	$0.02	$0.07	....	$0.07	......	$0.03	
20	Applying tie plates.........	Number	15,000	15	....	....	5,607	3,746	24,368	....	....	....	400	24,768	20
		Cost	$0.001	$0.32	....	....	$0.002	$0.02	$0.005	....	....	....	$0.12	$0.006	
21	Repairing signs...........	Number	200	...	19	10	...	...	229	....	....	....	......	229	21
		Cost	$0.06	...	$2.79	$0.82	...	...	$0.32	....	....	....	......	$0.32	
22	Repairing right of way fences	Rod	3,891	386	36,734	4,867	2,482	14,069	62,429	9,602	1,692	11,294	315	74,038	22
		Cost	$0.66	$0.45	$0.007	$0.14	$0.25	$0.03	$0.08	$0.04	$0.02	$0.04	$0.13	$0.07	
23	Repairing cattle guards and wing fences.	Number	40	2	225	187	45	31	530	17	....	17	......	547	23
		Cost	$2.14	$1.44	$2.88	$0.70	$3.72	$4.89	$2.24	$3.75	....	$3.75	......	$2.29	
24	Repairing grade crossings...	Number	30	...	122	80	12	18	262	13	8	21	6	289	24
		Cost	$3.07	...	$1.68	$3.81	$14.13	$5.02	$3.29	$13.88	$9.24	$12.11	$25.10	$4.38	
25	Unloading coal for station use	Tons	...	10	40	2	287	......	339	171	85	256	......	595	25
		Cost	.....	$0.42	$0.85	$0.48	$0.45	....	$0.50	$0.87	$0.26	$0.67	......	$0.57	
26	Unloading coal for water stations...........	Tons	32	25	83	130	86	36	392	...	....	....	......	392	26
		Cost	$0.13	$0.09	$0.62	$0.27	$0.33	$0.32	$0.34	..	....	....	......	$0.34	
27	Patroling track............	Hours	7,168	3,331	1,909	7,891	5,504	5,555	31,358	2,157	355	2,512	1,930	35,800	27
28	Repairing roadbed damaged by washouts............	Hours	131	21	333	503	983	92	2,063	498	8	506	30	2,599	28
29	Loading and unloading ties..	Hours	3,226	638	1,915	1,979	6,382	2,929	17,069	994	593	1,587	1,623	20,279	29
30	Applying frogs and switches	Hours	2,356	823	271	3,237	2,846	1,290	10,823	1,033	1,276	2,309	371	13,503	30
31	Applying other track material..............	Hours	4,379	7,303	10,488	10,183	9,490	5,137	46,980	5,760	4,705	10,465	1,344	58,789	31
32	Repairing track damaged by washouts...........	Hours	274	427	367	778	390	515	2,751	310	.....	310	161	3,222	32
33	Repairing track damaged by wrecks..............	Hours	1,506	525	923	2,024	2,863	421	8,262	1,460	888	2,348	3,653	14.263	33
34	Cleaning and scrubbing station buildings...........	Hours	125	2,919	40	473	1,344	485	5,386	64	73	137	...	5,523	34
35	Transferring and handling freight at stations..	Hours	533	1,261	634	231	4,220	309	7,188	134	165	299	225	7,612	35
36	Care of switch lamps outside switch yards..........	Hours	641	1,084	188	1,973	1,303	2,097	7,286	1,702	786	2,488	102	9,876	36
37	Care of switch lamps in switch yards.	Hours	1,465	2,367	1,253	2,201	2,862	1,000	11,148	1,363	1,401	2,764	663	14,575	37
38	Care of signal lamps........	Hours	2,385	72	136	2,029	2,171	798	7,591	27	......	27	1,450	9,068	38
39	Watching crossings..	Hours	12,679	10,560	2,447	6,931	1,948	1,456	36,021	1,084	1,536	2,620	2,848	41,489	39
40	Clearing wrecks, transferring freight and baggage.....	Hours	4,278	420	854	738	1,693	.....	7,983	1,027	36	1,063	40	9,086	40
41	Removing and burying stock killed..............	Hours	163	109	54	368	739	209	1,642	547	216	163	54	2,459	41
42	Removing snow, ice and sand from platform and tracks .	Hours	784	19	110	1,533	67	23	2,536	......	229	229	......	2,765	42
43	Signals and interlockers.....	Hours	1,189		30	999	2,210	95	4,523	7	31	38	528	5,089	43
44	Care of station grounds.....	Hours	7,457	4,907	4,467	6,446	8,598	2,864	34,739	2,438	2,988	5,426	1,324	41,489	44
45	New work.....	Hours	22,935	5,468	8,944	7,928	10,135	878	56,288	641	2,224	2,865	999	60,152	45
46	All other work not classified above....	Hours	86,995	49,613	32,120	46,653	58,647	36,527	310,555	45,398	27,730	73,128	89,955	473,638	46

case, and the material used or released. Other pages are for detailed reports of rails, ties and other materials received and shipped, also material released from tracks taken up and abandoned. A page for daily report of motor car service is shown in Fig. 3. The total hours of work shown in the daily record are to be balanced with the total shown on the time sheet in the front part of the book. Instructions as to the use of the book are printed on the opening pages.

Classification of tracks on which work is done is a special feature of the system. Thus the daily distribution report, Fig. 2, has a column headed "track

THIS BOOK-MONTH OF 192																									FIRST HALF			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		Total Hours	Rate	Amount Earned		Deductions				Name			
Straight Time																										1		
Overtime																												
Straight Time																										2		
Overtime																												
Straight																												

FIG. 4. SEMI-MONTHLY TIME REPORT

letter," in which is entered the letter for one of the 26 classifications, which are as follows:

A. First and second main tracks.
B. Passing tracks.
C. Team tracks.
D. Industry tracks.
E. Stockyard tracks.
F. Tracks at division or train terminals used exclusively, or nearly so, for reclassifying and storing through trains and passing them through yards. By "through" trains are meant those which are not started or terminated at the station where they use these reclassifying or storage tracks.
G. Tracks used exclusively, or substantially so, for making up or breaking up freight trains starting or terminating at that particular station.
H. Tracks used exclusively, or nearly so, for making up and breaking up passenger trains.
I. Tracks used for storing caboose cars.
J. Tracks used for storing passenger equipment.
K. Tracks used for storing wrecking and work outfits.
L. Storage tracks for bad order freight cars.
M. Storage tracks for bad order passenger cars.
N. Passenger depot tracks.
O. Freight house tracks.
P. Car to car transfer tracks.
Q. Scale tracks.
R. Freight car repair tracks.
S. Passenger car repair tracks.
T. Shop and all Mechanical Department tracks not otherwise specified.
U. Coach cleaning tracks.
V. Tracks to and from coal chutes.
W. Enginehouse tracks.
X. Turntable tracks.
Y. Wye tracks.
Z. Company material tracks.

For the semi-monthly report covering the first half of the month a sheet 17 x 9½ in. is used, ruled as shown in Fig. 4. This is to be made up daily and sent to the roadmaster on the fifteenth of the month. A more elaborate report is made for the second half of the month, with additional information for the entire month. This has pages 10 x 9½ in., the first few pages being very similar to Fig. 4. Beyond these are pages giving the time and amount of work of various kinds for each day of the month, a portion of this part of the report being shown in Fig. 5. There are 46 different items, and for accounting purposes these are arranged under the designations of various accounts, as shown. They include also separate divisions for maintenance labor, transportation labor and labor on

DAILY MOTOR CAR REPORT								6
Date	Miles Run	Number of Men	Number of Pounds Carried	USED				
				Gallons Gasoline	Gallons Kerosene	Quarts Oil	Pounds Grease	
1								
2								
3								
29								
30								
31								
Total								

No.____ Batteries used during month No.____ Belts used during month
No.____ Spark-plugs used during month ____

FIG. 3. REPORT OF SECTION MOTOR CAR SERVICE

new work. The second of these divisions is to show what proportion of the section gang's time is taken up by labor chargeable to transportation accounts, such as cleaning stations, unloading coal for stations, caring for switch and signal lamps. The third division includes grading, unloading ballast, tracklaying and removing tracks. It was desired to get cost data on the essential work of track maintenance, and for this reason the headings for distribution of time are given so plainly that the foreman should have no difficulty in transferring the figures correctly from his pocket time book to the distribution sheet. For accounting purposes, it was necessary to group work under various account numbers. These accounts and the subdivisions of work are as shown in the accompanying table.

The semi-monthly time books go from the roadmasters to the Bureau of Accounts, where the payrolls and distribution are made up and where the statistics relating to unit costs are compiled. The figures are made up in

DISTRIBUTION OF MAINTENANCE LABOR. MONTH OF_____ 19___																							
Acct. No.	Description of Work	Units	1	2	3	4	5	6	7	8	9	10	11	12	12	14	15	16	17	31	Total Units	Total Hours	Amount
202	1 Cleaning Weeds From Track	Hours																					
		Track Feet																					
	2 Cleaning Ditches in Cuts	Hours																					
		Lineal Feet																					
	3 Cleaning Surface Ditches	Hours																					
		Lineal Feet																					
	4 Mowing and Burning Right of Way	Hours																					
		Track Feet																					
	5 Patrolling Track	Hours																					
	6 Repairing ROADBED Damaged by Washouts	Hours																					
218	Unloading Ballast	Hours																					
		Number of Cars																					
220	1 Applying Chats and Gravel Ballast	Hours																					
		Inches Lift																					
		Track Feet																					
	2 Applying Slag and Rock Ballast	Hours																					
		Inches Lift																					
		Track Feet																					
	3 Applying Cinders, Sand or other Ballast	Hours																					
		Inches Lift																					
		Track Feet																					
	4 Inserting Ties in Chats and Gravel Ballast	Hours																					
		Number of Ties																					
	5 Inserting Ties in Slag and Rock Ballast	Hours																					
		Number of Ties																					
	6 Inserting Ties in Sand, Cinders or Earth	Hours																					
		Number of Ties																					
	7 Surfacing Track on Chats or Gravel	Hours																					
		Track Feet																					
TOTAL HOURS FORWARDED																							

FIG. 5. PORTION OF MONTHLY WORK REPORT

sheets, covering definite territory. There is first a grouping of all the sections on a roadmaster's territory with the costs of the various kinds of work on each section, and an average for the whole territory. Second, a grouping of the average of the roadmasters on a division. Third, the average of all the divisions in a district, together with the average for the entire system. The figures are reviewed by the district engineers and attention is directed to work on any territory or section which seems out of line. In the accompanying table is shown a portion of the sheet for the eleven divisions and districts, with the summary for the entire system, the figures being for the month of July, 1920. The left hand column of description of work is the same on all the three sheets. On the roadmaster's sheet the column headings are the names of the roadmasters, and on the section sheets the headings are the designations of the track sections.

This system of track reports and accounting was devised by F. G. Jonah, chief engineer of the St. Louis-San Francisco Ry., in conjunction with the railway company's accounting bureau. It has been in operation since February, 1920. When the new time books were first issued, instructors went over the road explaining to the section foreman what was wanted and how they were to make out the reports. There has been little trouble from inaccurate or incomplete figures and the reports are found to improve steadily.

Treated Wood Spoiled by Cutting

CARELESSNESS in the use of treated timber in railway work by cutting and boring the pieces so as to expose untreated or lightly treated surfaces is a common condition which causes waste of money and material and a shortened life of the timber and is likely to be taken as an argument against the value of preservative treatment. This situation is pointed out emphatically in a report on the abuse of treated timber, presented at the recent annual meeting of the American Railway Bridge and Building Association.

Specific instances of such abuse are the cropping of piles after driving without applying preservative to the exposed surface, boring and framing treated sticks and adzing piles to form a bearing for braces. The heads of cropped piles should be coated with hot creosote oil until the wood will take up no more oil. Holes should be bored for a driving fit, or hot creosote oil should be poured into them. If piles are not in line after driving, it is better to apply blocks to bring the bracing into line rather than to cut away the surface of the pile for this purpose. In general, all portions of treated timber which have been cut or bored below the penetration of the creosote should be covered thoroughly with hot creosote oil. Further, treated timbers should not be so handled with bars, picks or hooks as to make holes extending through the treated surface.

Several examples of bad practice are given in the committee report, which points out that they are not the results of malicious intent but of lack of thoughtfulness and instruction. Similar practices are being repeated daily in all parts of the country and are the cause of many reported failures of treated material. The committee states that timber will not decay if it is properly seasoned, is well treated with creosote and is so handled and used that the seal of the treated area of the wood is not broken.

Notes from Foreign Fields

THE RAILWAYS OF THE ORIENT

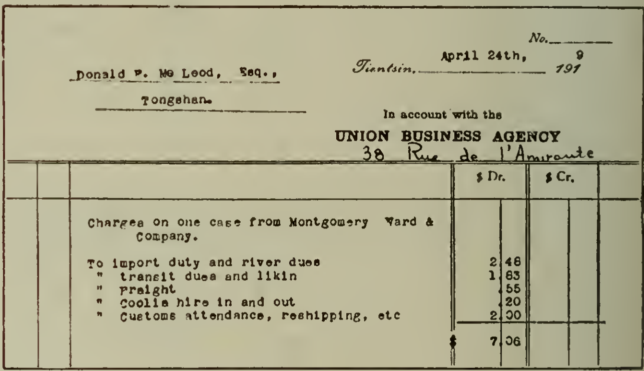
By Donald F. McLeod
Formerly of Chinese Government Engineering College

CHINA has nearly half of the railway mileage of the Orient. The total is about 20,000 miles, distributed as follows:

	English Miles
In China	10,000
In Japanese Empire, including Taiwan (Formosa) and Sakhalin, but not Chosen (Korea)	6,500
In Chosen	850
In Burmah, Siam, Malaysia, Indo-China and the Philippine Islands	3,000
Total	20,350

The types of rolling stock and construction of roadbed are for the most part European. The dining cars and freight cars of the South Manchurian and Chosen Railways are of American type. The locomotives on these roads are mostly American, and there are many American locomotives on the Peking-Mukden Ry., the Peking-Suiyuan (Kalgan) Ry., and some others.

Twice within the past three years the writer has traveled the 2,150 miles of railway route, including



No.

Tientsin, April 24th, 1919

Donald F. McLeod, Esq.,
Tongshan.

In account with the
UNION BUSINESS AGENCY
38 Rue de l'Amiraute

	$ Dr.	$ Cr.
Charges on one case from Montgomery Ward & Company.		
To import duty and river dues	2.48	
" transit dues and likin	1.83	
" Freight	.55	
" Coolie hire in and out	.20	
" Customs attendance, reshipping, etc	2.00	
	$ 7.06	

TRANSPORTATION CHARGES—CHICAGO TO TONGSHAN

ferry-boat trip of 170 miles, between Yokohama and Peking. There is little to choose between in traveling on this line and a similar length of railway journey in America. One does not recognize the names of the stations when they are announced by the trainman; but this is the case, not infrequently, in America. The seating arrangement is not so comfortable in the narrow-gage coaches of the Japanese railways as in American passenger cars. The former consists of two long seats facing one another along the sides of the car. The speed is moderate, being about 26 miles per hour, including stops. The stops, however, take up considerable time. At many of the twenty-five, and more, halting places between Tokyo and Shimonoseki, 700 miles, the length of stop is from eight to ten minutes. One of the features of the stop is the trundling out on the platform in front of the cars of a cubical water tank on wheels, and replenishing the supply of drinking water on the cars by means of a pump and hose. The regularity of the time as compared with the schedule was perfect. One could set

THE RAILWAYS OF CHINA AND THE ORIENT

ones watch by the leaving time of the train at any of the twenty-five scheduled halting places.

The trip on the ferry steamers between Shimonoseki and the mainland at Fusan, Chosen is a comfortable one. These steamers are maintained by the Japanese government. Their speed is about twenty knots per hour. No cars are ferried from the islands to the mainland, as the mainland railways are standard gage, and the island railways are narrow gage.

The speed of express trains on the Chosen Railways and South Manchurian Railways is 28 miles, per hour, including stops; the speed, similarly for Peking-Mukden express trains is 22 miles per hour. Accidents, with injury to passengers, or loss of life, are unknown.

There are no passenger cars of the Pullman type. However, the first-class coaches on the Peking-Mukden line are divided into compartments, after the English type, and closely simulate the Pullman drawing-room cars of American railways. There are second-class passenger cars, third-class passenger cars; and passengers of the laboring class (coolies) are transported as a sort of fourth class in open freight cars with no seats.

On all of the railways above mentioned English is supposed to be spoken by the conductors and trainmen. However, the English spoken is usually confined to the recognizing of a few set phrases. For example a dining-car attendant will come into the first-class coach and say, "Dinner is now ready." Suppose a passenger asks him "How long a period will dinner be served?" the answer will be, "Yes." Occasionally one meets a conductor who has a good mastery of the English language, even better than that of many Chinese students of English.

Much water has flowed under the bridges since the installation of the first railway in China (1877). This was a little railway running from Shanghai to the port of Woosung. A short time after trains began running a Chinese was run over and killed. The Imperial Government made the accident an excuse for

putting the railway out of business. They bought it from the owners and had the rails torn up. The present Chinese Government, so-called Republican, is not buying railways to tear them up. Quite the contrary. They wish railways built, and have granted many railway concessions.

The railway routes held by concession from the Chinese government are shown on the sketch map of China and its environs herewith, which also shows railways under construction, those in operation, or which have been operated, and routes along which it has been proposed that railways should be built. The railways in operation are paying well. They have all the freight and passenger traffic that they can transport, and their rates for both are high, judged by American standards. The train crews, station men, shop men, clerks, etc., are Chinese and work for low wages. It has been stated, for example, that the operating expenses of the Peking-Mukden Ry. are only 17 per cent of the total annual outgo, including fixed charges, such as interest on bonds.

Nominally, the bulk of the railways in China are under government control. Actually, the European bond-holders have much to say regarding the management, and it is understood that certain of the official positions, rather few, however, shall be filled by the appointment of Europeans. It may be mentioned in passing that the government at Peking has little power. The following states have been in open insurrection for about five years: Kwangtung, Kwangsi, Kweichow and Yunnan. Of late these have been joined by Szechuen and part of Shensi. Within the past month Hunan has been lost to Peking by the capture of Changsha by forces from the South. The Fleet has been in rebellion for several years. So much for the parts of the Republic openly disloyal; although it may be remarked of these that they do not pull together against the government but are divided into at least four factions.

Railroads, Revolution and Banditry

Similarly the parts of the country that are nominally loyal to the government are divided into factions, which are continually squabbling over something or other. Outside of that, the governor of each state maintains an army of his own, usually at least as strong as the whole federal army. Any time it strikes the fancy of a governor to move his troops toward Peking, or elsewhere, he commandeers enough first-class cars and locomotives from the federal railway to serve his purposes, without so much as saying "By your leave." The protests of the members of the European officials, such as traffic managers are of no avail, and the military trains must have precedence over the best express trains.

Another vicissitude of railroading in China is the playful habit of *regular* bandits of swooping down on a train, or on a station, and making off with all the cash in sight; also of carrying off civil engineers, or other members of the staff and holding them for ransom. The usual number of bandits in a group is about one thousand. The number is invariably great enough to overawe any small group of soldiery that may be available. These valiant protectors reserve their fire until the bandits have accomplished their purpose, and are out of range. It is then the custom for the soldiers to make a big show of firing off rifles. In this manner the gallant soldiers persuade themselves that they have behaved in a courageous manner and have frightened the bandits away. It is a favorite custom of winding up a career of banditry to have the local governor or a federal general offer a successful bandit an officer's commission, all of his robber following thus becoming recognized soldiers.

Armies both of the North and the South, during the fighting in Hunan, have laid waste villages, towns and cities. The most powerful governor in all China, Chang tso lin, of Manchuria, is notorious as being an ex-bandit.

Freight Traffic on Chinese Railways

Freight cars, commonly called "goods wagons," after the English fashion, are entirely different from those used in America. To begin with, they are small. Fifteen to twenty tons is a load for the average, and some of them, including coal cars, have a capacity of less than ten tons. They are roofless usually. Trainmen do not travel over the tops of freight trains, as in America. The few cars with roofs have the roofs rounded, without running boards. The goods on the cars are protected from the weather by means of coarse matting. Usually a servant is sent on a car of goods. He protects the car from thieves, maintains the cover of matting, and pays the *likin* tax when the car passes from one province into another. In the usual case a car can not be transferred from one railway to another, and the goods are trans-shipped to another car. The non-transfer of cars is made necessary by there being no standardization of patterns of cars, every line having types of its own. This makes it necessary to keep a car near home so that repair parts may be available when necessary. The mention of the payment of a *likin* tax will be made a text for sketching the general tax situation in North China as applied to the transportation of any commodities from place to place.

In the language of old England of the time of James I, the general attitude of the Chinese governments, federal and state, might be put in a text reading somewhat as follows: *Thou shalt not move commodities from place to place. Lo, it is better that goods should be consumed at the place of origin. But should necessity compel thee in such wise that some small portion of goods shall be transported, then shall such a matter accrue to the benefit of those having dominion over thee.*

Let the reader examine the bill for services paid by the writer to a shipping agency in Tientsin. It is typical of the general expenses connected with the movement of goods. The "case" on which the charges were made weighed perhaps a hundredweight, and the contents cost in Chicago about fifty dollars. At the time the bill was paid the $7.06 charges (Chinese currency) would come to about thirteen per cent of the original cost of the goods. The trans-Pacific freight was prepaid in Chicago.

The import duties are collected by the Maritime Customs service of China, which is invariably managed by a British subject. There are forty-nine ports of entry managed by 7,640 officials, about one-fifth of whom are European; the remainder, Chinese. One of the functions of the Maritime Customs is to distribute lights, buoys, beacons, etc., and to provide for the maintenance of these by collecting tonnage taxes on shipping. Transit dues have always to be paid when goods are shipped from one city to another. This brake on the

wheels of commerce is applied even to small packages going short distances by parcels post. The *likin* tax is the perquisite of the state governors, who are supposed to give part of it to the federal government. "Supposed" is the correct word. There must be a great surplus when the federal government gets anything.

About two years ago the celebrated ex-bandit governor, Chang tso lin, came down to Shanhaiquan to take over some millions of rounds of rifle cartridges and several hundred thousand rifles from a Japanese ship. Ostensibly he did this to accommodate the federal government. So far as the writer is aware, the celebrated Chang is still making excuses as to why he has not delivered the consignment to Peking. He commandeered eighteen first-class coaches from the Peking-Mukden Ry. (June 20, 1920) to take along his bodyguard of four hundred picked soldiers while making a friendly (?) visit to Peking. Perhaps to talk this matter over. Perhaps to suggest to Peking that his countrymen in general are making a great mistake in regarding the Easterners (Japanese) otherwise than as very fine people of the yellow race, who have the very best of intentions with regard to China. He, Chang, lives on the very best of terms with them at Fengtien (Mukden). The governor of Chihli suggests that the *likin* tax in this state should be doubled, as he is not getting sufficient funds to support his soldiery in the style to which they are accustomed.

Coolie Hire and Freight Handling

Coolie hire one has with him always, whenever he wants to move anything anywhere. It is not sufficient that one pay the charges for delivery of goods at the freight shed of a railway. The railway has no anxiety regarding freight handlers. The shipper pays coolie hire to get the goods into the freight car.

Trade is discouraged, further, by the imposition of export duties. These are paid in at least two places: First at the place of origin of the goods, which may be an interior town from which goods are shipped to a large ocean port by river; or it may be a shore port from which goods are shipped by junk or coastal steamer to a deep-water port; second, at the deep-water port when the goods are shipped. *Likin* taxes are paid on goods exported as well as on those imported. If goods are shipped by rail to an ocean port to be transshipped to a steamer, the following would be paid in a typical case: (1) Coolie hire to get the goods out of the warehouse, (2) coolie hire to get the goods to the railway freight house, (3) coolie hire to get the goods in a freight car, (4) export duties (transit dues), (5) *likin* tax, (6) coolie hire for trans-shipping, (7) export duties at the port and (8) shipping agent's charges.

During the summer of 1919 the Peking-Suiyuan, the only really Chinese railway, maintained an automobile passenger and freight service across the Desert of Gobi from Kalgan to Urga. The general route is shown in the accompanying sketch map. Along this route, of about 600 miles, there are no roads worthy of the name. Many of the mountain passes are steep and rocky. No proper system of making repairs to the automobiles was organized. The Chinese chauffeurs were unskilled, and drove recklessly. The outward journey took five days; the return journey, four days. The service did not pay, although the passenger and freight rates were enormously high.

In a previous article (*Engineering News-Record*, April 29, 1920, p. 862) the writer described the roadless condition of China, and showed the insufficiency of railways. Perhaps, aërial transit may help supply the deficiency in means of transportation in the future. There are some signs of the beginnings of aviation. An aërial transportation recently formed in Hong Kong has received from America a consignment of eleven Curtiss hydro-aëroplanes. It is reported that these are to be put on passenger and freight service between Hong Kong, Canton, Macao, Foochow and Shanghai. Some of the machines in the consignment have fuel capacity for 800 miles, carrying ten passengers. There are several privately owned aëroplanes located at Shanghai.

The Chinese government has been assembling and testing six Handley-Page aëroplanes. What the Chinese government will do with its aëroplanes is a matter of doubt. Some Chinese statesmen, like those of other nations, are great talkers. The following propositions have been made in regard to the half-dozen Handley-Pages: That they be used for carrying mails between the larger cities; that they be used for making explorations of a topographical character in connection with railway surveys; that they be used for coast patrols; that they be used for police, or military, duty, such as running down banditti.

Just what to do with the planes at present is only one of the problems confronting the faction-ridden government. As noted in an earlier part of this article, only about half of China is even nominally loyal and little attention is paid to the federal government by the governors of the "loyal" provinces. The Peking government has pledged practically everything pledgeable as security for loans to get money to pay its officials, and is estimated to be running into debt, now, at the rate of $7,000,000 silver (about $5,000,000 U. S.) per month. Truly, to use an apt Americanism, the Chinese government is where its Handley-Pages ought to be . . . It is "up in the air."

[Since the receipt of Mr. McLeod's manuscript, Mr. A. M. Burch of Mineapolis, who recently returned from the Orient, has addressed a letter to us, from which the following is a quotation.—Editor.]

I was disappointed in the amount of engineering work being done in China. Owing to China's great lack of funds, nearly everything of any magnitude has been postponed. I found that the Siems Carey Co. have entirely abandoned their railway building until conditions are more settled and the American International Corporation were marking time on the Grand Canal project, awaiting approval of their plans by their New York office and later by the Chinese government. It is probable that they will start construction on this work within the coming year.

I can see no immediate prospect of further railroad building until some such scheme as the Consortium goes through. There is the greatest need of railroad extension but all the railroads are at a standstill in their construction work, owing to this lack of funds. I found nothing in the construction line going on but the erection of the Rockefeller Foundation, which was the biggest thing in that line I saw. This was a very beautiful series of buildings in Chinese architecture at Peking.

Letters to the Editor

Street Railway Paving Primarily a Tax

Sir—After listening for eighteen years or so to the plaint of the street railway man that he ought to be relieved from the obligation to pave because he is no longer using horses to cause that " 'ard, 'ard 'ammer on the 'ard 'ighway," it was a relief to see the other side of the case set forth so firmly and clearly in your editorial note of Oct. 28, entitled "Street Railways and Pavements." Only the doctrine of economic determinism or class interest can account for the sincerely-uttered belief of many street-railway track engineers that such trifling things as 15-ton to 30-ton (and worse) cars bumping over low joints and shaky special work do not shorten the life of the paving. Whatever may be the case in streets with a discontinuous type of paving, such as block or brick, the veriest tyro can see what the vibrations set up by a heavy car do to the monolithic types of pavement. If my knowledge of this subject is not at fault, one of the principal causes in shortening the life of monolithic pavement is the entrance of water through fissures. If that is so, the long cracks that may be seen paralleling so many car tracks must be held accountable for a big share of the upkeep bill. As for rail corrugation, a force that can loosen the strongest foundation surely must, and does, affect the paving.

However, I would not undertake to say whether the street railway's responsibility for destruction (not necessarily wear) of pavement is so great as to justify its being charged with maintaining the space between and for 2 ft. on each side of the rails. What the street railway engineer overlooks is that his obligation is primarily a tax; a *quid pro quo*—said "quo" being the franchise, the stipulated rate of fare, etc. An indication that this is so is afforded by the fact that in at least one case the street railway is responsible for all the paving—curb to curb—wherever it operates. Obviously, the obligation to pave all the street is a tax just as Baltimore's park upkeep assessment on the street railways is a tax or the stipulation in one State that 5 per cent of street-railway and motor-bus gross earnings shall go into a school fund. The trouble with the almost universal paving regulation is that it confuses a more or less logical obligation with the revenue needs of the government. The Baltimore park tax and the New Jersey earnings tax leave no room for doubt as to their meaning, for there is no one who would assert that street railways as such wear out public parks or that they should maintain the schools.

A more reasonable argument set up by electric-railway men is that, granting paving is a tax primarily, they ought not to be taxed several times over. Without question, a single all-inclusive tax would be the ideal procedure. Yet who does not know that the history of taxation is one of the seizure of expedients? As one of our oldest utilities, the street railway has gathered unto itself a wider variety of taxes than its juniors. But the lustful eye of Taxation has already been cast upon the youthful motor-bus and motor-truck. If British precedent is to be followed here, as it was in the case of street-railway paving obligations, our automotive friends will have a few grievances of their own. Here is a little story and calculation showing what is going on across the pond:

In 1910 the British Government placed a tax of 6c. a gallon on motor spirit, avowing solemnly that the proceeds were "for the improvement, construction and maintenance of roads in the United Kingdom, and to render financial assistance to the County Councils." A Road Board actually did spend the money as specified until the year 1915. By that time, although the tax had just been doubled (though 6 cents to public-utility operators), the money was diverted to war purposes instead of helping out local road authorities up "to 75 per cent of the net roadway cost." Deprived of this help, the local county councils have had to levy direct road maintenance charges upon public-utility vehicles. Here is the way it works out:

Assume the fair gross earnings of 40c. per bus-mile, consumption of one-sixth gallon fuel per bus-mile and a road upkeep tax of 6c. per bus-mile. Then the fuel and roadway taxes alone will amount to 7/40 or 17.5 per cent of the gross earnings. Add thereto property taxes, income taxes, etc., and we find that 20 per cent of the gross income is chargeable to tax account. Surely no street railway is any worse off than this after two generations of intimacy with the tax-gatherer, whereas the latter is just beginning to get acquainted with the automotive tribe.

The desperate financial plight of most electric railways naturally has led them to seek means to divest themselves of dischargeable tax burdens. The "horseless age" paving argument has been played up most strongly because it sounds so plausible and because paving upkeep is indeed a dread load for them to carry today. It seems to me, however, that it would be a wiser policy to show simply that electric railways are in need of relief. This puts it up to the community to decide how far it is willing to go in the removal of any kind of impost, and even to subsidize the electric railway, as several Massachusetts towns are doing now. Electric-railway operators ought not to put themselves in the wrong on a disputable engineering question when the matter really at issue is the undisputable one that electric railways must have relief—be it through lower expenses or greater income.

WALTER JACKSON,
Consultant Electric Railway Fares
and Service Motor Buses.

Mount Vernon, N. Y., Oct. 31.

Is Surveying a "Trade"?

Sir—I cut the enclosed from a local daily paper. You will note that the U. S. Army, in an advertisement for men, has a picture of two soldiers, one looking through a transit and the other recording notes. Right over their heads are the words in large type "The U. S. Army Teaches Trades."

We have all felt more or less chagrined at times because many people who, we hoped, would know better have classed us in the category of tradesmen rather than professional men. I believe, however, that it will be a shock to members of the profession that officers in the U. S. Army who are

responsible for advertisements for recruits place us, or the surveyors among us, in the category of tradesmen.

Chicago, Nov. 1. A. L. DABNEY, Consulting Engineer.

[Mr. Dabney raises a point on which opinion is decidedly at variance. By some it is held that the land surveyor, from the nature of his work is not justified in assuming the title "engineer." Others classify him as a professional man and not as a tradesman. It is to the point, however, to note that in many of the professional registration acts recently passed a sharp distinction is made between the professional engineer and the land surveyor, and different examinations and licenses apply to the two titles.—EDITOR.]

History's Evidence on Prohibition

Sir—In your issue of Aug. 5, p. 279, H. F. Ammidown requests me to discuss the question: "Have Persia, Greece and Rome stood the test of time so much better than China?" To refresh the recollection of your readers, I will state that the occasion of Mr. Ammidown's question was my assertion that enforced prohibition had caused the degeneration of China.

History records that Ancient Iran, a part of which is now known as Modern Persia, was a powerful empire, and it is readily admitted that Modern Persia is far from that, in fact that it has greatly degenerated. But this same history also shows that the blight of Islam attacked Persia about A. D. 630, Mohammed, its founder, having appeared as a prophet at Mecca about A. D. 610. From A. D. 640 to 642, the empire of Iran went to pieces incident to trouble resulting from Mohammedanism. The foundation stone of Islam may be said to be prohibition of spiritous, vinous and malt liquors (Koran v. 7) (Sura 2, v. 216; 5, v. 92). Prior to the fall of Ancient Iran the Persians used liquors as stimulants, but since adopting the Islam religion, they have used many different kinds of narcotics, producing more opium than they consume and exporting from eight to ten thousand cases annually to China. The only deduction we can make from the facts is that the prohibition of liquor and the substitution of narcotics has been the cause of Persia's decline.

As to Greece and Rome, no one can truthfully assert that any degeneration of the people similar to that in China, Persia and other old prohibition countries, has occurred. The Greeks still use liquors as stimulants and always have. They are a powerful race today, strong physically and mentally, and as an engineer who has employed thousands of them for the past thirty-four years up to within the last year, I can testify that they are good workmen and as clean morally as the best American workmen. No defense of the Italians is needed. They have continued to use wines and other liquors as beverages from the days of the Roman Empire to this day, have continued to progress and from Torricelli to Marconi, have been leaders in engineering. Also the Italian laborer is the best and most efficient worker this country has ever admitted from abroad.

The fall of the Greek and Roman Empires was only such a change in government as must be expected in all countries; the causes are well known and understood, there being no need for repeating them here. The events in past history have left no marks of degeneracy upon the modern Greeks and Latins, as upon the Chinese, Persians and others, who have substituted the use of narcotics for liquors as stimulants.

As regards Mr. Sheibley's communications in the same number, I am glad to admit that China is improving since the younger generation has caused the repeal of the prohibition laws to the extent of not only permitting but encouraging the establishment of breweries and wineries in China. With the introduction of mild stimulants, like light wine and beer, it is hoped that the Chinese will be redeemed. When this has occurred it will be time enough to admit them to fellowship with the American "home brewers."

F. C. FINKLE, Consulting Engineer.

Los Angeles, Cal., Oct. 27.

Information on Deterioration of Slag Concrete Wanted

Sir—In connection with researches on concrete aggregates which are being carried on by the Committee on Aggregates of the American Concrete Institute and Committee C-9 of the American Society for Testing Materials, information is desired by the writer of any instances of concrete made with slag as a coarse aggregate which have shown any signs of deterioration with age.

It is requested that full information be given as to the conditions of laying, character of sand, proportions, kind of cement used, whether portland, natural or puzzolan, and the age of the concrete. If samples of concrete are available they may be forwarded for inspection. If it is desired that the information be kept confidential this should be stated in writing, addressing me at 136 Federal St., Boston.

Boston, Mass., Nov. 6. SANFORD E. THOMPSON, Chairman Committee on Concrete Aggregates, American Concrete Institute.

Methods and Results of Iowa Impact Tests on Highway Bridges

Sir—A letter of J. H. Ames, of the Iowa Highway Commission, calling attention to the impact tests made by the commission in 1912 appears in your issue of Oct. 21, 1920. As I alone proposed and made these tests for the commission I feel that it is my duty to give sufficient facts at this time regarding these tests to acquaint engineers in general with the results actually obtained, although the results are referred to in my "Structural Engineering" and are well known to some of the highway commissions, particularly the Illinois commission.

I obtained four impact instruments from the American Railway Association; these instruments had been used by Professor Turneaure and a committee in making tests for the Association to determine impact in railroad bridges due to railroad loading, which of course consists of locomotives and trains. I started out making tests on highway bridges following the instructions given me by the railroad people and using live loads consisting of trucks and traction engines.

Considerable impact was indicated by the instruments in the members of light ordinary highway bridges supporting wood floors. After a little practice in the work the question occurred to me as to how much of the movement of the needle of the impact instrument was due to actual impact and how much was due to vibration. So I decided to back up and make a thorough investigation of the instruments and determine independently the stress constants of each instrument and also, if possible, determine the amount of the movement of the needle due to vibration and the amount of movement of the needle due to actual impact.

By clamping an instrument onto an angle bar and vibrating the bar when there was no stress in the bar extensive movement of the needle was obtained, which no doubt was due solely to vibration. This experiment showed that the movement of the needle of the impact instrument due to vibration of a bridge member could easily be confused with the movement of the needle due to impact. Next, an instrument was clamped onto a bar having a known modulus of elasticity and the bar was placed in a testing machine. The actual stress in the bar was given by the testing machine and the stress indicated by the impact instrument was obtained. The discrepancies of the impact instruments were obtained in this way and constants for correcting the stress reading of the impact instruments were determined, as just explained. Then, loads were applied to the bar suddenly and the movement of the needle due to impact was recorded. Next, by jarring the bar during the application of the same suddenly applied load (knowing the correct stress for the static load and the movement of the needle due to vibration) the movement of the needle on the instrument due to impact was fairly well isolated from the movement due to vibration.

After these preliminary investigations of the impact instruments were completed tests were made to determine impact in practically all kinds of bridges throughout Iowa due to practically all kinds of loading. It was found in the case of bridges having concrete floors that automobiles (having pneumatic tires) produced no impact at all. Traction engines and trucks produced but very slight impact, while in the case of light bridges with wood floors the impact did not exceed 10 per cent of the static stress in any case although the live load included fairly heavy trucks speeded up to 15 miles per hour.

In the case of a drove of cattle passing over a bridge very severe vibration was indicated by the instruments, yet very little impact occurred, due no doubt to the fact that the cattle had never had military drill.

Prof. F. O. Dufour, formerly of the University of Illinois, A. N. Johnson, formerly State Engineers of Illinois, and myself, I believe, were first to investigate impact in highway bridges.

As consulting engineer for the Iowa Highway Commission it was my duty to select loadings and develop the designs of the highway bridges in that state, which I did with the exception of the culverts. I made a very thorough investigation of live loads before the present live load was selected. At first an imaginary impact stress was provided for but was ignored after I had made some careful observations, and was literally forgotten after the impact tests extending over a period of several months were made.

The tests made in Illinois by Prof. Dufour and Mr. Johnson and the tests I made in Iowa should have been fully published. But the Illinois and Iowa commissions seemed to be about the only parties interested in impact on highway bridges at that time. I offered to write a bulletin covering my work on impact but funds were not available at that time. The authorities in Illinois and Iowa were satisfied that impact should be ignored and that seemed to be all that was necessary. For the benefit of those desiring to investigate impact I wish to submit the following for consideration:

Concrete bridges and steel bridges carrying concrete floors are subjected to very little impact, due to the fact that the inertia of the structure must be overcome before impact affects the stresses in the structure.

The case of railroad bridges is entirely different from that of highway bridges. In the case of railroad bridges the nosing of the train which is continuously applied as the train passes over the structure and the hammering due to the counter-weights, which is also continuously applied as the train passes over the structure, cause accumulative impact. There is no case where a highway bridge will be subjected to accumulative impact. The case of a chuck hole in a concrete floor on a highway bridge has been mentioned as the cause of heavy impact. One chuck hole in a highway bridge floor would not cause accumulative impact. A wheel striking such a chuck hole would cause an impact directly on the floor but the inertia of the floor and the bridge would absorb the blow and mostly vibration would result. If there were several chuck holes in the floor of a highway bridge spaced at a critical distance apart and a critical load passed over this improbable floor at a critical speed impact probably would be produced to quite an extent. But no doubt the live load would be wrecked in the meantime.

I have designed hundreds of highway bridges and have seen thousands, but I have never found a serious chuck hole on a bridge carrying a concrete floor.

The tests made by the Bureau of Public Roads are of value in so far as they apply to pavements. We all emphasize the importance of maintenance of all types of pavements, while the public demands maintenance of bridge floors. The officials' attention would be called to the condition of the floor very forcibly before a floor would get into such a bad condition that impact would be of importance.

J. E. KIRKHAM, Bridge Engineer,
Pierre, S. D., Nov. 2. South Dakota Highway Commission.

Inclined-Bearing Tests and the Howe Formula

Sir—The writer has read with interest the comments of H. D. Dewell in your issue of Oct. 21, 1920, p. 811, on the test methods used in determining the crushing strength of Southern pine at angles to the grain.

It is not conceded that the typical joint illustrated in Mr. Simpson's article (Sept. 30, 1920, p. 654) is universally the most economical form to use, for by a slight rearrangement of the cutting planes in his notch it is possible to reduce the effective force in the strut to its horizontal component. Moreover, if we increase the values as given by the Howe formula by an allowance for shear, and also take into account the shearing resistance of the connecting bolts, I see no reason why practically any joint should not be feasible whose design is based on the Howe formula.

As safe shearing values for timber have been generally established, it seemed wise to the writer to eliminate shear as much as possible from the tests in order that data on simple crushing strength of inclined faces might be built up. In this manner we will be enabled to deal separately with each phase of a given design problem, and thus tend to clear up the existing situation. At best, qualities of wood are extremely variable, even in the same species.

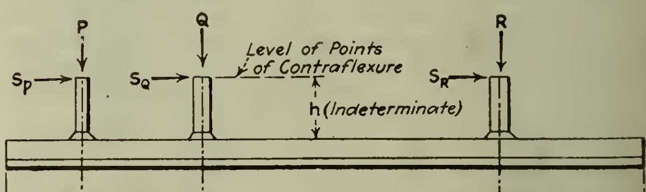
It is admitted that the basis of the Howe formula is different from that of the Southern pine tests; but it is also contended that an apparent agreement between the two graphs, plotted between the same terminal values, constitutes a fortunate and labor-saving coincidence. If we consider the Howe formula, regardless of its origin, as a general expression of the law of variation in Southern pine, we then have a satisfactory equation for use which is doubtless less complicated than any original one which could be devised.

The writer hopes to see the work go on, especially along the lines indicated in the last paragraph of Mr. Dewell's letter.

Q. C. AYRES,
Iowa State College.
Ames, Iowa,
Oct. 27.

Effect of Column Base on Theory of Continuous Foundation Girders

Sir—Prof. Ellis' discussion of the continuous three-column foundation in *Engineering News-Record* of Oct. 7, 1920, is interesting and suggestive. I find, however, that the equations therein developed are applicable only to the case in which the columns have base shoes with pins, thus eliminating column moment. Referring to the figure accompanying this letter, it is clear that without pins the only case in which the shears S_p, S_q and S_r would be zero is that in which the neutral axes at P, Q and R remain horizontal.



THREE-COLUMN FOUNDATION AFFECTED BY COLUMN SHEARS

This is a very special case. Also the column conditions at the story above may be such as to cause moment to be be transmitted to the foundation girder. I think the case is susceptible of a solution which would be closely approximate, but I doubt whether in most offices the cost of computation would not exceed the saving of material. It would be useful, however, to have several type-cases computed as a guide for the designer in proportioning the projections of the foundation girder.

ALBERT SMITH,
Professor of Structural Engineering,
Lafayette, Ind., Oct. 18. Purdue University.

Ancient and Modern Direct-Process Irons Identical in Composition

Sir—I have read the interesting article "Direct-Process Native Furnace Iron Like Metal in Delhi Pillar," published in *Engineering News-Record* of Oct. 21, 1920, relating to a paper on the primitive method of wrought-iron making as actually practised in India in the proximity of modern steelworks, read by Andrew McWilliam before the British Iron and Steel Institute. This instance of the oldest metallurgical method of iron-making being in operation besides modern steelworks is not unique. In several of the Mediterranean countries, wherever the cost of labor and the abundance of charcoal allows it, the Catalan process survives to a small extent. The Catalan, Corsican, and Elba processes are chemically identical with the direct methods of iron-making still in use in India, Burmah, Africa and other regions where modern methods have not yet penetrated. In a few places the furnaces work with natural draft; in others, native iron-makers use bellows and a variety of blowing appliances, such as the hydraulic blowing machine known as "trompe," which provide the blast for the Catalan and similar forges used in Europe.

The production of direct-process wrought iron and of steel in the forge has in our days only historical interest; the few examples remaining will gradually disappear through the introduction of modern methods. It will be interesting to note in this connection that metal almost of the same composition as that of the direct-process furnace has been produced in open-hearth practice, which showed: Combined carbon 0.060, silicon 0.040, sulphur 0.047, phosphorus 0.032, manganese 0.100 per cent.

The practice of wrought-iron making in the Indian forge is the same now, as it was in the first millenium B. C., and before. So also the grade and preparation of the iron ore reduced. All things being equal, the composition of the resulting material must be exactly the same. This is confirmed by the similarity of analytical composition of the metal forming the other two iron columns existing in India besides the Delhi Pillar: the column of Dhar in the Central provinces, and that of Konarak in Orissa. Numerous specimens of direct-process iron found in Ceylon are also analogous in composition.

New York City, Nov. 1.

BAXERES DE ALZUGARAY,
Consulting Chemist and Metallurgist.

Strength of Concrete Made From Large Size Aggregate

Sir—The article in *Engineering News-Record* Sept. 30, 1920, describing the use of 6 in. bank run aggregate in the construction of the Stevenson dam emphasizes our lack of knowledge of the effect of such oversize material on the compressive strength of concrete, and brings up several important points in testing practice which should be given consideration by testing engineers. No doubt the use of oversize aggregate will prove economical and satisfactory in many cases where adherence to the usual 1½ in. maximum size results in extra expense for the handling of the rejected material, but the true strength values of the concretes should be known.

Tests with which the writer is familiar have shown that a 1½ maximum size aggregate containing a high percentage of the larger particles may be so grouped in a 6 by 12-in. cylinder as to result in a wedging action which considerably lowers compressive strength. The use of 2½-in. aggregate in a 6-in. cube no doubt gives lower strength values and greater variation in individual test results. Tests have also shown that specimens made with that portion of the batch of mixed concrete passing the ⅜-in. screen will run from 75 per cent to 100 per cent stronger than other specimens from the same batch in which particles up to 1½ in. are retained. The test results of the Stevenson dam concrete are probably the same amount higher than those which would have been obtained had sufficiently large test pieces been molded to include the aggregate up to 6 in. Such specimens should have a minimum cross-section of not less than 450 sq.in., in the form of a 24-in. cube or a cylinder 24 in. in diameter. Specimens of such size are very heavy and difficult to handle, and there are few testing machines with sufficient clearance between the vertical screws to accommodate them.

The main point to be emphasized is that tests made on small specimens from which the larger particles of the batch have been rejected will furnish results far too high, and that regardless of any other conditions of the test the quantity of cement in a unit volume of concrete is an important factor which should not be disregarded in interpreting the test results.

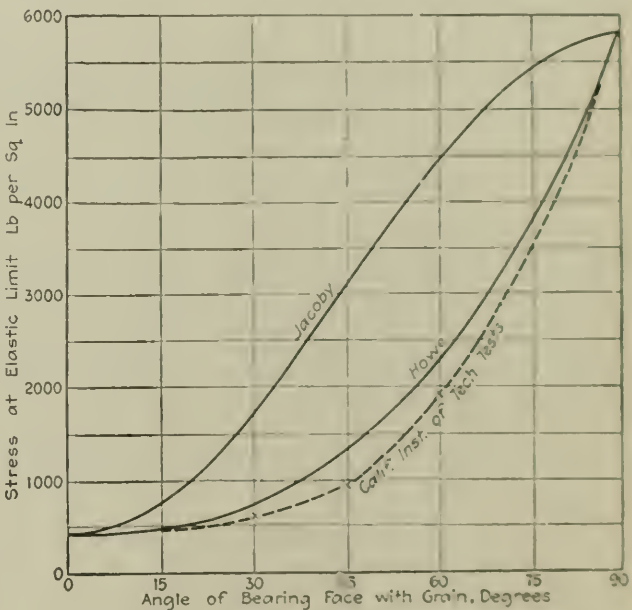
G. M. WILLIAMS,
Professor of Civil Engineering,
University of Saskatchewan.

Saskatoon, Sask., Oct. 8.

Tests of Bearing Strength of Redwood Agree with Howe's Formula

Sir—In connection with the two articles on the crushing strength of wood at various angles to the grain which were published in *Engineering News-Record* of Sept. 30, 1920, the following results of tests made on redwood at the California Institute of Technology during the past year may be of interest.

The specimens tested were 1⅞ x 1⅞ in. in cross-section and 3 in. long, cut from clear stock so that the grain of the five



INCLINED-BEARING TESTS ON REDWOOD

tests pieces made angles of 0°, 30°, 45°, 60° and 90° with the bearing faces. A 30,000-lb. Olsen testing machine was used and the deformations for successive increments of load were read on dial gauge compressometers. The elastic limit for each specimen was determined from stress-strain diagrams drawn from these data. As was anticipated, all the speciments except those in end bearing and cross bearing failed in shear.

TESTS OF CALIFORNIA REDWOOD IN COMPRESSION AT VARIOUS ANGLES TO GRAIN

Angle of Bearing Face with Grain	Compressive Stress at Elastic Limit Lb. per Sq.In. Set 1	Set 2	Set 3	Set 4	Set 5	Aver.	Allowable Stress by Formula of Jacoby	Howe
90°	5,800	6,500	6,000	5,730	5,000	5,806	5,806	5,8[illegible]
60°	1,680	2,250	2,370	1,910	1,260	1,894	4,452	2,350
45°	1,000	940	1,050	820	920	946	3,098	1,350
30°	450	840	670	630	545	627	1,744	74[illegible]
0°	350	440	410	365	390	391	391	39[illegible]

The accompanying curves, plotted from the above data, indicate that for redwood Howe's formula gives values more nearly in accord with the experimental data than does Jacoby's.

R. R. MARTEL,
California Institute of Technology.

Pasadena, Cal., Oct. 24.

News of the Week

New York, November 11, 1920

Discount on Water Bills Must Be Stopped by Company

In granting a new schedule of rates to yield 8 per cent on a valuation of $266,165 and $15,394 for current expenses, the Railroad Commission of California, in a ruling announced Oct. 13, ordered the Pasadena Consolidated Water Co. to discontinue its practice of allowing 10 per cent discount on water bills paid before a stated date. The commission declared that a water company can protect itself against bad bills by rules and regulations. The company supplies water for domestic use and irrigation in the vicinity of Pasadena. A similar ruling was made in another state not long ago.

Approval by Voters of Public Works Bond Issues is Countrywide

Billions of Dollars Provided for Construction of Roads, Water-Works, Tunnels and Other Public Improvements — Few Projects Defeated

Returns from all sections of the country indicate a sweeping approval by voters on Nov. 2 of bond issues for public works construction. There follow details of some of the more important projects for which funds were voted:

Baltimore Votes $51,750,000 of Bonds—Baltimore's four big municipal improvement loans (providing for expenditure of a total of $51,750,000 on new schools, sewers, streets and bridges, conduits, harbor and water-supply betterments and a new municipal hospital) were each ratified by majorities in excess of 150,000. (See *Engineering News-Record*, Oct. 28, 1920, p. 866, for further details.) Plans for floating the bonds are to be taken up at a joint meeting of the Public Improvement Commission and the Commissioners of Finance, shortly to be called by William F. Broening, mayor of Trenton. The bonds are to bear interest at 5 per cent.

Construction operations are to start in the early spring, and the advertising for sale of sufficient blocks of securities to cover initial outlays on the work may be expected in January or February, although the officials will be guided in large measure by market conditions, deferring action to await a favorable market. Bids are to be submitted to the Municipal Board of Awards, Mayor Broening, president.

Members of the Public Improvement Commission, to have charge of the expenditure of $41,000,000 of the total, took the oath of office Nov. 4, and the members of the Port Development Commission, to supervise the expenditure of $10,000,000 on harbor improvements, qualified Nov. 8. The members of the commissions are: (1) Public Improvements: Robert Garrett, of Robert Garrett & Sons, bankers, Garrett Building, chairman; Jacob Epstein, Judge Henry D. Harlan, former Mayor J. Barry Mahool and William Kalb. (2) Port Development: John E. Greiner, of J. E. Greiner & Co., consulting engineers, Fidelity Building, chairman; Austin McLanahan, Benjamin F. Woelper, Jr., former Mayor James H. Preston, and Elmore B. Jeffery. The hospital loan will be expended under the direction of the Municipal Board of Estimates.

Hudson River Tunnel and Delaware River Bridge Bonds Carry—The $28,000,000 New Jersey bond issue for a vehicular tunnel beneath the Hudson River between New York City and Jersey City and for a bridge over the Delaware River between Philadelphia and Camden was carried by a heavy majority. Full returns are not available, but it is believed that every county in the state indorsed the project. The majorities in Essex, Hudson, Passaic and Union Counties, opposite New

Civil Engineers Refuse To Join Federated Engineering Societies

In Record Total of 5,608 Ballots Proposal To Enter New Organization Is Defeated by Margin of Almost 1,000 Votes

By a vote of 3,278 to 2,330 the American Society of Civil Engineers, in the letter ballot canvassed Nov. 8, defeated the proposal to become a member of the Federated American Engineering Societies. The total vote of 5,608, analyzed by districts in the accompanying table, exceeds by almost 1,000 the heavy balloting recorded Oct. 6 on the constitutional amendment questionnaire and reported in the news section (p. 767) of this journal Oct. 14.

AMERICAN SOCIETY CIVIL ENGINEERS VOTE ON PROPOSAL TO JOIN THE FEDERATED AMERICAN ENGINEERING SOCIETIES

District*:	1†	1‡	2	3	4	5	6	7	8	9	10	11	12	13	Total
Yes	24	272	153	101	311	192	239	223	144	115	122	192	111	131	2,330
No	31	792	290	198	192	224	237	148	356	221	172	149	122	146	3,278
Total	55	1,064	443	299	503	416	476	371	500	336	294	341	233	277	5,608

* Dist. 1, N. Y. City and foreign; Dist. 2, New England States; Dist. 3, N. Y. State and Quebec; Dist. 4, Eastern Penn., Md., N. J., Del.; Dist 5, D. C., Va., N. and S. C., Ga., Fla.; Dist. 6, Western Penn., W. Va., Ohio; Dist. 7, Ontario, Mich., Wis., Minn., Manitoba, Ia.; Dist. 8, Ill., Ind., Ky., Tenn.; Dist. 9, Ala., Miss., La., Ark., Mo.; Dist. 10, Okla., Kan., Col., Utah, Neb., Wyo., N. and S. D., Mont., Saskatchewan and Alberta; Dist. 11, Tex., Mex., Ariz., S. Cal.; Dist. 12, B. C., Idaho, Wash., Ore., Alaska; Dist. 13, Northern Cal., Nev.

† Foreign. ‡ Resident.

The federation project was defeated this week in nine of the society's thirteen districts, affirmative majorities being returned only from Districts 4, 6, 7 and 11, covering the Pennsylvania-Ohio, the Great Lakes, and the Southwest territories. By far the largest negative plurality was rolled up in the New York district (No. 1) where the "No" votes totalled 792 against only 272 "Yes" ballots. In District 6 (Western Pa., W. Va., and Ohio) opinion was almost equally divided, there being 239 negative votes and 237 affirmative. The western states, contrary to predictions that had been current while the balloting was in progress, returned no heavy total in favor of the federation, and there is nothing in the result to indicate any contest between East and West.

The announcement of the result terminates a contest in which active campaigns were conducted by both the advocates and the opponents of the federation. In addition to arguments pro and con, prepared by special committees named by the society's Board of Direction and circulated in printed form to the corporate membership, additional appeals carrying long lists of signatures were distributed.

The action of the American Society of Civil Engineers comes almost on the eve of the first meeting of the American Engineering Council, the governing body of the Federated American Engineering Societies, which is to convene at Washington, D. C., Nov. 18 and 19. All of the other founder societies—mechanical, electrical and mining—have already become charter members of the federation, in addition to a score or more of city, state and regional organizations.

York City, were large, while in Mercer County, the center of the state, a majority of 3,000 votes was recorded. If the bonds had not carried the cost of the two projects might have been met by direct taxation. Under the terms of the bond authorization act tolls will be charged for the use of the tunnel and bridge in order to meet the bond and other charges.

Newark Votes for Municipal Light and Power—By a vote of 35,814 to 34,165, Newark, N. J., voted for the establishment of a municipal light, heat and power plant. No plans have been made or money provided for the project. Charles P. Gillen is mayor.

Large Loan at Philadelphia—A $33,000,000 loan for municipal improvements was authorized.

Harrisburg Votes Water Bonds—A $1,600,000 loan for water-works improvements at Harrisburg, Pa., was authorized. (See p. 963 for details.)

St. Paul Votes Water Bonds and Charter Amendments—A bond issue of $4,000,000 was voted by St. Paul, Minn., for the construction of a filter plant, service reservoir, pumping plant, and reinforcing water mains to remedy low pressure in portions of the city. The present supply is from lakes north of the city and artesian wells. The new supply will probably be taken from the Mississippi River north of the city. John W. Kelsey is superintendent of the water department.

The charter of St. Paul was amended (1) to permit levying a wheelage tax for construction and maintenance of pavements and (2) to permit charging to abutting property owners the cost of a 12-ft. strip of new pavements in place of having all the cost met by benefit assessments.

Road Bond Amendments Carry

Missouri City Bond Limit Increased—A constitutional amendment allowing Missouri cities of 100,000 and over (St. Louis and Kansas City) to raise the limit of bonded indebtedness from 5 to 10 per cent of their assessed valuation probably carried, there being a favorable majority of about 130,000 in St. Louis, Kansas City and St. Joseph, which it is thought can not be overcome by the smaller cities and rural districts. This amendment was particularly desired by Kansas City to enable it to improve its water-works (see *Engineering News-Record*, Oct. 28, p. 865).

Minnesota Ratifies Babcock Good Roads Amendment—Minnesota ratified Constitutional Amendment 1, popularly known as the Babcock Good Roads Amendment, whereby a state system of paved roads, 6,900 miles in length, connecting all county seats and other towns of over 1,500 population, and sufficient funds for the proper construction and maintenance of such a system, are provided. No time limit is set as the date for completion of the system, neither is it specified what maximum financial obligation may be incurred, with the exception that not more than $10,000,000 in bonds may be issued in a single year or more than $75,000,000 be outstanding at any time.

West Virginia Votes Ten to One for Road Bond Amendment—By a vote that is estimated as 10 to 1 West Virginia ratified a constitutional amendment providing for the issuance of $50,000,000 in bonds for construction of a system of highways connecting county seats.

Missouri Road Amendment Apparently Carries—The heavy vote in cities is expected to give a large majority in favor of Constitutional Amendment 6, authorizing the issuance of $60,000,000 in bonds for highway construction under state supervision. Early estimates put the majority by which the amendment will be carried at 100,000. Rural districts, the last to report returns, appear unfavorable to the proposed amendment. Incomplete returns from 29 counties give the amendment a majority of 49,612, and complete returns from 17 a majority of 4,186.

One Possible Road Bonds Defeat

Carlyon Bill Apparently Defeated—Washington State's proposed constitutional amendment, whereby bonding of the state for $30,000,000 for 20 years, bonds to be retired through revenue from motor vehicle licenses, was apparently defeated. The proposed amendment was known as the Carlyon Bill. Incomplete returns from Seattle and from King County showed 26,000 votes for and 35,000 against the amendment.

Georgia's "Baby Bond" Amendment Passes—A constitutional amendment authorizing the issuance of 10-year bonds for street paving by cities in Georgia of more than 150,000 population passed. It is agreed that a great amount of municipal street work will be done during 1921 because of the new amendment, Atlanta alone contemplating the issuance of bonds to the amount of $5,000,000. The amendment was popularly called the "baby bond" amendment.

County Votes $1,000,000 in Highway Bonds—Susquehanna County, Pa., voted to issue road bonds to the amount of $1,000,000. The majority was 1,123, though some 3,000 voters failed to vote on the bill.

Alabama County Votes Road Bonds—The majority in favor of bonding Morgan County, Ala., in the sum of $440,000 for road improvement is expected to be around 600, early returns indicate.

State Railway Tunnel Bonds

Colorado State Railway Tunnel Bonds Probably Carried—Incomplete returns indicate a favorable vote on the amendment to the Colorado State constitution authorizing a bond issue of $18,550,000 for the construction of three tunnels through mountain ranges to improve the transportation service of districts now almost isolated and also to improve through traffic facilities by giving lower grades and avoiding present open summits at high elevations where snow troubles are serious. The six-mile Moffat tunnel on the Denver & Salt Lake R.R. is estimated to cost $7,517,936; the six-mile Monarch tunnel on the Denver & Rio Grande R.R., $7,[illegible]-400, and the 1½-mile San Juan R.R. on another line of the latter road, $3,[illegible]-397, a total of $18,404,730. These tunnels are to be owned by the state and leased to the railroads, the law requiring the latter to make use of the new facilities provided. A description of this project was given in *Engineering News-Record* of April 8, 1920, p. 716

Bridge Bonds Approved

Wayne County Bridge Bonds Voted—The construction of two bridges across the Rouge River at Detroit, Mich., was authorized by the voters of Wayne County—one at Fort St. and one at Jefferson Ave.

Some of the Favorable Results in Ohio—Votes in favor of municipal improvements were cast in a number of Ohio cities. Some of these were: *Akron:* $2,000,000 voted for parks; $250,000 for approaches to the North Hill viaduct.—*Ashtabula:* $1,000,000 for a new light and power plant.—*Marion:* $525,000 for storm sewers defeated, but a tax levy proposed for a $1,000,000 outlay for sanitary sewers and sewage treatment was carried.—*Sandusky:* $244,000 for resurfacing downtown streets.

Chicago Votes Park Bonds—A $1,000,000 bond issue for the extension of Lincoln Park was voted at Chicago. Most of the work will be done by day labor.

Leavenworth to Buy Waterworks—A vote of nearly 2 to 1 was cast to buy the property of the Leavenworth and Ft. Leavenworth Water Co. Bonds will be issued to pay for the plant which a board of engineers recently appraised at $650,000.

Topeka Votes Water Bonds—A total of $535,000 water bonds was voted. A filtration plant will be built after plans by C. A. Haskins, Lawrence Kan.

Some Adverse Votes

Two Bond Issues Defeated at Louisville—A $500,000 war memorial and auditorium loan and a $1,000,000 loan for the University of Louisville failed to receive the necessary two-thirds majority at Louisville, Ky.

Franklin County, O., Votes Against Bridge Bonds—A county bridge bond issue was defeated by 8,816 votes, according to reports from Columbus, O.

Sandusky Votes Down War Memorial—For the second time the voters of Sandusky, Ohio, defeated a proposed $250,000 bond issue for a soldiers' memorial building.

Toledo Prefers Service at Cost to Municipal Railway—A service-at-cost street railway ordinance was carried at Toledo, Ohio, by a vote of 46,000 to 18,000. By somewhat lighter total vote, of about the same ratio, but inverted, a $4,000,000 and an alternative $3,000,000 bond issue ordinance for municipal ownership were defeated.

Flexible Interest Rate To Aid California Road Bond Sales

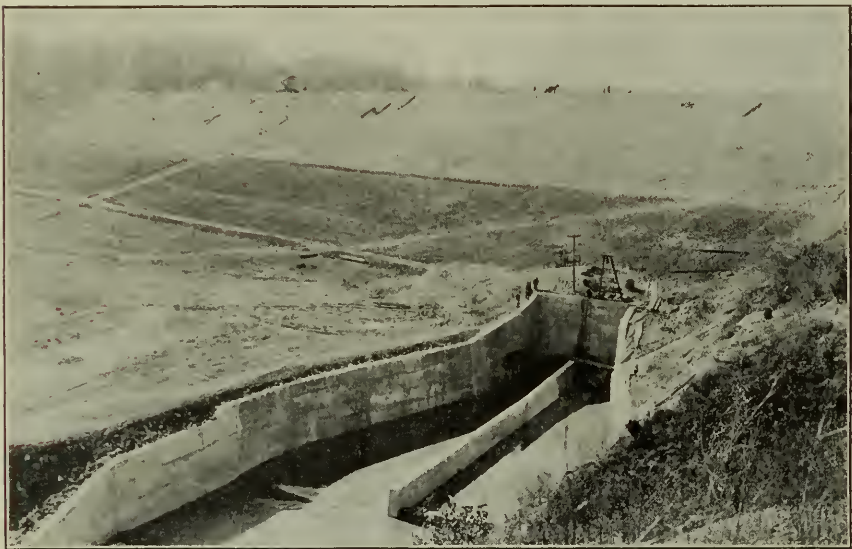
At the election on Nov. 2 California voters approved a measure providing for a flexible interest rate on highway bonds, and the means for adjusting that rate to suit market conditions. This measure, which was strongly supported by the state highway commission, is expected to expedite materially the financing of state highway work. It will distribute more equitably highway costs and will relieve the highway commission of the necessity of getting counties to pay the difference between the par and market values of bonds used for road work within their boundaries.

Under the new plan there is created a state highway finance board consisting of the governor, controller, treasurer, chairman of the state board of control, and chairman of the state highway commission, all serving without compensation or expense. When a block of highway bonds is to be sold this board is to investigate market conditions and fix a rate of interest, not exceeding 6 per cent, such that the bonds can be sold at par.

The second part of the measure relieves counties of the payment of interest on state highway construction within their boundaries a requirement that has been in effect since the state highway commission was organized. That provision was included in the original plan because it was presumed that the roads would be of more value for local than for through traffic. It has been found, however, such a plan makes an unfair distribution of the burden. In constructing trunk-lines and laterals by the most direct routes, and with what the highway commission calls "the phenomenal development of through traffic, both passenger and freight," local traffic on most state highways is now but 25 per cent of the total. Moreover, some of the most expensive construction was through counties having a small assessed valuation — Mono County was raising 48c. on the $100 to pay state highway bond interest while San Francisco paid nothing at all.

Germantown Dam Completed

Last week the embankment of the Germantown dam of the Miami Conservancy District, about 10 mi. northwest of Dayton, Ohio, was completed, the officials of the district advise. Work was at once started on placing the permanent floor in the twin outlet conduits, which will reduce the conduits to half their initial height; to carry the flow of freshlets during construction and to reduce the depth of ponding back of the uncompleted embankment, the conduits were built of twice their design depth, and have served during the past year in this condition. The final floor, now being built, is at half the height of the conduit opening, and the space below is to be filled when flow has been diverted to the new floor. It is expected that this work and all necessary finishing operations at Germantown will be completed this season.



GERMANTOWN DAM, FIRST OF MIAMI CONSERVANCY DISTRICTS' FIVE FLOOD CONTROL DAMS TO BE COMPLETED

As the Germantown dam is the first of the District's five dams to be completed, the present stage represents an important step in the progress of the Miami Valley flood protection. The dam will be ready for full service in the coming spring floods, and by exerting its full detention action (the double-size conduits were in service during the 1920 high water) it will contribute its intended share toward reduction of floods in the lower part of the valley.

Work on the dam began in spring of 1918 and has progressed according to schedule and without mishap. The dam is 110 ft. high and contains about 900,000 cu.yd. of embankment, most of it placed by hydraulic sluicing. Arthur L. Pauls, division engineer, and Albert Armstrong, superintendent, are directly responsible for the conduct of the work.

One Indicted in Building Graft Inquiry

Lockwood Committee Probe Discloses Transfer of $25,000 by New York Contractor to Call Off Strike

The indictment of George S. Backer, a New York City contractor, on the charge of perjury in connection with his testimony; the cancellation of New York County courthouse contracts because of indications of collusion in bidding; and the possibility of further indictments, and contract cancellations by the city on school and other work, are the recent outstanding features in the building graft inquiry being conducted by the Lockwood Joint Legislative Committee on Housing being held at the City Hall, New York City, with Samuel Untermyer as counsel for the committee.

Mr. Backer, who has been operating in New York City for years, acted as a go-between in the transfer of $25,000 from the contractor for whom he was acting as superintendent of construction, and two walking delegates. The money was paid to call off a strike but Backer first testified that he had gambled the money away at the racetrack and in playing cards. When cross-examined he admitted having paid the money to two "strangers," who, he understood, were acting as agents for Robert P. Brindell, the "king" of the New York building labor world. Backer was arraigned before Judge Mulqueen, of General Sessions, Nov. 8, having previously been released after arrest on $25,000 cash bail.

The cancellation of the contract for furnishing cut limestone for the New York County courthouse came as a result of the testimony offered by Henry Hanlein, who had been awarded the contract, in which it was intimated Hanlein was to be the only bidder as a result of a conference and an agreement among the cut limestone producers in New York City.

Investigations are under way both by the Lockwood committee and the New York Board of Estimate and Apportionment into the presence of irregularities in the award or prosecution of school and other contracts for the City of New York, involving the expenditure of approximately $60,000,000.

Purchase of Fifty-Two Snow Plows Advised by Highway Engineer

In order that the New Jersey State Highway Department may not be short of equipment with which to keep main trunk-line routes open to traffic throughout the winter, Thomas J. Wasser, state highway engineer, at a recent meeting of the Highway Commission recommended the purchase of 52 additional snow plows. The Department already owns 22 plows. It is understood that the Highway Department will soon receive proposals for the supply of the needed plows.

Southern Power Co. Will Build New Station

Plans are being prepared by the Southern Power Company for the construction of a new 60,000-kva. water-power plant near Charlotte, N. C. This will be the ninth hydro-electric plant to be tied into that company's system of 2,050 miles of high-voltage transmission lines and brings the total rating of its hydro-electric and steam stations up to 340,900 kva. The new station will be laid out for four units, operating under a head of 85 ft. It will be of the usual type of construction adopted by the Southern Power Company. The dam and power house will require about 250,000 yards of masonry. Preliminary specifications for the four waterwheels have been sent out to the manufacturers. W. S. Lee, vice-president and chief engineer of the Southern Power Company, states that the plans for the new station call for its completion in the summer of 1922.

Hetch Hetchy Cost-Plus Contract Is Valid—Work Resumed

The supreme court of California has decreed that nothing in San Francisco's charter prevents the city from entering into a contract on a cost-plus fee basis such as that made with the Construction Company of North America for driving 18 miles of tunnel on the Hetch Hetchy project. The validity of the contract was challenged in a taxpayers' suit filed last May and which placed an injunction on the payment of $276,776, the initial fee due the construction company.

Work on the tunnels was shut down on Aug. 26 by a strike of the tunnel workers, and, pending the outcome of the suit over the contract, was not resumed. With the favorable decision of the court, however, new crews have been brought in and, beginning Nov. 1, the several headings are all being worked.

Rex Starr, sub-contractor for the 8 miles of tunnel on the upper end, has assigned his contract to L. DeLucca. Contract for the 10 miles on the lower end is held by A. C. Dennis.

At the main Hetch Hetchy dam the Utah Construction Company has excavated both abutments from crest level down to water level, opened quarries, built tracks to bunkers, crushers and screens and installed another incline, with a capacity of 40 tons, down to the floor of the valley. The entire foundation of the dam is expected to be exposed, and concrete pouring under way within four months.

New Railway Survey in Manitoba

The Government of the Province of Manitoba has granted authority to the Canadian National Rys. to proceed immediately with a survey for a new line from The Pas to the Flin Flon mining area, about ninety miles northward.

Mississippi River Traffic Held Up For Terminals

(Washington Correspondence)

While two of the new power boats and several of the modern barges built for the Mississippi-Warrior River barge lines have been delivered, Brig.-Gen. William D. Connor, in charge of inland water transportation for the War Department, states that the experiment, so far as operation on these rivers is concerned, cannot really begin until next spring. The full new equipment, it is expected, will be delivered during the winter. Thus far the barge lines have been conducted with makeshift equipment which has literally been wracked to pieces. Operation with that plant, Brigadier-General Connor points out, is in no way indicative of what can be accomplished with equipment especially designed for use on the Mississippi and Warrior Rivers.

Those connected with the barge line experiment feel that the perfection of operation is only a matter of time and that the really important part of the experiment has been successfully concluded—the determination of the fact that tonnage is available in sufficient quantity to justify the operation of these lines. Despite the uncertain service, there never has been a time since the Mississippi barges have been operated that there has not been a superabundance of freight.

Under present conditions the cost of handling freight at terminals is excessive. It averages between $1.25 and $1.50 at St. Louis. The average at New Orleans is slightly less. Plans for the establishment of well equipped terminals are now being perfected. Plans for the terminal at Mobile have been completed and are now in the hands of contractors who are studying them. The plans for the Memphis terminal are well advanced and some work has been done on a plan for improved terminal facilities at New Orleans. It is the intention to develop terminals at Vicksburg, Cairo, and East St. Louis and greatly improve the terminal at St. Louis. A modern coal-loading plant will be established at the head of navigation on the Warrior River.

Water-Works Improvements for Harrisburg, Pa.

Recommendation for improvements and extensions to the water supply of Harrisburg, Pa., made recently by James H. Fuertes, consulting engineer, New York City, are estimated to cost about $1,500,000. The largest single item is $530.000 for a 30,000,000-gal. high-service reservoir. Among the other large items are $270,000 for a new sedimentation basin, six new filters, a 15,000,000-gal. pump, and boilers at the filter plant; some $300,000 for removal of pumps built in 1874, and provision of new pumps; and $285,000 for new water mains. A water bond issue of $1,600,000 was voted Nov. 2.

North Carolina Plans Road Bond Issue Campaign

The two leading good roads associations of North Carolina, the North Carolina Good Roads Association and the Citizens Highway Association, are planning to get together to work for adequate legislation at the January meeting of the State Legislature that will give the state a definite system of highways and sufficient money with which to construct and maintain it. A systematic speaking campaign will be inaugurated under the joint auspices of these two organizations and prominent legislators have been called upon to assist. The Citizens Highway Association has in mind the drafting of a good roads bill, embodying the views of the association, to be presented to the coming session of the Legislature. The bill, it is understood, will ask for the issuance of bonds in sufficient amount, probably $100,000,000, to establish a state system of highways.

Military Engineers To Attend 22nd Regiment Review

Five former colonels and the New York Post of the Society of American Military Engineers are to be the guests of honor at the military review of the 22nd Engineers to be given at 8:30 p.m., Nov. 15, at the regiment's armory, 168th St. and Fort Washington Ave., New York City.

The 22nd Engineers is the first National Guard engineer unit to become federalized, the completion of its federalization taking place Nov. 5. It is partly in celebration of this event and partly as an honor to the retiring colonel of the regiment that the review is to be held. Col. George D. Snyder is the retiring colonel and will act as reviewing officer, and Col. F. E. Humphreys, a graduate of West Point but who is not now in the regular army, is the 22nd's new commanding officer.

Military Engineers Start Drive To Increase Membership

At a recent meeting of the board of directors of the New York Post, Society of American Military Engineers, the membership committee was enlarged as the first step in an intensive campaign to bring into the organization ex-service men and others interested in the national defense. There are now 111 members in the post, and it is estimated that in New York and vicinity, there are from 800 to 1,000 ex-service engineers eligible to membership.

The new membership committee, which still retains as its chairman the chairman of the old committee—Col. T. C. Clarke—is composed of the following men: Cols. O. B. Perry and E. S. Shaughnessy; Lieut.-Cols. Philander Betts, J. P. Hogan, and Evarts Tracey; Majors J. P. Hallihan, Chandler Davis, E. C. Church, Irving V. A. Huie, W. J. Hammer, A. C. Harper, J. W. Mark, and E. E. Sherwood and Lt. A. D Fitzgerald.

Low Bids Received in Trial N. Y. Highway Letting

Thirty-eight bids, each of them below the engineer's estimate, were received upon eleven road construction projects in the trial letting held by the New York Highway Commission Oct. 29. Bids were received upon each of the eleven projects advertised. Six bids were received upon each of two projects, five upon each of three others, three on three different projects and two projects each received one bid each. The projects advertised aggregated 32.91 mi. and are situated in eleven different counties of the state.

On one project the low bid was 8 per cent below the engineer's estimate. The average of the low bids on all eleven projects below the engineer's estimate was 4½ per cent. Another feature in the trial letting was the presence of a comparatively small variation between high and low bids, with three exceptions the high and low bids not varying more than 2 per cent. Among the contractors submitting bids were the names of those now doing extensive work for the state.

It is the intention of the New York Highway Commission, as noted in *Engineering News-Record*, Oct. 28, p. 865, to carry on what winter work it can economically and to let as many contracts as possible during the winter so that construction may start early in the spring of 1921. The trial letting, which has proven quite successful, will doubtless lead the New York Highway Commission to the early letting of many other contracts.

Bill Opposes Publicity for Contracts

Contractors generally are thought to be opposed to Senator Smoot's bill providing for the abolition of the Returns Office in the Department of the Interior. In this office a copy of all contracts made by the War, Navy or Interior Departments is filed in accordance with the statute enacted during the Civil War. The law was aimed at alleged favoritisms in the awarding of contracts during the Civil War. Since that time all contracts made by these departments have been filed in the Returns Office. The law provides that any person may inspect these contracts and that a copy must be furnished for a fee of 5c. per 100 words.

The opposition to the Returns Office is understood to come largely from the Navy Department. Some officials are of the opinion that the disclosures of contracts ought to be discretionary. It is thought to be in the interest of contractors generally, however, that no secrecy be allowed to surround contracts. The Secretary of the Interior has announced his opposition to the bill. He says the existing law should be extended to all government departments. At the same time he suggests that the Returns Office probably should be taken out of his department and made a part of the Treasury Department.

Rivers and Harbors Congress

The annual convention of the National Rivers and Harbors Congress will be held in Washington, Dec. 8, 9 and 10, 1920.

St. Paul Engineers Object to Clause in Registration Bill

The Engineers' Society of St. Paul, at its regular meeting Oct. 11, refused to approve the registration bill as prepared by the Joint Board unless Section 2 is replaced by Section 2 of Engineering Council's bill. The Section 2 objected to states that no no one is prohibited from designing or executing work, provided that his plans and specifications are not signed by the author as "registered" architect, engineer or surveyor.

The history of the proposed Minnesota Registration Law is as follows: Two years ago the local chapter of the American Institute of Architects introduced a bill into the Legislature providing for the registration of architects somewhat along the lines of the present bill. They claimed that the bill was harmless and asked the engineers not to oppose it as no one was excluded from practicing. This bill did not pass.

When the architects joined with the engineers this summer to formulate a joint bill the inclusion of such a clause as Section 2 again came up. The reason given for including it is that, according to legal advice, such is the only way a registration bill for engineers and architects can be passed.

A. R. A. Joint Committee on Automatic Train Control

At the recent meeting in New York of the Joint Committee on Automatic Train Control, which was appointed by President R. H. Aishton, of the American Railway Association, the following officers were appointed: Chairman of the committee, C. E. Denney, vice-president and general manager, New York, Chicago & St. Louis R.R.; vice-chairman for operating division, T. H. Beacom, vice-president and general manager, Chicago, Rock Island & Pacific Ry.; vice-chairman for engineering division, A. M. Burt, assistant to the operating vice-president, Northern Pacific Ry.; vice-chairman for signal division, W. J. Eck, signal and electrical superintendent, Southern Ry., and vice-chairman for mechanical division, J. T. Wallis, chief of motive power, Pennsylvania System.

The duties of the Joint Committee are to confer with the Interstate Commerce Commission, to prescribe rules for tests, and to arrange for actual tests. Under the terms of the Transportation Act the Interstate Commerce Commission has authority to order any carrier, upon two years' notice, to install automatic stops and train control of a design approved by the commission.

Governor's Conference To Consider Housing Problems

Housing problems and the promotion of home ownership will be considered at the State Governor's Conference at Madison, Wis., Dec. 1 to 3. Among the other topics on the program are the Kansas Industrial Relations Court and state incomes and expenses. Miles C. Riley, Madison, Wis., is secretary of the conference.

Cornell Engineers Increase Society Membership

At the meeting of the Cornell Society of Civil Engineers in New York City, Oct. 19, a resolution was passed changing the name of the society to the Cornell Society of Engineers and making eligible for membership not only the civil enginers but also all "persons who have been members of the engineering colleges of Cornell University as students or teachers for a period of one year or longer." This provision will admit to membership all Sibley college men, including the mechanical engineers, electrical engineers and the architects.

The Cornell Society of Civil Engineers had a membership of 1,015, and it is expected that the action taken Oct. 19 will result in forming the largest alumni engineering society in the United States, since those now eligible for membership are three times as great in number as previously.

In 1919, shortly after it was learned that the combination of the engineering colleges of Cornell University was under consideration, the executive committee of the Cornell Society of Civil Engineers began to consider the best way to enlarge the society, and it was decided that action should be taken looking to the admission of all Cornell engineers.

The meeting last week was addressed by Dean-elect Dexter S. Kimball, Cornell University, and by Clifford M. Holland, chief engineer, Bridge and Tunnel Commission of New York and New Jersey.

The following officers were elected for the year 1920-1921: President, Ira W. McConnell; first vice-president, J. Wright Taussig; second vice-president, Prof. Henry N. Ogden; recording secretary, Earl W. Hall; corresponding secretary and treasurer, Carroll R. Harding.

Highway Construction in Illinois Speeded Up

During the five weeks ended Oct. 29, the State of Illinois added to its 1920 highway mileage 77 mi. of federal-aid roads and 30 mi. of state-aid roads, a total of 107 mi. completed for the five-weeks' period. This makes a total of 310 mi. constructed under the supervision of the Division of Highways since Jan. 1, 1920. Illinois still has 158 mi. of uncompleted 1919 and 1920 contracts. All of this mileage is hard surfacing.

Devil's Gate Flood Control Dam Completed in Pasadena

The Devil's Gate Dam, a unit of the Los Angeles County flood control system, was completed in October. It is located on the Arroyo Seco, a flashy winter stream tributary to the Los Angeles River, in the City of Pasadena. The dam has a maximum height of about 120 ft. above bed rock, is arched in plan, has a crest length of 310 ft., with a roadway and two sidewalks across the top. It is built of masonry and has an outlet near the bottom, a tunnel outlet through the mountain and a regulator-spillway. J. W. Regan is flood control engineer. Notes on the dam appeared in *Engineering News-Record*, Feb. 13, 1919, p. 351, and March 6, 1919, p. 315.

Montreal Bridge Plan Considered

A meeting held at Montreal, Nov. 2, under the auspices of the Central Montreal Terminal Co., failed to attract any enthusiastic representation. The chairman, C. N. Armstrong, explained the purpose of the meeting as being to give those interested in a St. Lawrence River bridge project an opportunity to express their opinions. The company, formed in 1890, was prepared to erect a fifteen-span bridge, he stated, the bridge to be 5,000 ft. long and to provide for two railway tracks, two vehicle roadways, and two footways. This structure would reach Papineau Ave. for vehicle and passenger access, the railway level extending to Ontario St. The company has acquired real estate for the project and is expecting to ask for government subsidies. It has claimed to have exclusive right for the construction of a river crossing at Montreal, and considers the present public sentiment in favor of a crossing to entitle it to public support. The principal officers of the company are C. N. Armstrong, president. F. E. Cae, secretary, E. R. Lafleur, chief engineer.

Engineering Council Urges Engineer for Shipping Board

An effort will be made by Engineering Council to secure the nomination of an engineer as a member of the Shipping Board. It is possible that names may be submitted to the President in each of the geographical divisions of the coast. The act provides that these divisions must be recognized in the selection of Shipping Board members. The divisions of the coast usually accepted are: North Atlantic, South Atlantic, Gulf, Pacific, and Great Lakes.

It is believed that the President will withhold his nominations for the Shipping Board until Congress has remedied its oversight in failing to provide for an appropriation for the salaries of the members. A recent publication of a list of names purporting to be those that the President would nominate, was declared to be entirely unauthentic at the White House.

American Road Builders To Hold Annual Meeting

The annual meeting of the American Road Builders' Association is to be held at the Automobile Club, New York City, the afternoon and evening of Nov. 15. Election of officers will be held in the afternoon and, after a dinner at the club, committee reports will be received and informal discussions will be heard on various phases of the road construction situation. A meeting of the executive committee will be held immediately preceding the annual meeting that is scheduled for 3 p.m.

The ballot that has been prepared by the nominating committee follows:

President, M. A. Faherty, chairman, Chicago Board of Local Improvements; vice-president, Northeastern District, J. A. Duchastel, city engineer, Outremont, Canada; vice-president, Southern District, Lieut.-Col. H. L. Bowlby, Bureau of Public Roads; vice-president, Central District, Robert C. Terrell, state engineer, Oklahoma; vice-president, Western District, S. Benson, chairman, Oregon State Highway Commission; secretary, E. L. Powers, editor of *Good Roads;* treasurer, Senator James H. MacDonald, former Connecticut State Highway Commissioner.

The directors proposed are:

Irving W. Patterson, chief engineer, State Board of Public Roads, R. I.; William R. Smith, president, Lane Construction Corp., Meriden, Conn.; John Swan, director of public works, Pittsburgh; J. H. Cranford, president, Cranford Paving Co., Washington; W. G. Sucro, Baltimore County Roads Engineer, Md.; W. A. McClean, Deputy Minister of Highways, Province of Ont., Canada; and A. B. Fletcher, state highway engineer, Cal.

Rail Guarantee $656,000,000

According to figures made public by the Interstate Commerce Commission, Nov. 2, $656,000,000 will have to be provided by the Federal Government to pay the railroads the guaranteed return under private operation for the period March 1 to Sept. 1, 1920. The railroads suffered an actual deficit of $206,000,000 during this period and the Treasury must pay them $450,000,000, the amount of the guarantee provided in the Transportation Act.

Montreal Street Tunnel Planned

A proposal for a street tunnel under the Champ de Mars and Jacques Cartier Square has been made to the Chambre de Commerce by Joseph Girard. A committee of the Chambre did not endorse the project, but recommended that it be forwarded to the city's administrative commission. The plan is for a tunnel from Craig St. to the harbor front, to enable up and down traffic to avoid the congested territory between.

Major Jenny Speaks at Allied Machinery Smoker

Major J. A. Jenny, who accompanied Gen. Pershing to France when the vanguard of the American Expeditionary Forces sailed early in 1917, was the principal speaker at a smoker given at the Allied Machinery Center, New York City, Oct. 29. He discussed port construction, storage depots and construction and maintenance of light railways in the forward areas.

Civil Service Examinations United States

For the Civil Service examinations listed below apply to the Municipal Civil Service Commission of the City of New York, Room 1400, Municipal Building, New York, N. Y.

Assistant Engineer, Grade C. Bureau of Buildings, $2,160 to $2,760 a year. Applications received until Nov. 17.

Junior Draughtsman, Grade B. Salary $1,560 to $2,160 a year.

For the United States civil service examination listed below apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the Civil Service Commission.

Senior Engineer, Grade 2, $2,100 to $2,700 a year.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ROAD BUILDERS ASSOCIATION, New York City, Nov 15, 1920.

FEDERATED AMERICAN ENGINEERING SOCIETIES New York; Washington, D. C., Nov. 15-19.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS Washington, D. C.; Washington, D. C., Dec. 13-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City, Jan 19, 1921.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. 25-27.

The American Society for Steel Treating announces that a chapter has been formed in Syracuse, including in its membership some of the most prominent men of the local steel industry. Its officials include the following, the first two named being president and secretary: Howard J. Stagg, Halcomb Steel Co.; W. F. McNully, New Process Gear Corporation; F. C. Raab, Brown-Lipe-Chapin Co.; L. M. Sonner, H. H. Franklin Mfg. Co.; R. C. Gebert, Hammond Steel Co.; P. A. Hopkins, Penn Spring Works; E. D. Newkirk, Onondaga Steel Co.; O. L. Van Valkenburg, Crucible Steel Co.

The Colorado Society of Civil Engineers, at its monthly meeting Oct. 28, passed resolutions recommending the construction of the three proposed tunnels, passage of the educational amendment and the issuance of bonds to be used in the construction of state highways.

The Oklahoma Society of Engineers at the annual meeting held in Tulsa, Oct. 26-27, by previous arrangement resolved itself into the State Engineering Council. All engineering organiza-

tions in the state were invited to send committees to the meeting to consider jointly matters of legislation and to effect a permanent organization. The engineers' licensing bill and a salary schedule for highway engineers in the state were agreed upon. A bill to strengthen the special assessment paving law was referred to counsel. The engineers recommended the construction of an Engineering Building at the State University to cost $500,000 and recommended the strengthening of the Engineering Department of the State Board of Health. The officers elected for the coming year were: President, George J. Stein, Miami, Okla.; vice-presidents, V. V. Long, Oklahoma City, B. E. Clark, McAlester, and B. F. Lewis, Enid; secretary-treasurer, Donald Witten, Tulsa.

The San Francisco Engineer's Club. at its meeting Oct. 29, elected the following officers: President, J. E. Woodbridge; secretary, C. H. Snyder.

The Pittsburgh Chapter, Am. Soc. C. E. held its annual meeting Oct. 25. Harlan Bartholomew discussed "Zoning as Applied to City Planning." The following officers were elected: President, N. S. Sprague; vice-president, Paul L. Wolfel; secretary and treasurer, Nathan Schein.

The Engineering Society of Buffalo announces the following meetings: Nov. 16, American Chemical and Electrochemical Societies, joint meeting at Niagara Falls, N. Y.; Nov. 23, American Institute of Architects—Oswald Stein will give an illustrated talk on the "Manufacture and Possibilities of Terra Cotta"; Nov. 30, Society of Automotive Engineers.

Personal Notes

MAJOR H. F. CAMERON, recently commissioned in the Corps of Engineers, U. S. A., has been assigned to duty as assistant to the District Engineer on the construction of the Wilson Dam at Florence, Ala. During the World War he served with rank of lieutenant colonel, Engineers, U. S. A., as chief of the Machinery and Engineering Materials Division, Director of Purchase and Storage, Quartermaster Corps at Washington. Major Cameron's previous experience included a number of years' service in the Philippines for the J. G. White Co. and on Government waterworks and highway construction.

A. R. MANN, formerly president Western Canada Shipbuilders, Ltd., has been elected president of the Northern Construction Co., Winnipeg.

ALFRED M. BARRETT, deputy commissioner, Public Service Commission, First District, New York, and previously superintendent of highways, Borough of Queens, has been appointed Public Service Commissioner for this district to succeed Lewis Nixon, resigned.

H. N. ANDREWS, recently with the engineering department, Youngstown Steel Co., Youngstown, Ohio, has accepted a position with the Wheeling Steel Corporation, Wheeling, W. Va., in its engineering department.

A. L. DIERSTEIN, recently connected with the U. S. Engineer Office, Washington, D. C., has accepted a position with Yeager & Sons, contractors, as engineer in charge of construction of a concrete highway bridge at Danville, Ill.

DAVID F. STOCKBRIDGE, formerly with the Koppers Co., Pittsburgh, Pa., is now chief engineer of The Briggs Company, Lansing, Mich., dealers in building material.

M. R. THORNE, recently general superintendent of the Arthur McMullen Co., New York City, has taken a position with the Atmospheric Nitrogen Corporation to supervise the construction of its plant at Syracuse, N. Y.

J. WALTER ATLEE, recently with the Virginia Railway Co., has accepted a position as office engineer with the C. H. Mead Coal Co., Buckley, W. Va.

NEELY J. CROMER, civil engineer, has accepted a position with the South Carolina State Highway Department at Lanes, S. C.

GEORGE LAUTZ, recently chief engineer of District 1 of the U. S. Forest Service, has been appointed assistant to T. W. Norcross, chief engineer of the U. S. Forest Service in Washington, D. C.

W. PAXTON, formerly with the Goodyear Tire & Rubber Co., Akron, Ohio, has been appointed consulting engineer for the city of Akron in connection with the handling of city garbage and street cleaning.

OTTO S. HESS, district engineer of the Michigan State Highway Commission, has been appointed managing engineer, Kent County Road Commission.

HENRY EXALL ELROD, formerly valuation engineer, Houston, Tex., has been appointed valuation engineer by the city of Dallas to investigate and report concerning the properties of the Dallas Telephone Company.

MANLEY OSGOOD, formerly city engineer of Ann Arbor, Mich., has accepted a position as manager of the Ann Arbor Asphalt Co.

W. G. CHASE, consulting engineer, Winnipeg, and chief engineer of the Winnipeg Aqueduct, has been appointed consulting engineer to the Saskatchewan Water Commission.

H. E. ECKLES, civil engineer, formerly connected with the Board of Local Improvements, Chicago, has accepted a position as assistant engineer on electrification development connected with the depot and terminal electrification project of the Illinois Central R.R., Chicago.

EUGENE H. PADDOCK, recently assistant sanitary engineer in the U. S. Public Health Service, has accepted a position as resident engineer with the Tayford Company, Inc., Lee, Mass., on a hydro-electric development project.

J. R. SHERMAN, recently employed by the Braden Copper Co. on construction work in Chile, has been appointed engineer for the Kittitas Reclamation District in Washington.

MAJOR GEORGE A. LEWIS of Auburn, N. Y., has been named chief engineer and superintendent of the Auburn Water Board to succeed L. B. Cleveland, resigned.

A. E. FOREMAN has resigned as chief engineer, Department of Public Works, Victoria, B. C., Can., to enter private practice.

JOHN T. SCULLY has opened an office in Cambridge, Mass. In addition to engineering construction he will engage in real estate development by selecting sites best adapted to his clients' requirements and giving the benefit of expert service in the construction of his plant.

F. L. FELLOWS, city engineer, Vancouver, has been appointed consulting engineer to the Saskatchewan Water Commission.

T. W. FATHERSON, engineer maintenance of way of the Chicago Great Western R.R., with headquarters at Des Moines, Iowa, has been appointed superintendent of the Western division with headquarters at Clarion, Iowa.

Obituary

PERCY B. TAYLOR, consulting structural engineer, died Oct. 21 in Newark, N. J. He was born in Manchester, England, in 1865. He came to this country in 1873 and was connected with Cyrus Currier & Sons and the Taylor-Martin Co., of which he was the head. In 1897 he entered private practice as a consulting engineer in factory construction and affiliated branches of engineering. He designed many industrial buildings for concerns in Newark, including the United Color and Pigment Co., Heller & Merz, Amalgamated Dyestuffs Co., and the American Oil & Supply Co.

DANIEL A. CURTIN, civil engineer, died Nov. 4 in New York. He was for many years employed by the City of New York and previously was chief engineer for the Park Department of Brooklyn.

JOHN B. BENTON, who prior to his retirement from civil engineering work was president of the Benton Manufacturing Co., died Nov. 5 in Union Springs, N. Y. He was 85 years old. He had served as division engineer on the construction of the Erie Canal.

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Engineering News-Record

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. Mehren, Editor

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Better Freight Yards

IN THE broad scheme of railway improvement which must be undertaken to obtain increased speed economy and efficiency in transportation, one of the principal items will be freight yards with better facilities for quick switching movements. In some cases new yards will be established, in the design of which the engineer will have a free hand. Far more general will be the improvement and enlargement of present yards, where conditions of traffic and area are limiting factors in layout revision—as at Lincoln, Neb. (See p. 996.) As a typical case this revision is worth careful study.

Bond Election Results

LATER returns of votes cast Nov. 2 on state and municipal bond issues justify our comments of last week to the effect that the mass of the people, through their willingness to vote money for public improvements, have renewed confidence in our industrial future. True, it now appears that in several states constitutional amendments authorizing road bond issues failed, as did the proposed state railway tunnel bond amendment in Colorado, but a large total of state bonds—principally for roads—carried. A full knowledge of conditions affecting some of the defeated state bond proposals would probably show that if any error of judgment had been made it was due to mixed issues or to a conservatism deserving at least as much praise as blame. Discrimination in voting on bond issues is commendable.

End of Car Shortage in Sight

WHEN car reports for the current week are published the country may find that the end of car shortage has virtually been reached by a return to normal conditions. For the week ended Oct. 30 the excess of car requisitions over the supply was 55,412, compared to 65,965 for the preceding week. Of the reported shortage approximately 17,500 cars are represented by loads held awaiting export shipment. The worst average condition following the switchmen's strike was represented by a shortage of approximately 145,000 cars. Since that time movement and loading have steadily risen and more recently have been accelerated by the 30-miles-per-day-30-tons-per-car program of the Association of Railway Executives, until car loading passed the million mark during the first three weeks in October. The record is one of unprecedented accomplishment, with great credit due the railroad managements. For the last week in October a decrease of 26,000 in cars loaded was noted, indicating an actual falling off in traffic, further borne out by subsequent estimates. Evidently the backbone of the car shortage situation has been broken, but, according to Interstate Commerce Commissioner Aitchison "what has been done was first aid and not a cure."

To Facilitate Interstate Engineering

ENGINEERS will heartily welcome the National Council of State Boards of Engineering Examiners which unostentatiously came into being Oct. 7 in Chicago (see news pages). Interstate business of consulting engineers has already been subjected to annoyance if not actual curtailment because of the lack of workable reciprocity clauses and uniformity of requirements for license or registration, and such troubles will increase as registration spreads. The new organization proposes to iron out these difficulties and make the engineering service throughout the United States as fluid as the interpretation of the various laws will permit. Seven states are now represented in the council and it is hoped that the other four states which have license or registration laws will follow suit. Until a uniform law can be secured in all the states—a long hard task, if ever achieved—uniformity in administration should be the aim. The provision for uniform examination already made in Illinois and Michigan should be extended to other states.

"Low-Grade" Tonnage Rates

DURING the period that the recent flat percentage increase in railroad freight rates has been in effect, complaint, and we believe just complaint, has been made by shippers of some "low-grade" materials which are very largely subject to the short haul since they originate in many sections of the country and cannot compete in long-haul trade. The construction industry has felt the effect of such rates acutely because so many of its materials fall in this class. While the general advance in rates since 1913 has been about 101 per cent, the percentage increase on some low-grade, short hauls has been much more. This resulted from the Director General's order No. 28, during Federal control, by which short-haul rates were increased in amounts ranging up to 50 per cent, though the general increase was only 25 per cent. The effects of this order have been accentuated by the recent blanket percentage increase. Now, for instance, the increase on the minimum short-haul rate on sand and gravel is 142 per cent greater than the 1913 rate, while the general increase is only 101 per cent. Since the terminal cost of handling low-grade tonnage is usually very much less than the handling costs of most other commodities—particularly where cars must be made up and broken at more than one point—there is good ground for complaint respecting existing rates on certain low-grade short hauls. The Interstate Commerce Commission had to take such quick action in the recent increase that it was impossible to go over the whole rate structure. However, some low-grade tonnage, such as iron ore, did receive consideration. Now the case of other low-grade commodities should be taken in hand. Equitable adjustment is possible, without impairing railroad income, by placing the burden where it can better be borne.

Why Let India Surpass Us?

INDIA is a land of cheap labor and it is not an industrial country, yet one of its government reports asserts that "the whole industrial future of India is bound up with and dependent upon the provision of cheap power." On the basis of this need further detailed attention to India's water power is urged—in the report reviewed elsewhere in this issue—and, judging from previous policy, that attention will be forthcoming, backed up with the necessary government funds. A significant sidelight on water-power development in the United States is that British engineers in reporting on power sites in far-away India cite the fact that the United States has utilized only 24 per cent of its available water resources and compare this with the 43 per cent developed in Germany. In a country as young, comparatively, as the United States it is not to be expected that we would have a high percentage of development but by this time we certainly should have very definite and exhaustive information about water-power resources. It is a pity that so great an industrial country as the United States, where labor costs have been on the increase for years, where modern civilization demands almost universal use of power, particularly electric power, and where water-power sites are many and easily accessible, should be so far behind in water-power investigation.

Friction Heads in Hydraulic Dredging

QUANTITATIVE knowledge of friction heads is of great importance in hydraulic dredging operations. Recognizing this fact, what engineer can put his hand on a published record which contains accurate and comprehensive values of friction heads where mixtures of earth and water are being pumped? In some way it has come to be assumed that at ordinary dredging velocities of 12 to 15 ft. a second the friction head in pumping earth and water is about 4 ft. in 100 ft. Obviously this cannot be true of all mixtures regardless of the character of the earth, stream velocity, percentage of solids carried and pipe size and alignment. Yet almost no test information is available as basis for more precise assumptions. Under these conditions the tests of P. J. McAuliffe, described on p. 988, form a notable contribution to our stock of data, even though the tests were somewhat crude. As such data accumulate hydraulic dredging practice is likely to see much development in its detail practices. For example, the observations made during the hydraulic-fill operations of the Miami Conservancy District (described in our issues of Sept. 9, 16 and 23, 1920) were such as to show that it will pay to take great care in the layout of pipe systems. In that work a friction head of 4 ft., found in pumping fine glacial till and clay, was about the minimum; ordinary drift of clay, sand and gravel required a head of 6 to 8 ft., while with heavy, harsh glacial sand and gravel the heads rose to 10 and 12 ft. Friction losses as high as this place a heavy penalty on pipe-line lengths and on bends and irregularities. In similar manner any other quantitative study of pumping is likely to lead to more efficient planning of work. Mr. McAuliffe's contribution tends toward progress of this kind. In addition it contains some interesting suggestions, among them that friction may decrease when the flow velocity is increased—a phenomenon of interesting possibilities.

The Refusal to Enter the Federation

LAST week's decision of the American Society of Civil Engineers to refrain from joining the federation creates a situation which may easily lead to unfortunate antagonisms. On the one hand, the societies in the federation may be sharply critical of the civil engineers. The civils, on the other hand, may be inclined to stand off and be indifferent to the federation's success or failure. Such attitudes would intensify the rift and prevent intercourse that would eventually remove the obstacles and permit engineers to present a unified front.

There is, we believe, unanimous demand for some sort of federation, or association, or committee to tie the engineering influences of the country together. Some believe it should be a strong organization, others that a loosely formed committee will suffice, still others that only a clearing house is needed. But while opinion may differ on the form of association we have yet to meet the engineer who believed that no centralizing organization was needed.

That some type of organization is demanded, therefore, is the premise of the argument. If the new federation should fail it would be a serious blow to the possibility of engineers getting together; the present members would be discouraged and would be unwilling to unite on any further venture. Whatever the civil engineers may think as to the defects of the federation, no matter how greatly they believe it must be changed before they can participate in its activities, they should, nevertheless, regard it as the nucleus of the organization through which all engineers will eventually function together. The changes may divest it of all resemblance to its present self, but it must be the nucleus unless there is to be discouragement that will long prevent the forming of an effective organization.

On the other hand, the federation needs to take serious thought of the objections of the civil engineers to the end that those objections in so far as they may be found valid may gradually be removed. Compromise now would seem impossible. The federation must begin to function and through its functioning discover its deficiencies and its strength. Then only can the correctness or fallacy of the civil engineers' contentions be determined.

The American Association of Engineers, if we have correctly sensed its attitude, is an illustration of what a benevolent neutrality might be. The association will not join the federation. On the other hand, it will not attempt to set up antagonisms. It has signified its willingness to co-operate with the federation where the interests are mutual. Such a relationship will be favorable to the modification in time of one or both the organizations—to consolidation possibly—to whatever may be to the best interests of the profession.

Finally it will be well for all parties to remember that the vote of the civils on the federation may have been much influenced by the society's internal situation. The amendments, the federation itself, the proposal to enter the federation and the coming election of officers are all intermeshed. We are not prepared to say that the result would have been otherwise had the federation proposal stood alone, but we are sure that the recent balloting was accompanied by prejudices awakened by other issues. Later it will be possible to weigh in calmer mood the proposal to work with other societies.

That there may be calmness, that there may be, some years from now, a mending of the present rift, it is important that the attitudes of the federation and of the American Society of Civil Engineers toward each other be one of sympathy and one that will in all things make for mutual understanding.

Successful Prophecy, and the Future of Rail Quality

SOME years ago railway rails were failing at an uncomfortably rapid rate. Traffic had been growing heavier, and rails had not been getting better in due proportion. Perhaps the conscience of public and railway engineers had become more sensitive, too—at all events the rail problem was made a matter of anxious study. Not long after this study began, M. H. Wickhorst, one of the engineers engaged in it, predicted that progressive improvement in the matter of rail failures might be expected, and he sketched a curve showing how rail failures would decrease during the next half dozen years; in effect he predicted that by 1921 or 1922 nine-tenths of the rail failures would be eliminated, as compared with ten years before. Mr. Wickhorst has qualified as prophet, for the 1919 record of rail failures, just published, shows an amazingly accurate agreement of the actual failures with the curve he forecast; 80 per cent reduction in failures has already been attained. The physical phenomena of rail service and failure are exceptionally intricate and erratic, and no law governs the improvement that has been recorded, yet the prediction and the verification are such as would be eminently satisfying even in the case of a sequence of events following definite laws.

Fully as surprising as the outcome of the prediction is the fact that no one knows how the improvement in the rail situation was brought about; or, at least, no one has yet told. It did not result from more precise specifying of quality, for rail specifications have not changed essentially. Nor is more careful inspection a probable factor. It seems necessary to conclude that the improvement was brought about in part, if not wholly, by persistent effort of the steel-mill men themselves—due perhaps to the spur of publicity, since the yearly publication of the scores made by the different mills tended toward competition for the best showing. The competition could only supply a motive, however, and it remains a secret what means the mill men employed to improve their rails.

More care in the melting and rolling of rail steel was a factor—that much may be taken for granted. For during the war years, when manufacture was inevitably hurried and less careful, and when attention was concentrated on products other than rails, the scores became poorer. Still, it should be possible to express this intangible "carefulness" in terms of measurable quantities; we cannot safeguard ourselves against a return to the more dangerous rails of ten years ago merely by pleading with the producers to be careful! We must translate our request into terms of procedure to be followed, properties desired, or tests to be met. This may become possible when the steel men reveal the secret of their campaign for rail improvement, a story that will doubtless be interesting in more ways than one.

Meanwhile, however, a mystery remains, one on which the whole future of rail safety may depend. The mystery lies in the fact, clearly proved by the statistics, that most rails are safe, while nearly all the early failures are localized in a small minority of the mills' rollings. Out of, say, a dozen lots of rail produced by a given mill in one year, each lot comprising thousands of tons, most of the failures developing during a given period of service are assignable to two or three lots, while the others come through the same number of service years with almost no failures. This fact points to a critical difference between separate lots of rails. Most of them are not merely good but extremely good while a few are extremely bad. If it were possible to discover why these occasional lots are bad, a sudden gain in rail safety would be within reach.

Now, there is no reason to believe that all of the rails in one of these lots contribute to the failure epidemic which marks that lot as abnormal. Indeed, there is no reason to believe—except because the statistics happen to be assembled that way—that *the lot as such* is abnormal at all. Probably a few small component parts of the lot, a few furnace-heats, are abnormal. There is no variation of procedure as between lots, nothing that would cause one entire lot to be bad and another good. If the small chance changes in the items of mill operation were responsible for the occurrence or non-occurence of rail failures, then the failures would be distributed over all rollings according to the laws of chance, either uniformly or according to the probability curve.

In fact, when the rail record of any one mill is studied the failures are seen to be distributed in so abrupt and spotty a way among the consecutive rollings that they cannot be due to any element of procedure which remains constant or nearly constant throughout the course of a rolling. Whatever the cause that produces bad rails, it can occur only rarely in the course of the rolling of a 1,000-ton lot—the minimum reported in the official statistics—but evidently is of strong effect when it occurs. This meteoric incidence seems to center the responsibility on the heat as a unit: one or a few individual heats in the course of a rolling are defective.

To restate this conclusion: the abnormal number of failures which the records charge against a given rolling should, instead, be charged against a few furnace heats out of the many comprised in that rolling. While this could be proved or disproved readily were rail failures reported and grouped by heat number, we must for the present be content to accept it as a conclusion having a high degree of probability in its favor. And, as it has the merit of indicating the most promising point of attack on the rail problem, it may claim to be the best working theory available. This point of attack is furnace and ingot-casting practice. So soon as that practice is made uniform heat epidemics of rail failures can no longer occur.

Hitherto studies directed toward the improvement of rails have ranged over the entire field from steel furnace to railway track. Blame has been placed by one investigator on high carbon, by another on premature or too rapid rolling, by others on one-sided cooling, on kinking in the straightening press, on excessive wheel loads from locomotives, on cold weather and frozen ballast, and so on without end. But if the present discussion of the case is sound, most of these indictments may be dismissed, since the ingot itself contains the seed of future rail destruction, regardless of rolling mills, wheel loads and weather. It is in study of the ingot, then, that the best promise lies for early progress in the improvement of rail quality.

Army Engineers Build New Highway Bridge Across Potomac

Concrete Structure at Washington, D. C., Replaces Old Aqueduct Bridge—Ribs Poured on Steel Arch Centers Floated Into Place on Scows

ONE of the largest concrete bridges now under construction in the country is being built by force account by the Corps of Engineers, U. S. Army, across the Potomac River at Washington, D. C., to take the place of the old Aqueduct Bridge which has been in existence for more than eighty years. Congress has officially named this structure the Georgetown Bridge. It was known originally as the Key Bridge, its Georgetown approach being near the home of Francis Scott Key, the author of the "Star Spangled Banner." While it has no outstanding features of structural novelty, the methods of construction are interesting, particularly the use of centers made up of steel arches which are built on scows and floated into place.

The old Aqueduct Bridge crosses the Potomac River between Georgetown, D. C., and Rosslyn, Va. It was built from 1832 to 1840 under the direction of Major Turnbull, of the United States Army, for a combined roadway and an aqueduct carrying the Chesapeake & Ohio Canal across the river. The United States purchased the structure in 1886, and in 1888 the timber aqueduct was removed and an iron deck truss erected in its place. There has been for a long time trouble with the pier foundations which have required constant attention and maintenance, and the bridge structure itself is quite inadequate to carry the heavy traffic which now passes between Washington and its Virginia suburbs.

By act of Congress, May 18, 1916, the construction of a new bridge to replace the Aqueduct Bridge was authorized, $150,000 was appropriated for surveys, plans, estimates and for the purchase of necessary land for approaches, and $1,000,000 was authorized for construction purposed. Since that time the sum of $2,100-000 has been fixed by Congress as the authorized cost of construction. As the bridge crosses a navigable river between the District of Columbia and a State it comes under the jurisdiction of the United States and the construction was assigned to the Corps of Engineers.

Surveys made soon after the initial appropriation led to the location of the bridge, as shown in one of the drawings, at a point east of the present structure and on such an angle thereto that the Washington approach is one city block east of the old Washington approach, while the Virginia approach intersects that of the old bridge 100 ft. south of the south abutment.

Reinforced concrete was selected as the material for the structure. The total length, including approaches, is about 2,700 ft., and the length of the masonry structure proper, about 1,450 ft., which length is made up of a central 208-ft., arch over the center of the

THE GEORGETOWN BRIDGE ACROSS THE

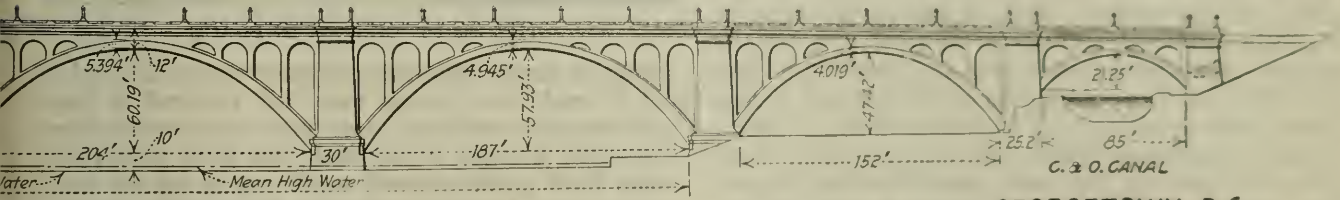
CONSTRUCTION OF GEORGETOWN BRIDGE IN LATE OCTOBER
Looking toward Washington on North Shore

channel with arches on either side 204 ft. and 187 ft., and approach arches of 152 ft. and 85 ft., the latter being over the Chesapeake & Ohio canal, on the Washington side.

The depth of water in the river is about 22 ft. and fairly uniform over the entire area. The rock surface varies in depth from 24 to 26 ft. below mean low water, and the normal range of tide is about 3 ft. High freshets are of infrequent occurrence and short duration, but they do attain a considerable height at times. During the freshet of June, 1889, for instance, the water reached 19.5 ft. above low water, this being the maximum of which there is any record. Extensive rock excavation, including core borings at each pier and abutment, shows a solid Potomac gneiss formation which carried no open seams.

The bridge is 70 ft. wide from out to out of cornices, which allows for a double-track electric line, two 16-ft. roadways, and two 8-ft. sidewalks. Street cars are a solid reinforced-concrete arch, the reinforcement, however, not being exceptionally heavy, as shown in the details of the 208-ft. arch given herewith. The ribs are braced across at intervals of about 20 ft. with transverse beams 18 in. wide and nearly the depth of the arch ribs. The roadway is supported on spandrel posts 48 in. in the line of the bridge and 36 in. transverse to the bridge. Two of these posts are on each side rib and three on the center rib, the posts being connected by a cross-wall 12 in. thick. They support the roadway, which is of combination I-beam and reinforced-concrete construction as shown in the detail.

The main feature of this floor is the small posts placed on the spandrel walls which are connected by I-beams incased in concrete. Above this is the structure proper, which is built in to accommodate the yokes of the underground trolley street car system. This particular form of construction was made in the



OMAC RIVER AT WASHINGTON, D. C.

GEORGETOWN, D.C.
NORTH

to use the central conduit system common in the City of Washington, which fact requires a somewhat unusual floor system arrangement, as shown in the drawing and described hereinafter. The height of the bridge above the river at midstream will be about 85 ft., and the elevation of the bridge at shore abutments 79 ft., allowing a clear waterway at the center span of 72 ft., at the second spans of 70 ft., and at the short spans of 68 ft. There is little navigation at this part of the Potomac River, except for pleasure craft, as tidewater stops at Little Falls, about two miles upstream.

The structural design of the several arches is consistently the same, except for the variations due to dimensional differences. The river piers are of solid concrete up to the top of the springing line of the arches, above which point the piers separate into three shafts corresponding in width to the three arch ribs. The abutments are of similar design, except that they are founded on solid rock above water and they are further extended by counterfort reinforced-concrete retaining walls to retain the fill.

The details of these retaining walls are shown in one of the drawings. They consist of thin walls, attaining a maximum height of about 55 ft. and of a thickness varying from 20 in. at the top to 30 in. at the bottom, reinforced as shown against bending and resting on reinforced-concrete precast pile footings. The walls are held in position against the outward thrust of the retained fill by continuous counterforts running clear across the abutments. These counterforts are concrete walls reinforced in both directions as shown. The roadway as well as the approach is carried on an earth fill inside the box.

As stated, the arches are of the three-ribbed type, the inner rib being 21 ft. wide and the two outside ribs each 11 ft. with a 3-in. showing corbel, the clear space between the ribs being 11 ft. 6 in. Each rib is original design in order to utilize some I-beams which were used in the cofferdams in building the piers. There is now under contemplation, however, a change of the design whereby an ordinary jack arch system of floor supports is used. Expansion joints in each arch are provided at one end of each of the spandrel arches, as shown in the drawing, and a double floor post support is provided at each joint.

The river piers were all built within cofferdams which were pumped dry before any of the excavation inside of them was made or any of the concrete placed. These dams were in about 22 ft. of water with a covering of 3 to 4 ft. of mud over the rock bottom. No difficulty was found in laying them dry or in keeping them dry. The uniform practice in the construction of the cofferdams was to frame the bracing of the dam, which was about 40 x 100 ft., in plan, complete on the shore and float this framework to its proper location, where it was sunk into place by loading. The sheathing for the dam was then driven. This sheathing consisted of sections made up of a composite of 12-in. I-beams with 5 x 5-in. timbers bolted to 7-in. channels with their legs turned inward, as shown in the detail drawing. It was found quite easy to drive this type of sheathing in place in the small bite in the mud which it had to take. The I-beams were subsequently used in part of the falsework to the bridge, and will be used in the floor superstructure. They are readily pulled and are now on the job straight and quite reusable.

In concreting the cofferdams for the base of piers the earlier piers had form boxes placed around the lower bracing and concrete was poured in pockets made by these boxes up to a point well above the lowest wale and its cross-bracing. In the last pier which was placed, however, the concrete was poured uniformly up to the base of the lowest wale and its cross-braces, when that whole system of bracing was removed and the

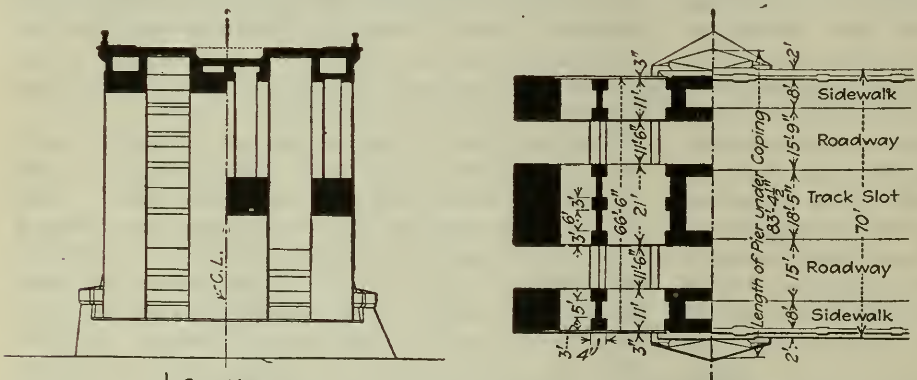
concrete already placed used as a backing for the braces of the lowest wales of the dam. The succeeding concrete was poured in stages from wale level to wale level, each line of braces being removed as the concrete reached it. It was found that the work could be done more rapidly this way than by the earlier method.

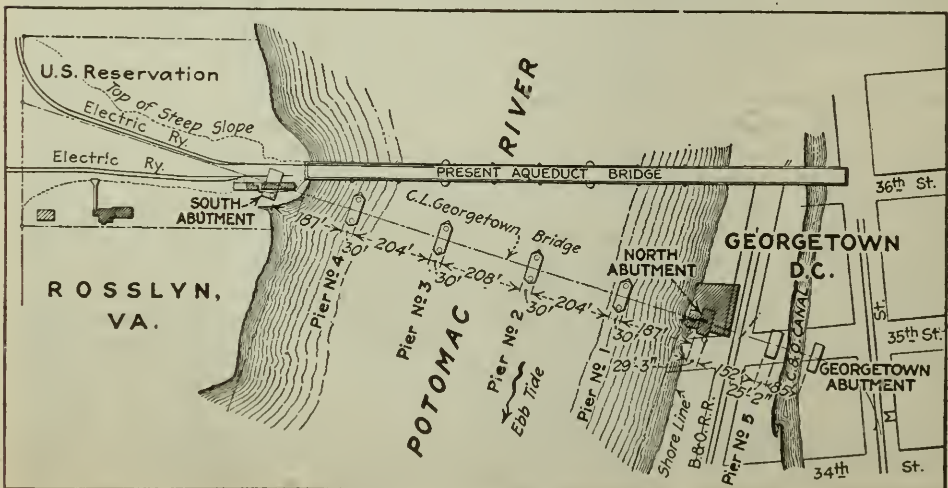
The abutments were placed in the dry, excavation being made behind timber sheetpiling. Pier 5, which is just south of the Chesapeake & Ohio canal, is in the south wall of that canal. This is an old rubble wall with earth fill and not at all stable. It was necessary, therefore, to place this pier in two halves, the southerly half being completed and used as a support for shoring before excavation was carried through the northerly half to the canal edge. The canal was retained during this latter excavation and during the placing of the concrete in the pier behind a straight sheetpile wall made up of the I-beam and channel combination sheathing.

Special consideration was given to the matter of centering for the arches. While floods in the Potomac River are occasional, still the spring ice danger is quite marked. Jams have been known to occur which piled up the ice near the old Aqueduct Bridge and sudden thaws cause floods and ice battering which would be extremely dangerous to any supported centering. Steel arch ribs spanning the piers were therefore decided upon, but it was some time before a final decision was given as to the proper method of erecting these ribs. Finally it was decided that it would be more economical to erect the ribs on a timber trestle mounted on scows and float the scow into place between the piers with the tide. While this required a considerable amount of timber falsework for the erection, it was felt that it would save money over that required to have large derricks erected on each pier which would have to be used to swing a half arch into place were those arches built by the method sometimes in use for steel arch centres. Another alternative of having the arches swung into place from a heavy floating derrick was abandoned because of the impossibility of getting such a derrick or high cost of building one.

THE 208-FT. CENTER IN PLACE

Full centers for the arches are used only for the 208-ft. and 204-ft. spans. In the 187-ft. span the lowest panel of the rib is removed and for the 152-ft. span the lower two panels are removed. The method used is shown in the accompanying views and drawings. Eight steel arch rib centers, built by the Blaw-Knox Co., are supplied for the work. These are put together in groups of two, each group forming a support extending over the entire rib width. Two sets of two trusses each form the centers for a single arch and are to be used successively, first the group of two being used under the center 21-ft. rib and after that has been cast the set on either side is to be moved sideways to form the outside 11-ft. rib. One complete set is to be used under the 208-ft. and the two 204-ft. arches, and another complete set under the two 187-ft. and the one 162-ft. arches. The 85-ft. arch will probably be concreted over fixed centers although the design of the centering permits it being adapted even for this small arch. The general details of the steel





BOX ABUTMENT AT SOUTH END OF GEORGETOWN

centers are shown in the accompanying drawings of the complete set for the 208-ft. arch. The design is peculiar only in the adaptation of the standard to the varying span lengths. Thus the full size rib is used for the 208- and 204-ft. spans, taking care of the variation by dropping the lower pin elevation. For the 152-ft. span the lower two panels of the rib are removed and the lower pin placed in the upper chord of the rib as shown in one of the details. For the 85-ft. span only the upper two panels of the rib would be used.

The center unit, as shown, consists of two three-hinged arch ribs spaced 7 ft. c. to c., with upper and lower chords of built-up sections in straight line chords. Spanning these chords are I-beam stringers bolted to the ribs and these beams carry the 3-in. lagging through blocking which varies with the curve and span of the arch. At the crown of the 208-ft. arch, for instance, this blocking is about 4 ft. high, as shown in one of the views.

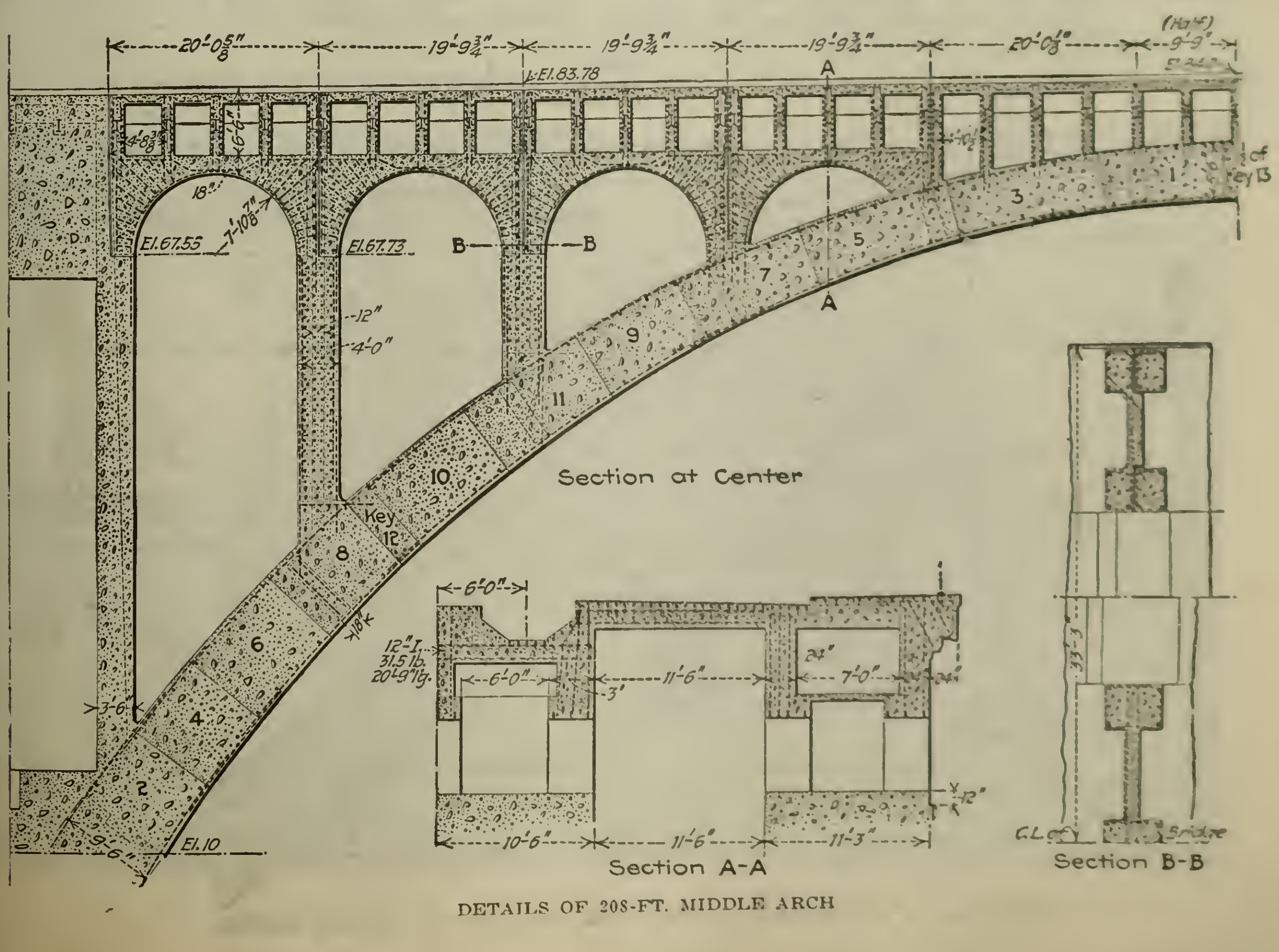
The forms of the concrete ribs are of wood braced back to the outstanding I-beams on top of the centers. They are in unit sections of a standard length to fit the concreting sections as indicated on the main arch elevation herewith. They are also in two transverse sections, which being joined together make the full 21 ft. which for the middle rib but which can be separated for the 11-ft. side ribs. It is the intention, therefore, to use these rib forms over and over again.

The lower hinge details are shown on one of the drawings. A projecting corbel was left in the lower part of each pier, and a cribbing of timber built up on it for the width of the pier. On this was mounted, in proper transverse position, the nest of I-beam cribs

SHEET PILING FOR COFFERDAMS

with the intervening wedges. Above the level of this nest of beams and against the face of the pier a steel plate was fastened by bolts cast into the concrete as a backing for the arch centers when placed. The shoe of the rib was bolted onto the rib itself and when the centers are dropped into place, as described below, the bolts protruding from the pier are sliped into the outstanding angle on the shoe, and the vertical steel wedges dropped into position behind the shoe. In striking the centers the wedges under the shoe are to be knocked out and the centers lowered on hydraulic jacks.

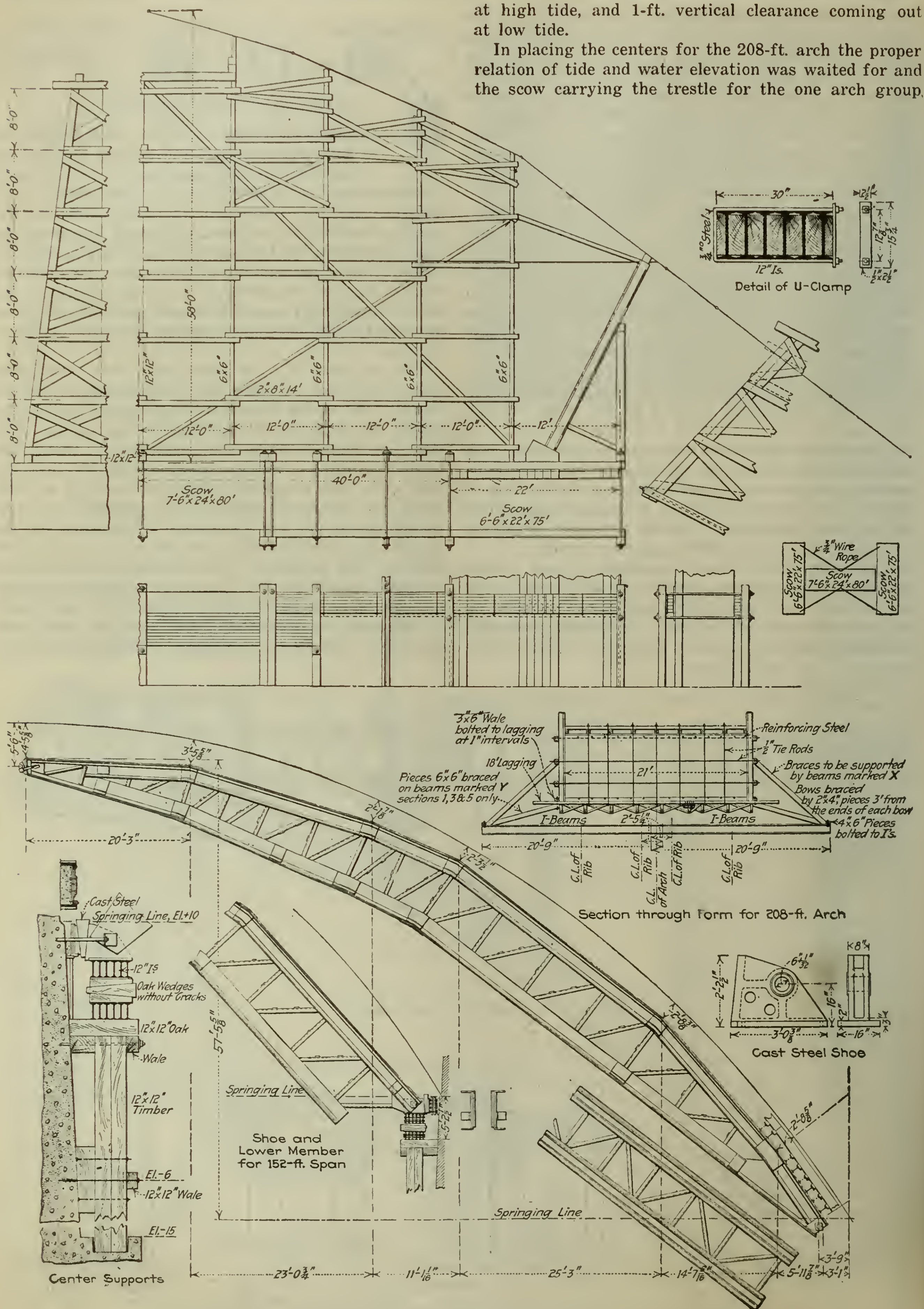
The steel arch ribs are floated into place on a heavy trestle supported on three scows lashed together in the shape of the capital letter I, this lashing being both by means of continuous I-beams over the joints. The detail is shown in one of the drawings. On this group barge is erected a wooden trestle which supports the steel arch ribs mainly at the crown and at a point about the haunch. Intermediate supports are not counted on in holding the ribs; in fact, most of the weight is transmitted down the heavy A-frame at the haunch. The centers in a two-truss group are erected complete on this trestle. The weight of the steel submerges the scow about 1 ft. There is normally about a 3-ft. tide, so the trestle was built so that there would be a 1-ft. vertical clearance in floating into place



DETAILS OF 208-FT. MIDDLE ARCH

at high tide, and 1-ft. vertical clearance coming out at low tide.

In placing the centers for the 208-ft. arch the proper relation of tide and water elevation was waited for and the scow carrying the trestle for the one arch group,

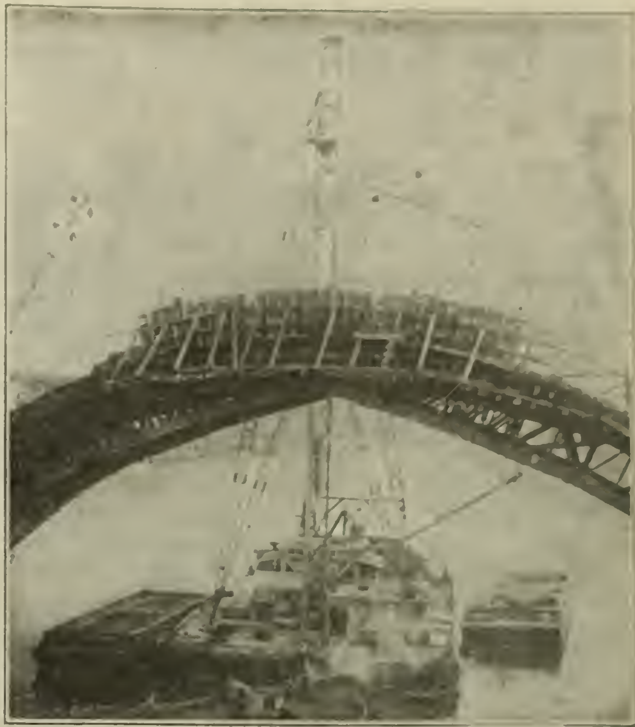


DETAILS OF FALSEWORK CENTERS FOR GEORGETOWN BRIDGE ARCHES

was floated between the piers. There was 4-in. horizontal clearance at this time and as the tide dropped the rib settled perfectly into position. The shoes at each end of the centers had to slide about 2-in. on their supports to take their seat against the wedges which had been left in place. To hold the arch in position while taking its seat with the drop of the tide, the scow was tied upstream and downstream and to the pier with cables, and in addition there were porvided ⅞-in. steel rods with turnbuckles extending up and down stream from the ends of the steel centers to bolts set in the piers. The latter were a great assistance, as the cables were too flexible to hold the large structure in exactly the right position. As the tide dropped the scows were readily floated away and were towed over at the Virginia side of the bridge to be used for the erection of the second set of centers.

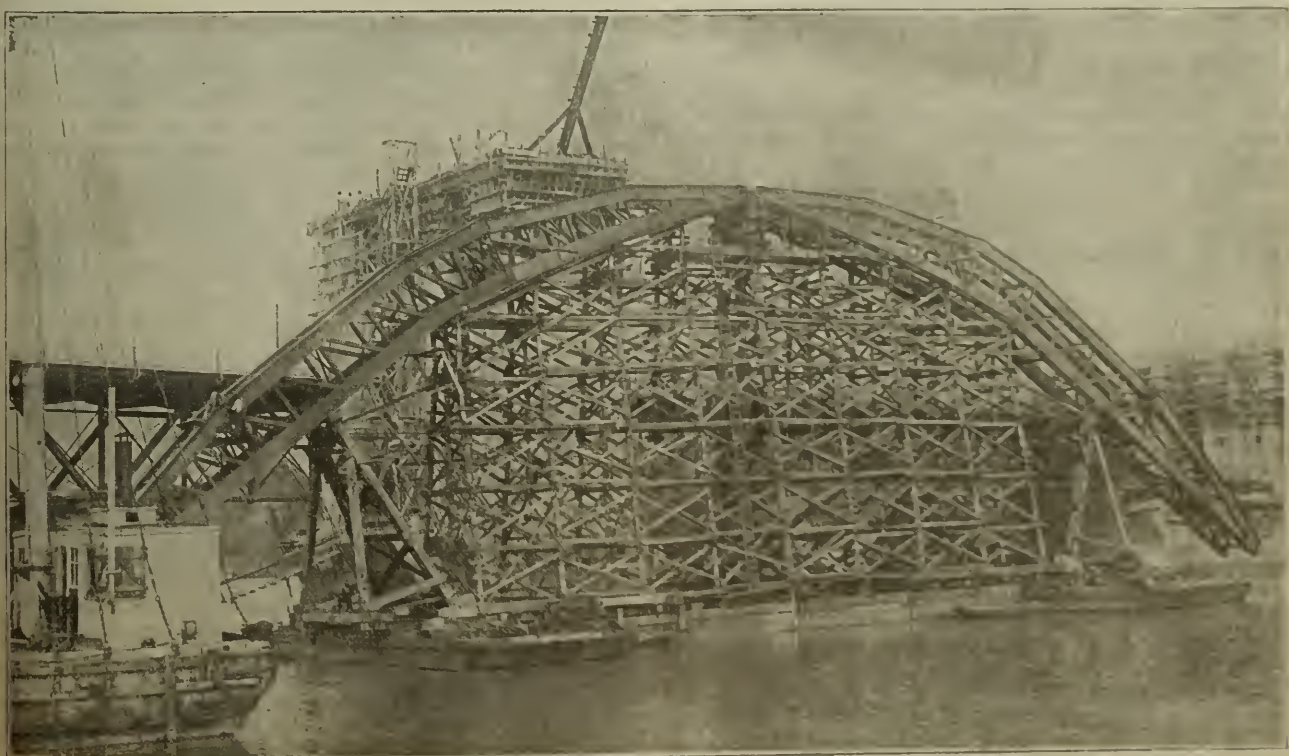
Concreting of the various piers and abutments was carried on by two separate plants. There is a cableway extending over the entire span from shore to shore and this is used for transmission of material over the entire span from shore to shore and this is used for transmission of material to the various piers. It is also used in the concreting of Pier 1 and of the north abutment from a concreting plant located inside of Pier 2 just out the District shore. In this plant material is brought in in the strip of land between the canal and the river and loaded into bins immediately over the mixer plant. An elevator tower rises between two of the shafts of the pier to a platform where buckets can be reached from the cableway.

For the river concreting the rather elaborate mixing plant shown in one of the views has been built. This consists of two large scows lashed together by completely encircling cables and by cross I-beams which carry the steel tower and counterweighted chuting equipment built by the Insley company. All sand and gravel is brought in by scow from the lower Potomac, and can be transferred directly by grab bucket to the mixing plant. Cement is brought in on the B. & O. R.R., whose tracks run under the first span.



FLOATING CONCRETE PLANT READY TO PLACE CONCRETE AT CROWN OF 208-FT. ARCH

The live load assumed in the design was 80 lb. per square foot for those portions of roadway not occupied by tracks, with both tracks occupied completely by street cars having 37,500 lb. on each axle, or 3,500



FALSEWORK CENTERS FOR 208-FT. ARCH ON SCOW

lb. per lineal foot of track. The maximum allowable stress in arch ribs, including dead and live load, arch shortening and temperature is 600 lb. per square inch. The maximum stress in steel is 16,000 lb. per square inch.

The Georgetown bridge has been designed and its construction is being prosecuted under the direction of the Chief of Engineers, U. S. Army, by the District Engineer Office at Washington, D. C. Col. C. A. F. Flagler was in charge of that office during the formative stages of the project and the preparation of the architectural plans. The architecture was designed by Nathan C. Wyeth, Washington, D. C., and was approved by the Commission of Fine Arts. Construction work was begun in August, 1917, under Col. W. L. Fisk, but since February, 1919, the work has been in charge of Major M. C. Tyler, district engineer. Major L. E. Oliver is resident engineer.

Recent Experiences with Wood Block Pavement

Analyses of Recent Failures with Suggestions as to Prevention—Pitch Coated Base Under Tightly Laid Blocks Best

WOOD blocks laid as tightly as possible on a smooth base and with a pitch filler will eliminate many of the difficulties encountered by street engineers in the past few years. This statement together with an admonition to be sure to have the sapwood fully treated by driving all air out of the wood before impregnation was made by Dr. Hermann von Schrenck in his paper on "Experiences With Wood Block Pavement" presented at the recent meeting of the American Society for Municipal improvements. The following is an abstract of the paper:

During the past two years numerous failures of one kind and another have been experienced with wood block pavements. Following periods of heavy rainfall during the summer of 1919 and at various times during 1920, wood blocks buckled and heaved and in some instances on long stretches of city streets the blocks floated away from the base. There has also been an increase in the number of cases of failure by decay of supposedly well-treated blocks. Cases of excessive bleeding have been reported, but less frequently than in former years. A case has also been reported of blocks shrinking excessively to such an extent that the blocks become loose in the streets. These failures, so far as the writer has been able to examine them, have been due almost wholly to conditions entirely within the control of the engineer, rather than to any inherent defect of creosoted wood blocks.

Timber.—Where the present specifications of the A. S. M. I. have been followed as to the kind and quality of timber a reasonably dense, satisfactory block has been obtained and few, if any, failures have been reported because of the character of the wood. In view of the failure of the sapwood of treated blocks, the writer has had numerous inquiries as to whether sapwood was not a serious defect in a paving block. Sapwood, if sound, has all the strength qualities of heartwood, and the trouble is from the treatment rather than from the wood.

Preservative.—Preservatives used during the last few years, while not always in accordance with the specifications of the A. S. M. I., have been more or less satisfactory and there has been very little complaint. Where a good coal tar product is used with a fairly high percentage of high boiling compounds failures will be few and far between, in fact, the writer has yet to see any failures of blocks due to the oil used where such oil was a pure coal tar compound.

Treatment.—The treating specifications as at present prescribed have proved satisfactory and there seems to be no reason to ascribe any of the recent failures to treatment.

Condition of Timber.—The present specification provides that "the timber may be either air-seasoned or green, but should preferably be treated within three months from the time it is sawed." Recent experiences indicate that it may possibly be desirable to put a greater emphasis upon the necessity for having timber thoroughly air-seasoned, or with a minimum moisture content. Reference has been made to failures due to decay. In 1915 the writer discussed failures in various cities due to the decay of the sapwood of treated blocks and showed that this was due almost entirely to failure to obtain proper sap penetration. The sap decay of creosoted blocks has become more evident, not only on the streets then noted, but also on many new streets. Proper lasting qualities cannot be obtained unless the blocks are thoroughly penetrated with the preservative, meaning by this at least perfect penetration of every part of the sapwood, which can only be obtained if the blocks are as dry as possible. There is no question but that many of the failures are due to the fact that the blocks were not thoroughly dry and that water pockets were still present in the sapwood, thereby preventing complete penetration of the preservative. No amount of steam treatment will make possible equitable distribution of creosoted oil in wet wood. The initial steam treatment of paving blocks is not so much to get rid of water as to assist in driving out the air, which is the principal factor causing bleeding after the blocks are laid in the street.

Inspection.—The present specifications of the A. S. M. I. call for careful inspection of the blocks after treatment by sawing a number of the blocks through the center and at right angles to the fibers. This is practically the only way to detect the extent of the penetration of the preservative.

Laying.—By far the largest number of failures of wood block paving in recent times has been due to the manner in which the blocks were laid in the streets. In the early days when more or less rough concrete foundations were used the sand cushion came into use largely to give a smooth base on which to lay the blocks. During the period of its more extensive use difficulties of all sorts arose. The blocks bulged in spots after rainfalls, and after every heavy rainfall whole street sections floated away. In many cases curbstones were thrown out of line. Another difficulty occurred due to the shifting of the sand base, giving irregular depressions and frequently holes. It has long been realized that the sand cushion was largely responsible for the swelling and the displacement. Water found its way between the individual blocks and was absorbed by the sand at the bottom of the blocks. The latter then swelled more at the bottom than they did at the top, with the resultant disturbances. In spite of the fact that these experiences are now of many years' standing many cities still use the sand cushion, notwithstanding the excellent results obtained in other cities with other methods.

Laying Blocks on Concrete Base

As a result of these experiences a number of cities adopted the plan of laying blocks directly on the concrete base either with a thin sand-cement mortar or frequently on a perfectly smooth concrete base with a bituminous coating. The first work of this sort was on Dearborn St., Chicago, between Adams St. and Jackson Blvd., put down in 1914. On the east half of the street a mortar cushion was used and the west side had a smooth concrete base with a bituminous coating. J. G. Gabelmen, engineer of streets, Chicago, makes the following report:

"The west side of Dearborn St. from Adams St. to Jackson Boulevard is in excellent condition with the exception of two cup holes. Two yards of maintenance would make it perfect. This side of the street is where the heavy trucks unload mail and should show much more wear than the east side of the street. The east side shows much more wear and is very uneven and full of depressions."

With the use of a bituminous coating on a smooth concrete base, particularly after the blocks were rolled, an

almost watertight condition obtained at the bottom of the blocks. Explosions after rainstorms, such as occurred on previous types of construction, happen very rarely, if at all, as blocks were more or less protected from water on all sides except at the top. The amount of water absorbed on the top was very small and usually disappeared rapidly by evaporation after the rain or sprinkling. There was practically no tendency for the blocks to enlarge. On the other hand, blocks thus protected lost the water content during the periods of high temperatures in summer and tended to become loose. This condition is described by W. W. Horner, chief engineer of paving, St. Louis, in *Engineering News-Record*, April 22, 1920, p. 814. In *Engineering News-Record*, Oct. 7, 1920, p. 686, Mr. Horner describes the action of one of the streets last referred to, which had been laid in the summer of 1919 after the relaying of the street first mentioned where the shrinkage had been so high.

By an ingenious method, fully described, Mr. Horner took up the shrinkage, which amounted in one case to a total of 1.3 ft. in 125 ft. After the complete closure of the blocks on this street, with terrific rainfalls coming early in September, there was not the slightest movement of the pavement in any direction. An almost ideal condition has been obtained. Blocks were protected against water at the base by the pitch coating, on all sides by the pitch filler, and the tops of the blocks, while not quite as effectively waterproof, absorbed only small quantities of water which disappeared rapidly after the sun came out. The heaving effect due to the absorption of the water at the base of the block was almost entirely eliminated.

The great trouble with wood block paving, aside from the question of bleeding, has been water, water absorption and water loss. Water absorption causes expansion which, when it takes place unevenly, as in the cases of sand cushions and frequently sand-cement cushions, brings about upheaval in the pavement and entire destruction of the street during heavy rainstorms. Water evaporation has caused loose blocks and a constantly disturbed street surface. The ideal condition is one in which the blocks are so prepared that they may have a minimum amount of water in the wood to start with and then to have them so protected that they will have little opportunity for absorbing water.

Earnings of New Zealand Government Railways

The Prime Minister of New Zealand, acting as Minister of Railways, has presented to the House of Representatives the annual statement of the Government railways for the fiscal year ended March 31, 1920. The statement shows a net profit of £1,647,420 ($8,017,-169) on a total capital to that date of £39,997,340 ($194,647,055) invested in Government railway construction in this Dominion. The receipts of the 3,006 mi. were £5,752,487 ($27,994,478), as compared with £4,-988,632 ($24,277,177) for the 2,993 mi. in operation during 1919, making the earnings £1,923 ($9,358) per mile during 1920, as compared with £1,670 ($8,126) per mile during 1919, with operating expenses amounting to £1,372 ($6,676) per mile during 1920, as compared with £1,107 ($5,387) during 1919.

During the fiscal year ended March 31, 1920, the New Zealand Government railways carried 12,760,814 passengers, as compared with 11,374,521 pasengers during the fiscal year 1919; 5,597,232 tons of freight as compared with 5,238,457 tons; and 403,047 head of live stock, as compared with 337,281. The train-mileage for 1920 amounted to 7,408,608, as compared with 7,477,583 mi. for 1919. At the end of March, 1920, the Government railways had 616 locomotives, as compared with 620 in 1919, 1,492 passenger cars, as compared with 1,489, and 22,937 freight cars, as compared with 22,658. —*Commerce Reports*.

Trend of Highway Development —A Survey

Minnesota Practice

THIS IS THE SECOND *of a series of staff articles on the highway situation. It deals with an extensive program of grading and gravel surfacing, with the success of a partial maintenance system and with the State's new trunk line system.*

The third article in the series will appear in next week's issue.—EDITOR.

MINNESOTA in 1920 stepped into the first rank of road building states in value of construction inaugurated. This advance is particularly notable because less than 35 miles of the new construction is hard paving. The large items are, 1,328 miles of grading and 1,129 miles of gravel surfacing. Measured in dollars, the contracts awarded in 1920 aggregate $1,163,-347 for paving, $9,360,133 for grading and $4,680,066 for gravel surfacing. The price for grading includes culverts. Bridges are a separate item; they have cost $1,780,000. Altogether this new construction amounts to about $17,000,000 of which over $14,000,000 is for grading and gravel surfacing. Perhaps 15 per cent will not be completed in 1920, but the contracts brought over from 1919 and completed, will make up the deficiency and leave the amounts given very nearly a correct statement of work done.

Concentration of expenditure in 1920 on permanent grade and structures and on gravel surfacing is a continuation of the practice of 1918 and 1919. Therefore the mileages and costs which have been stated, besides expressing magnitude of operations, reflect a policy of highway development. This policy is a large mileage construction of permanent grade prior to extensive perfection of permanent grade by paving. While the mileage of gravel surfacing operations appears to contradict this policy, the contradiction disappears when it is observed that in Minnesota practice a road is not regarded as permanently graded until the final earth grade is surfaced with gravel. Perhaps qualification of this statement could be urged but it is not gross exaggeration as it stands.

Heavy Grading—In the year's grading operations, yardages and prices and not methods command attention. Heavy earthwork prevails generally. There are 10,062,804 cu.yd. on the 1,328 miles being graded or an average of 7,600 cu.yd. per mile. This is a high average for prairie state highway conditions. An average, however, does not in this instance truly indicate earthwork magnitudes: (1- Because there is a wide range between the averages for different operations, and (2- because frequently there are large yardage concentrations in short cuts and fills. Illustrating the first condition are a 13½-mile grade in Polk County on which the earthwork averages 5,352 cu.yd. per mile and a 11.6-mile grade in Hennepin and Dakota counties on which the average is 43,264 cu.yd. per mile. Between these two is an 18-mile grade in Houston County on which the earth and rock eycavation averages 16,336 cu.yd. a mile. As examples of isolated concentrations of earthwork there are, in Scott County a 1,200-ft. cut 25 ft. deep requiring 42,025 cu.yd. of excavation and in Nicolet County a 4,700-ft. fill of 82,754 cu.yd.

Dealing with these heavy yardages, grading becomes a steam shovel or an elevating grader operation, choice being determined by the character of the material and the length of haul rather than by depth or yardage of excavation. Elevating graders are the predominant equipment. Ordinarily they are team operated, but there is a limited use of tractors. Unit prices this year have averaged 58c. a yard when the grade is to be surfaced with gravel and 65c. a yard where the grading is for paving.

Gravel surfacing prices, averaged on a basis of 1,013,392 cu.yd., have been 80c. a cubic yard for hauls up to ½ mile and 95c. a cubic yard for hauls from ½ mile to 1 mile; for greater hauls than 1 mile the price has been $1.10 plus 50c. per yard-mile. Abundant gravel deposits, generally, make local pits, with short hauls, possible for nearly all road operations. Except that a less than 1½-in. gravel is used in which the material below ¼ in. is required to have a cementing value of not less than 50, the construction is usual practice.

Construction Plants Compared—Concrete paving operations present nothing unusual in methods, but some unusual output rates and two apparent indications: (1) That central mixing plants and wet batch haulage have gained increased favor, and (2) that use of materials dumped on the subgrade is not likely to be permitted in future contracts. On two operations the two remarkable output rates of 1,072 ft. and 1,098 ft. of 18-ft. pavement in one day have been made. Incidentally the higher record was made by a central mixing plant with a six-bag mixer. The maximum haul on this job has been 4¼ miles with 2-ton trucks having Lee bodies. Six-mile hauls are contemplated as entirely practicable with 1-2-4 mix having a 2-in. slump. In September the maximum day's output of this plant was 1,828 sq.yd. of 8-in. slab and the average output per *working day* was 1,111.6 sq.yd. or 556 lin.ft. In observing these records opportunity was presented by comparing for three months for about ten jobs of concreting, the maximum day's yardage and the average yardage per working day. The latter was only from 50 to 70 per cent of the former and more usually only 50 per cent.

Based on 32.69 miles and 345,516 sq.yd. of pavement, the average cost to the state of concrete paving on this years' contract has been $3.25 a square yard and $34,340 a mile. Roughly the yardage price is about a dollar a yard higher than the prices bid for 1919 contracts.

Patrol Methods.—In highway maintenance, Minnesota dates back 11 years its recognition of the patrol system. Whenever its beginning, patrol maintenance in 1920 is giving admirable results. Six-mile sections and team patrol are general practice but tractor patrol in 20-mile sections and truck patrol on 25-mile sections are also employed. Minnesota drags and blade graders are the usual equipment. The drag gives the better results when it is used faithfully and continuously but is harder on teams and men than the blade machine and the use of the latter is increasing. One reason for excellent gravel and earth road maintenance in Minnesota is the liberal expenditure practiced. This runs in some counties as high as $750 per mile of road maintained, and for the state it averages $300 a mile. Concrete road maintenance has not yet become a big problem but in the work this year an innovation has been undertaken which promises economy. It is the use of cold cut-back tar for repairing cracks. Details of the practice will be described in a future article.

Increased traffic is calling for increased maintenance everywhere in the state. In 1919 the average traffic was 1,036 vehicles of which 92 per cent were motor driven. Traffic in 1920 has mounted well above these figures; in some counties it has doubled. As a result the heavy traffic routes have called for so much attention that secondary routes of the present 12,000-mile state road system have suffered neglect. To remedy this condition an amendment to the State Constitution was sought.

Next to its construction and maintenance program, promotion of the legislation which will give the state a distinctly state trunk-line system of highways has been the most vital task of the year's work. Briefly adoption of the constitutional amendment on Nov. 2 means that the state on Jan. 1 will take over for improvement and maintenance nearly 7,000 miles of trunk highways and will be provided with money to prosecute the work from sources largely outside the present sources of highway funds.

Miami Valley Flood Protection Rapidly Progressing

Germantown Dam Will Give Full Protection and Three Other Dams Partial Protection by Next Spring

CONSTRUCTION has progressed more rapidly than was anticipated on the flood protection works of the Miami Conservancy District according to the report as of Sept. 1, 1920, of the Department of Engineering and Construction. Summarized briefly, the relocation of public utilities is rapidly nearing completion. The outlet structure at Taylorsville, the last of these great structures to be built, has been nearly completed. The local protection work at Middletown, with the exception of a flood gate and some concrete revetment, has been finished. The rivers at Germantown, Englewood, Lockington and Huffman have been diverted through the outlet works, and the dams are built across the old river beds. Noteworthy progress has been made on the difficult and tedious local protection work at Dayton and Hamilton. The sluicing has gone so well that Germantown dam is already completed, as noted in the news pages of our issues of Nov. 11, 1920, and Lockington dam will be finished in the early winter.

VOLUME OF WORK PERFORMED AS OF SEPT. 1, 1920 BY THE MIAMI CONSERVANCY DISTRICT

Flood-Control Works Proper	
Earth removed from cut-off trenches, outlet works, spillways and structures	877,010 cu.yd.
Loose rock, hardpan and solid rock removed from cut-off trenches, outlet works, spillways and structures	442,567 cu.yd.
Earth placed in dams	3,978,490 cu.yd.
Earth placed in levees	721,246 cu.yd.
Earth removed from river channels	1,467,327 cu.yd
Earth moved in soil stripping and in dressing slopes with earth	181,276 cu.yd.
Earth moved in permanent road building	93,409 cu.yd.
Earth moved in sewer and drainage construction	25,242 cu.yd.
Concrete placed	144,734 cu.yd.
Clearing and grubbing	104 acres
Steel reinforcing and steel piling placed	1,446,245 lb.
Riprap placed	5,233 cu.yd.
Public-Service Relocations	
Earth excavation	1,785,250 cu.yd.
Loose and solid rock excavation	713,207 cu.yd.
Concrete placed in structures	32,698 cu.yd.
Gravel placed on relocated roads	26,882 sq.yd.
Steel reinforcing placed	811,179 lb.
Track laid	47.98 mi.
Ballast placed	214,000 cu.yd.
Railway relocated	23.6 mi.

As a large part of the total expenditure, both of money and effort, consists of preparatory work, and of

buying and installing plant, the works are much nearer actual completion than is indicated by a statement of quantities placed. The accompanying tabulation gives the principal quantities of work done, classified under two heads, flood-control works proper and public-service relocations. This tabulation does not include preparatory work, although the quantities in the preparatory work are quite large, nor does it include considerable minor work not susceptible of classification under the general headings used.

The policy of doing the important portions of the work with the District's own forces has been continued and the concrete work and hydraulic fills at the dams and the major part of the river improvements at Dayton and Hamilton have been handled in this manner.

However, a considerable number of minor features, that do not present serious problems to the small contractor, have been let to firms of good standing, with advantage to the District. This has been especially true with respect to team work and to revetment work on the river improvements. While the total number of these contracts has been quite large, there has been expended on them to date, not including the public-service relocations, approximately $631,000, or about 5 per cent of the work done to date on the flood protection works proper.

A form of agreement has been worked out wherein the District pays the actual cost plus a fee to the contractor. This fee increases gradually as the contractor is able to reduce the cost of the work below the engineer's estimate on which the contract is based; and his fee decreases in a similar manner if the cost of the work increases above the engineer's estimate. Thus, the contractor can make a fair profit only if he handles the work economically, and the more he saves the District, the more he makes himself. This form of agreement has been entered into with contractors of known ability, and has operated in a satisfactory manner.

Outside of the flood prevention works themselves the building of the public service relocations was largely done by contract. These contracts in the main have been completed.

The total expenditures to June 30, 1920, have been $42,893,465 of which $14,783,408 were for engineering and construction.

Shoshone Project Extensions

Following a visit of the Secretary of the Interior to the Shoshone Project of the U. S. Reclamation Service possible extensions were worked up as follows at his request:

The Garland and Frannie unit could be extended to include an additional area of 15,600 acres at an estimated cost of $1,880,000. The 66,000 acres now under ditch cost $5,420,000. Three other units, Willwood, Hart Mountain and Oregon Basin, with a possible area of 15,600, 38,800 and 90,000 acres, respectively, would cost approximately $1,220,000, $3,900,000 and $8,000,000 respectively. Some storage is built for all these units but distribution or drainage works, which are the principal construction items, have not been started. The total cost for the additional 160,000 acres would be $15,000,000. To date $6,260,000 has been spent on these units, of which the greater part, $5,420,000, has been apportioned to the Garland and Frannie unit.

Freight House Floor Construction

A REALLY satisfactory floor construction for railway freight houses has yet to be designed, judging from experience with different types of floors as recorded in a report read at the recent annual meeting of the American Railway Bridge and Building Association. The life and wearing quality of the floor depend not only upon the materials and methods of laying, but also upon the traffic and equipment passing over them, as well as upon climatic and physical conditions. For these reasons, a floor that is satisfactory in one case may prove a failure in other cases. A smooth and level surface is desirable to facilitate the movement of trucks and to reduce the wear and tear of trucks and damage to merchandise. Ease of repair and renewal is an important factor in the selection.

Pine plank flooring is used more widely than any other type, says the report. Repairs can be made readily, but after the floor is worn these repairs result in an uneven surface. Hardwood floors with subplanking are used extensively, but where a concrete base is used the nailing strips for the subplanking should be of creosoted material. A heavy hardwood floor without subplanking is suggested in the report, especially for cases where water lies on the floor frequently, as decay quickly develops in double floors under this condition. No such construction by any railway is on record.

Wood blocks on concrete are said to make a smooth and resilient surface with long life and low maintenance cost, but the floor will not stand exposure to weather and repairs usually leave an uneven surface which may result in damage to fragile goods in trucking. Floors of creosoted blocks are giving good service. but are open to the objection of tainting such goods as butter and flour. Experience with asphalt floors is varied. Trouble has been experienced where temperature changes are considerable, and in damp weather the surface is likely to become sticky or slippery. Repairs can be made without difficulty. Asphalt blocks are used only to a limited extent, but in one case the blocks began to wear on the edges after 18 months' use, thus causing a rough floor. Blocks can be renewed easily, but may produce an uneven surface.

Brick floors do not seem to be desirable. Although strong, durable and sanitary, they are hard upon the truckers' feet. Further, they are noisy and being rigid they are likely to cause damage to packages in handling. On the other hand, they are recommended for damp conditions and where oils and paints are stored. Concrete floors are said to be dusty, noisy, hard on the truckers and easily damaged by falling packages; they develop temperature cracks, break up under the trucks and become worn in spots which develop into large holes and uneven surface. For these reasons, says the report, the maintenance cost is high, and the construction does not compare favorably with other floors. The wearing quality of the concrete depends largely on the coarse aggregate used and the proper mixing of the materials. Several methods for producing hard wearing surfaces have been used with varying success. Concrete laid in 8 x 8-ft. slabs has not been successful.

For economy in floor construction, the report suggests laying out aisles or spaces for trucking. Then these can be paved with the better and more expensive flooring, cheaper materials being used for the storage spaces on which there is little or no trucking.

Effect of Fire on Concrete in Warehouse at Galveston

Two Conflagrations Within Past Six Months in Buildings Filled With Sisal Teach Lessons About Concrete—Eye Witnesses Testify as to Behavior

WITHIN the past six months two fires with similar characteristics occurred in the same concrete pier warehouse at Galveston, Tex. In the earlier fire, on May 29, the destruction of the concrete structure was fairly complete in the section where the fire was localized; in the latter fire, on Oct. 2, the structural damage was confined to extensive spalling at construction joints and to floor cracking. In both fires the burning material was sisal, a Central American hemp, in bales about 4 x 3 x 3 ft., weighing about 400 lb. each and stacked, in this case, with no aisles and within 3 ft. of ceiling and walls. The earlier fire has been reported in some detail in the "Quarterly" of the National Fire Protection Association, Oct., 1920, by H. H. Sutton. The following notes on that fire are taken from that account. In addition, there are presented herewith the reports of two engineers who happened to be eye witnesses of the Oct. 2 fire.

The warehouse in question is a four-section, two-story concrete building, located on the Galveston Wharf Co.'s Pier 41, which has an earth fill middle section with piled side extensions. The warehouse is 1,280 ft. long and from 100 to 300 ft. wide, and is divided by solid 12-in. reinforced-concrete walls into four independent sections, each about 300 ft. long. The structural design is simple, comprising round columns spaced 20 ft. center, carrying flat-slab floor and roof, and an outside 8-in. wall with sliding doors making up the other half of the wall area. The columns were 22 in. in diameter on the first floor, and 16 in. in the second floor, and were reinforced with vertical rods and rather widely spaced spirals as shown in the view. The second floor slab was 9 to 12 in. thick, but 9 in. where the fires occurred, with a 4-in. drop head 6 ft. square, and with column capitals 4 ft. 6 in. in diameter. The roof was 6 to 8 in. thick, with 3-in. drop head. There was no communication whatever between any adjacent two of the four sections, and a second-story outside platform prevented any communication of fire between the windows and doors of the first and second floors. Skylights with metal louvred sides and wired glass in metal frames were in the roof of each of the four sections.

COLLAPSED SECTION OF GALVESTON WAREHOUSE AFTER FIRE OF MAY 29, 1920

The concrete, according to testimony, was good, though the exact nature of the aggregate from which it was made has not yet been made known. Information is that "the concrete was what is commonly known as a 1:2:4 mix and that both gravel and crushed limestone were used as coarse aggregate in various parts of the structure, depending upon the materials available."

The structure was built in 1915-16 by Stone & Webster, with Ford, Bacon & Davis as designing engineers.

The May 29 fire started on the second floor of Section D, which is the outermost of the four sections of the warehouse, where the baled sisal stock had been stored without aisleways to within a few feet of the roof. The rolling metal doors in the exterior walls of the section were closed and could be opened only from the inside. The fire department reached the building with reasonable promptness and soon had a large number of lines of hose playing both from shore and from fire boats. The fire fighters were handicapped, however, by the smoke caused by the preparation in which some steel cotton bale ties had been dipped and from the heavy and acrid smoke from the burning sisal. They did not get the fire completely under control for two days and it was reported that the sisal was smoldering nearly a month later. No satisfactory explanation of the cause of the fire has been advanced.

The fire continued to burn in the second story of the section where it started for nearly seven hours when the roof over the section collapsed and caused the collapse of the floor slab between the first and second floors. The collapse of the section was complete, as is shown by two of the views herewith. It is stated that the columns failed generally at a point some 6 in. below the beginning of the capital.

No sprinklers were in the building at the time and part of the recommendation for future construction of this sort is that such protection be provided.

Floors Cracked But Not Dropped By Fire

By Edmund B. Besselievre,
Consulting Engineer, New York

DISASTROUS fires in adjacent sections of the same reinforced-concrete warehouse on Pier 41, Galveston, Tex., have produced such widely differing results that the writer believes a short description of the phenomena attending these fires will be of interest to engineers.

Local conditions at these fires were in many respects identical, both fires occurring in stored bales of sisal at about the same time of the day, both were practically of the same duration and caused about the same amount of loss. The main difference was that the first of the two fires referred to, on May 29, 1920, was on the upper deck of the warehouse, while the second and most recent fire, Oct. 2, 1920, was on the lower deck.

The phenomena that will be described incidental to the fire of Oct. 2, were witnessed by the writer, who happened to be on his way to Pier 41 on official business at the time the alarm was turned in, and the investigations referred to were made during the hottest part of the fire, thus producing ideal conditions for observing the action of reinforced-concrete floors under sustained intense heat. Subsequent examinations have been made frequently since the fire was extinguished.

The fire of Oct. 2 started on the lower deck of the pier at a point about 200 ft. from the shore end of the warehouse, and was of such a serious nature as to warrant a general alarm and the presence of all fire apparatus in Galveston together with four tugs to supplement the vehicular pumping equipment.

The sisal in which the fire started was piled to within 4 or 5 ft. of the floor of the upper deck of the pier, on which was stored, in the section above the fire, quantities of linoleum and raw sugar. The smoke from burning sisal is very dense and in addition has a very pungent, irritating odor, which kept the firemen from getting to the heart of the blaze and made it necessary to fight the fire through the doors of the warehouse.

The first alarm was turned in at 8:50 a.m. and at 10 a.m. the fire was perhaps burning most intensely. At this hour the writer, who was on the upper deck of the warehouse, went into the section immediately above the center of the fire, and noticed the intense heat of the concrete floor, it being sufficient to burn the feet even through the shoes. This fact aroused in the writer's mind the possibility of the floor failing and he searched for evidences of this. This evidence was presented by the appearance of large cracks running transversely of the floor, between the rolls of linoleum. As smoke and water were issuing from these cracks it was evident that they extended entirely through the floor. Aside from this the floor for several feet on either side of the cracks was raised for a distance of between 2 and 3 in. above the normal level.

As the fire progressed the heat of the floor increased, more of these cracks appeared, as well as others running longitudinally of the building and those first observed seemed to have widened. The attention of the Fire Marshal and other officials was called to this condition by the writer and it was deemed wise to prohibit men from attempting to go into the section below this floor. Everyone of the officials who inspected the floor was of the opinion that the failure of this floor was but a matter of minutes.

However, when the fire was declared under control that same evening, the floor was still intact, with its untouched original load still on it, although the heat of

NEAR VIEW OF COLLAPSED FLAT-SLAB FLOOR, MAY 29 FIRE

the concrete had increased to such a point that the rolls of linoleum and the raw sugar stored in that section were scorched.

Observations made since the fire was extinguished and the concrete cooled show that although the cracks naturally remain, no sinking of the floor has taken place and there is no apparent weakening. Where the floor blistered and rose it has receded to approximately its original level, but the finish coat of cement is of course badly broken and the rough concrete exposed.

As stated before the original load on the floor is still there, and although this load, as nearly as the writer could ascertain, is about one quarter of the maximum allowable dead-load, stated to be 375 lb. per sq.ft., the writer believes that if the floor had been seriously damaged, this load would have been sufficient to cause its collapse. It would seem to be so from the fact that the insurance inspectors have made a careful investigation of the floor and have not ordered the removal of the present load.

In the fire of May 29 on the upper deck, the combination of nearly maximum load, with the added weight of tremendous volumes of water and the intense heat, was sufficient to cause the floor to collapse, dropping the fire to the lower deck and carrying the roof and side walls of that section of the pier with it.

The writer has been told that the reason for the collapse of the floor in this earlier fire was due to the great expansion of the bales of sisal when drenched with large volumes of water and the pushing out of the walls of the building due to this expansion. Examination of the site of this fire does not show strong evidence of any occurrence of this kind, as the remains of the walls tend to incline toward a belief that they fell inward.

Questioning of men present at this and other sisal fires and familiar with the action of that material when soaked brings forth the statement that sisal when wet does not expand to any appreciable degree. On the other hand these authorities assert that wet bales under any pressure will compress in proportion to the pressure exerted, and this contraction has been known to be as great as one-third the height of the bale. As the bales in this early fire as well as in the one of Oct. 2 were piled to a height of at least 12 or 15 ft., this contraction would have been present in all bales except those in the uppermost layer.

The writer is inclined to accept this assertion as fact, for if any substantial degree of expansion had been present during the last fire, it would have resulted in the total collapse of that section of the warehouse. The bales were packed tightly from wall to wall and to within a few feet of the floor above, and the volume of water poured into the fire was enormous, being at one time, and for a period of hours, that flowing from over 50 lines of hose under high pressure. There was little room for expansion and if there had been any the side walls would have shown it. The photograph of the exterior of the pier at the point of concentration of this last fire, shown herewith, does not show any damage to the walls other than the natural smoking and the broken window sash.

It is the writer's opinion, that considering the concentration of intense heat a few feet below the floor, and considering the length of time the floor was subjected to this heat and the continuous deluge of water, producing a great volume of steam to assist in the disintegration, the performance of the concrete was very creditable, and the fact that the floor still shows no signs of collapse and upholds its load is an indication of apparently little permanent damage.

Construction Joints Dangerous in Concrete Building Fire

By W. J. Knight,
Consulting Engineer, St. Louis, Mo.

On Oct. 2, 1920, a very destructive fire occurred in the first floor of the short compartment of the reinforced-concrete pier No. 41 in Galveston, Texas. The pier was designed and constructed a few years since, and embodied the most modern type of flat-slab construction. The compartments of the pier, several in number, are separated by reinforced-concrete walls spaced about 300 ft. apart and having an average width of approximately 120 ft. The structure is two stories high with concrete pile foundations. The columns, 20 ft. on centers, are round with the usual capitals and drops 6 ft. square and 4 in. deep measuring from the bottom of slab. The second floor slabs of the compartment are 9 in. thick and the roof slabs about 6 in. thick.

At the time of the fire the compartment was filled with sisal hemp which is used extensively for cordage and binder twine, both alone and in conjunction with manila, and is also used for bags, hammocks and similar articles. The sisal hemp was piled in bales to within about 3 ft. of the ceilings, a condition that contributed no little to the difficulty of fighting the flames.

As is evidenced by the complete destruction of the compartment the heat was very intense. The type of construction adopted in the design of this pier, supposedly offers the greatest resistence to the detrimental effects of fire, due essentially to the entire absence of projecting members with sharp corners, with the exception of drops at column capitals. A close examination of the surviving panels of floor and roof revealed complete destruction of drops, although the adjacent flat slab was more or less intact. In Fig. 00 will be noted a typical example of the condition of drops after the fire had been extinguished. The drops presented a favorable opportunity for the heat to penetrate the concrete, beginning at the outer edges or corners and continuing toward the center until destruction had been accomplished.

The round columns suffered severely from the heat and in most cases were the initial cause of failure. It was interesting to note that the presence of metal guards at the base of columns gave great protection to the concrete and the same showed evidence of little or no damage, but the surfaces of the remainder of the portion of columns, where the flames and water had free access, were disintegrated, spalled off and very irregular. The sudden change in temperature occasioned by the cool water from fire hose, no doubt was the principal destructive element, due to a state of sudden contraction from an extreme expanded condition of surface material over the underlying material of a lesser temperature. The column capitals were greatly impaired by the damaging effects of the heat which was the greatest over the ceiling surfaces.

The writer was particularly impressed by the effect of the fire on the construction joints of all slabs where these joints occur. In all cases these joints were per-

ceptible from any point of vantage from one end of the structure to the other, where the panels remained in place each of the joints being emphasized by rough surfaces of the concrete which had spalled off along both sides of it as well as by the exposure of steel bars. The accompanying photographs offer opportunity for studying a condition which heretofore has not been observed or dwelt upon, to the writer's knowledge, in descriptions of similar failures from fire causes. The compartment can be repaired at comparatively little cost, with the exception of the panels through which construction joints extend. These joints where pouring operation was discontinued until the next day, or at a later time during erection, were not specially prepared by roughing the surfaces or by any other apparent means, to insure or contribute to the bonding of new concrete to the old. Examination disclosed very smooth surfaces and the absence of any indication of bond.

SHOWING HOW SLAB PROPS SPALLED OFF AND HOW CONSTRUCTION JOINTS BEHAVED IN OCT. 2 FIRE

The joints proved to be the weakest part of the entire construction in offering resistance to the effects of intense heat, and have rendered the question of repairing a difficult one, on account of the fact that almost without exception, the portions of panels on both sides of the joints are now at different elevations, varying from 1 in. to 1½ in. and in several cases badly buckled. The accompanying photograph illustrates this much neglected feature of construction and is typical of all joints of all slabs that survived the fire. The almost universal lack of proper care and precaution exercised by engineers and builders in the past, in guarding against ineffective and insufficient bond between old and new concrete surfaces, seem to indicate that tangible reasons for correction have been lacking. This fire demonstrates beyond doubt the surprising extent of weakness developed by construction joints during exposure to great heat. From the writer's observation, the havoc wrought by such joints should be a question of universal interest to the profession, if the reinforced-concrete structures of the future are to offer to the owners and to the public the maximum degree of protection and safety and the maximum salvage in the event of fire.

The result of the fires in this warehouse has shown conclusively the great value of flat surfaces without sharp corners of any character, if the greatest protection is to be attained. The spandrel beams over door openings in the earlier fire were nearly completely destroyed, as far as future effectiveness is concerned, although the flat slab in the immediate vicinity remained nearly intact. Projecting members of every nature, such as drops at column capitals and beams, were destroyed.

These fires have also shown that piers or buildings designed for housing similar materials should have compartments much smaller in size, to lessen the great liability involved by fire. Compartments not longer or wider than 150 ft. would be more conservative.

Owing to the very inflammable nature of the contents of this pier and the comparatively few buildings used for similar purposes, a recurrence of complete destruction by fire may not be expected at very frequent intervals, but the lessons taught are invaluable for the correction of proved evils practiced in the past.

The photographs and information concerning this fire were obtained through the co-operation and courtesy of George Sealy, of Galveston, for which the writer gives due recognition.

Color of Cypress Not Related to Durability

Southern bald cypress is about the most variable in color of any of our native woods, and in different localities is known as red cypress, yellow cypress, white cypress and black cypress. There is a rather prevalent belief that cypress with dark colored heartwood is the most durable, but the opinion of the U. S. Forest Products Laboratory is that as far as durability is concerned the color of the wood makes very little difference. In service records obtained by the laboratory, any difference in the length of service of red cypress and yellow cypress appears to be due entirely to a difference in the amount of sapwood in the timbers. Cypress trees with light-colored heartwood usually have more sapwood than those with dark colored heartwood, and sapwood is not resistant to decay. The important thing if durability is desired appears to be to select the heartwood of cypress regardless of its shade.

Filter Underdrain, Sand Bed and Wash-Water Experience

Symposium on Current Practice and Operating Success with Various Details of Mechanical or Rapid Water Filtration Plants

[An attempt is made in this second installment to learn of any new devices used to scour the few inches of sand at the top of the bed. V-shaped deflectors and water jets are discussed. experience with present gutter design and spacing in relation to mud-ball formation is given. On underwater shrinkage of sand beds additional views are expressed. The first installment published Nov. 4, p. 934, dealt with perforated-pipe underdrains, gravel depths, blow-ups, mud balls and washing.—EDITOR.]

Part II. Top-Sand Scouring Devices—Gutter Design and Relation to Wash—Under-Water Shrinkage of Sand Beds

SINCE modern filter design has done away entirely with mechanical rakes to stir up the sand beds, and has largely eliminated any jet action from the incoming wash water, one naturally—and properly—turns his study to the sand surface, where most of the dirt accumulates in the first 3 to 6 in. It is this foreign material that must be separated from the sand grains, put into suspension and carried to the gutter edge. Midway between gutters is a plane of no horizontal velocity. Turbidity in the sand on this plane must travel the longest distance to a gutter. Probably the miniature mud ball is started here. It occurred to the editor that some special arrangement to accelerate the speed of the turbidity from this plane might be advantageous. Experience at Oakland, Cal., with jets at the sand surface indicated that a very small jet force only was necessary to project sand grains as well as turbidity long distances if directed with the normal rising current. Hence the idea of a V-shaped deflector to give the rising turbidity at this no-horizontal-velocity plane an initial start was conceived. The Oakland experience would seem to call for a very small initial push toward the gutter edges, much smaller than that given by a jet. The easiest way seemed to be to bend the vertical current, but how much? How large a deflector would be necessary? No one of those answering the question has had experience with such a deflector, but eight men have tried sand scouring by other means. The two questions on the subject were as follows:

10. Have you ever tried a V-shaped deflector (or a perforated pipe carrying wash water) in the plane midway between gutters to start more quickly the soiled wash water toward the gutters? If so, what shape did you use and at what elevation above the sand did you find it gave the best results?

11. Have you ever tried, or do you know of any scheme other than air and the old mechanical rakes to scour the sand grains at the top of the filter? Separate water jets diverting a portion of the flow from the underdrains to the top have been suggested and used with success by the Champaign-Urbana Water Co.

Mr. Clark, Toledo — Where the distance between troughs is very much greater than in the old filters at Toledo, as also in some of the older plants of the country, I can understand that the deflector might be a distinct advantage. Even then I am inclined to believe that a spray pipe just below the plane of the tops of the troughs with lateral openings will be found more effective than a deflector.

Mr. Birdsall, Minneapolis — I have never tried the V-shaped deflector, but consider the idea a good one. Perforated pipe as an experiment has been tried without much success, possibly because of lack of proper water pressure.

Mr. Daily, St. Louis — See *Engineering News-Record*, p. 1198, June 17, where is described the use of sand washer ejectors set in a filter and left running. The wash-water valve was left open just enough to keep the sand bed fluid, hence a constant supply of sand was fed to the ejector because it sunk into the softened sand bed to the bottom. No deflectors have been tried.

Mr. Ellms, Cleveland — I have never tried V-shaped deflectors or perforated pipes, discharging wash water near the surface between the lateral gutters, to accelerate the movement of the dirty wash water to the gutters. It does not seem to me that such devices are necessary, provided the gutters are placed near enough together, and are of sufficient capacity to carry away the dirty wash water. In the two large plants with which the writer has been closely connected, the edges of the lateral gutters are 6 ft. apart. It is his impression that the waste water would be more quickly removed if these lateral gutters were placed somewhat closer together.

THE NEW TOLEDO FILTERS HAVE TREE TROUGHS

When the high velocity method of washing sand is used, the sand grains are automatically scoured as a result of the flotation of the sand bed. In fact, the writer has so often observed this phenomenon in glass filter tanks that he is convinced that no action of mechanical rakes or of separate water jets could add to the scrubbing effect obtained. The rising and the descending currents of sand under the influence of water rising at the rate of from $1\frac{1}{4}$ to $2\frac{1}{2}$ ft. per minute are constantly rubbing the sand grains against each other, and must of necessity remove adhering impurities which the rising wash water carries in suspension to the zone above the floating sand.

Mr. Eldredge, Ft. Worth—I have never tried a V-shaped deflector or perforated pipe in the plane midway between gutters. I have used separate water jets (operated by hand) in the top layer of sand and along the side walls of filters to assist in the cleansing. They were made of 1-in. pipe of suitable length with holes bored in the same plane. The ends were capped, connected to a water supply with 1-in. hose and used in a horizontal plane with full high pressure stream.

Mr. Buzzell, Flint—I have never tried a V-shaped deflector or any scheme other than air, water and rakes to scour the sand grains.

Prof. Hyde Berkeley—The Blaisdell tractor washer at Yuma and Calexico does not, I believe, give any trouble with mud balls from the highly turbid Colorado River water. But the character of that turbidity, due to alkali in the water, seems to be different from that in any other stream with which I am acquainted. However, this type of washer should surely prevent the formation of mud balls if anything will prevent it.

Mr. Waring, Ohio State Board of Health—It is our opinion that many of the so-called refinements are unnecessary, such as deflectors for the wash water attached to the wash water troughs, or sand catchers and special designs of sand valves to the underdrain system.

Gutter Design and Relation to Rate of Wash

So many plants have been designed with insufficient carrying capacity in the gutters that this question and three others intimately connected with gutters were propounded. Ten men answered the four questions.

12. Is the gutter design or basis for a design as developed at Cincinnati sound as proved by practice? What modifications have been found essential?

13. Are sand catchers desirable?

14. Are the gutters too often the governing factor in the permissible rate of wash?

15. Is not the minimum distance between gutters now usually allowed too great?

Mr. Sperry, Grand Rapids—We have no need of sand catchers. In the beginning we used a local sand rather than the Cape May sand specified. This was done on the certain knowledge that any sand placed would soon lose all of its characteristics as to size of grain due to the effects of the lime softening. For this reason we saved much by using a local sand of such characteristics that after some washing in place, the beds being made purposely overfull, we washed away the finer sands, leaving us very nearly the sand as specified as to effective size and uniformity coefficient. After this washing there were no sand losses.

The local gutters have been more than ample in carrying capacity. We have often wondered whether we would not reduce some of the sand coating with a much heavier wash. At present this rate is about 2 cu.ft. per sq.ft. per minute.

Mr. Clark, Toledo—Sand catchers are desirable, especially if air and water are used together for washing. The capacity of the gutters will, of course, limit the possible rate of wash, but other factors, such as size of sand, distance from normal sand level to upper edge of gutter and whether the gutters are provided with sand catchers or not, may also set the limiting rate of wash.

The tendency in this office is toward using a less distance between gutters in order to eliminate more quickly the suspended material in the wash water. It is believed that this will result in a perceptible saving in wash water. On the other hand, the upward flow between gutters closely spaced may be so great as to give trouble through loss of sand.

The drawing in the next column shows the old and new troughs at the Toledo plant. Assuming a 24-in. wash on the new filters the rise between the troughs will average 32 in. due to the lessened area. This rate is one-third greater than the 24-in. and I am inclined to believe approaches close to the danger line.

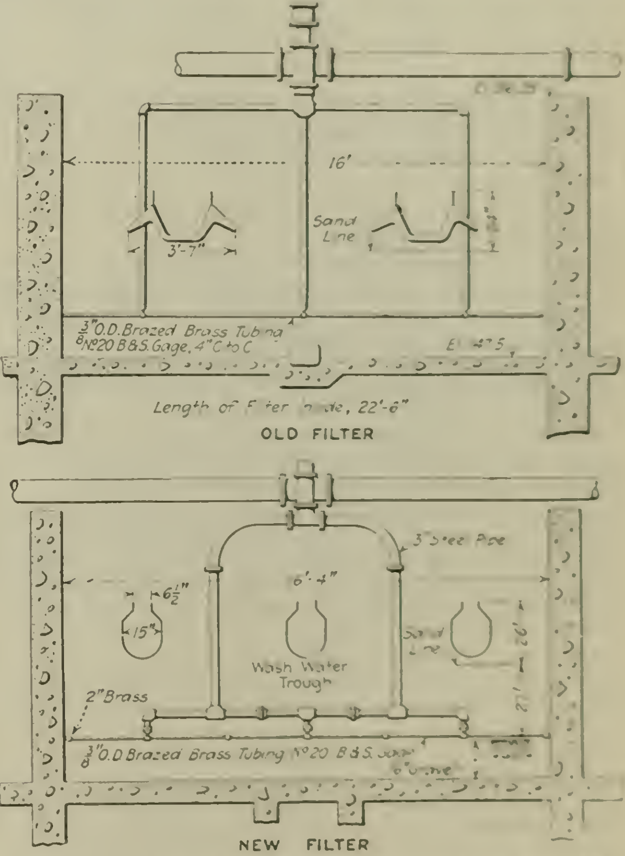
Mr. Buzzell, Flint—We are of the opinion that sand catchers are desirable and that the gutters are too often the governing factor in the permissible rate of wash. We have three gutters to each filter. (See *Engineering News-Record*, June 17, 1920, p. 1189).

Mr. Powell, Baltimore Co.—Except under unusual condition such appurtenances as sand catchers do not warrant the expenditure.

From past experience the writer is of the opinion the gutter spacing often employed is too wide, particularly so where the raw water carries a large amount of suspended matter. This condition is graphically shown on the accompanying chart plotted from our operating records. Prior to 1915 the plant consisted of two 500,000-gal. units of which each had a central wash-water trough so that during washing the water had a horizontal flow of 4½ ft. Mud-ball deposits rapidly formed along the sides and back of the filters.

In order to relieve this condition steps were cut in the front walls of the filters so that a portion of the dirty water was dischargegd into the sewer over these steps, thus creating a current along the sides of the filters. The conditions of the beds were somewhat improved by this arrangement, but the back corners still showed insufficient washing.

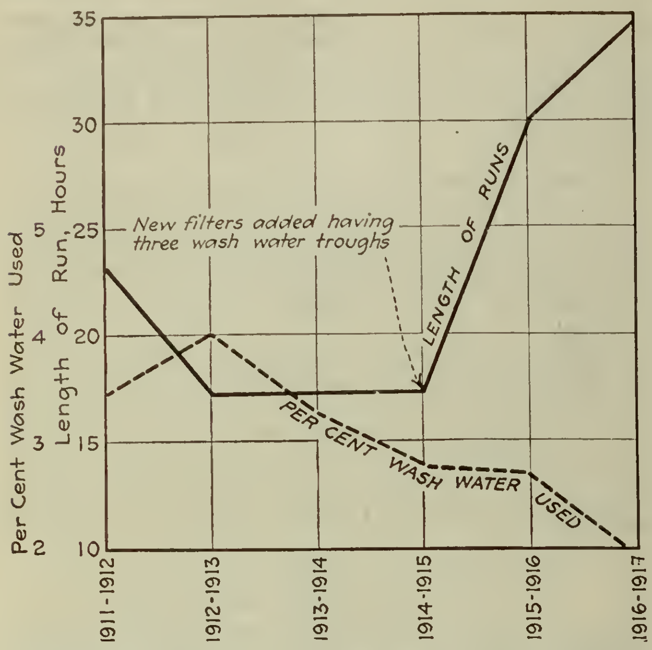
In 1915 three new units of the same size were added to the system, but three wash-water troughs were used, one central gutter of the same design as in the old units and two side ones. There was a very marked improvement in the operation of the new filters over the old ones. Mud-ball deposits were less frequent, the length of runs between cleanings was materially increased and the wash water was reduced.



OLD AND NEW WASH-WATER TROUGHS IN TOLEDO FILTER

The same improvement has been noted at the Westport filtration plant of the Consolidated Gas, Electric Light & Power Co. of Baltimore. This installation consisted originally of three 500,000-gal. units, each having a central gutter, the wash water traveling 4½ ft. horizontally. Two new units were designed with side troughs in addition to a central gutter. Fewer mud balls formed on the filters with the side troughs and better operation has been effected. The horizontal flow of water in the new filters is approximately 2 ft.

Mr. Birdsall, Minneapolis—The design is adequate. No modifications have been made other than to increase the number of troughs. The floor and the central collecting gutter is raised at the rear end of the filters and sloped toward the sewer end to save the wedge of water that would be lost each time that the filter is washed. Sand



THREE WASH TROUGHS AT BALTIMORE COUNTY PLANT IN PLACE OF ONE INCREASE RUN AND REDUCE WASH WATER

catchers are not needed at Minneapolis. The Minneapolis gutters have ample capacity.

Yes, the minimum distance between gutters is too great ordinarily. The new Minneapolis filters have nine instead of eight lateral gutters in each half filter. I would increase the number of gutters in future filters.

Mr. Daily, St. Louis — Sand catchers are not desirable with a properly designed filter. See answer to mud-ball question with reference to gutter spacing.

Mr. Ellms, Cleveland—The writer can see some advantage in the use of sand catchers on lateral gutters. Any extension from the side of the gutter in the form of an angle or of wings cuts off vertical currents rising along the side of the gutter. The zone above the projecting wings, therefore, is only subject to the horizontal currents, which, without the assistance of the flotation effects of the vertical currents, will probably not carry the sand into the gutters.

The writer is of the opinion that wash-water gutters are frequently too small. There is no doubt that the permissible rate of washing is limited by the carrying capacity of the gutters.

C. N. Miller's formula for determining the size of the wash-water gutters is undoubtedly conservative. Some observations made at the Cleveland filtration plant show that the central gutters in the tanks at this plant closely approximated the size as determined by the formula. This formula is designed to cover a condition where there is no free fall at the discharge end of the gutter. It was found in the central gutter of the Cleveland plant filter tanks, when washing at a rate of 27 in. per minute and where the outlet was submerged, that the cross-sectional area of the water in the gutter was only 3.5 per cent less than that called for by the Miller formula. The discharge from the lateral gutters falls freely into the central gutter, and Mr. Miller is careful to state that under such conditions his formula provides for a larger gutter than is necessary. In the case of the Cleveland filter tanks, the cross-sectional area of the water in the lateral gutter was found to be 76 per cent of that calculated by the Miller formula.

Mr. Eldredge, Fort Worth — I have never used sand catchers, but from the loss of sand in some plants would think them highly desirable.

The gutters are too often the factor governing the permissible rate of wash.

The minimum distance between gutters is too great. The additional first cost is soon recovered by the saving in wash water as well as in the advantage of a better wash.

Prof. Hyde, Berkeley—The gutters are too small at Harrisburg and at many other places. At Sacramento we propose ten gutters in a length of about 58 ft. This will place them 4 ft. 10 in. apart in the clear. Ordinarily the minimum distance apart has been too great.

Mr. Lovejoy, Louisville — My experience has been that sand catchers are not necessary if the filter design is right. I believe the gutters are too often the limiting factor in the permissible rate of wash.

It is my opinion that 6 ft. should be about the maximum distance between gutters, making a maximum travevl of 3 ft. each way.

Under-Water Shrinkage of Sand Beds

The day of colloids is here and the theory of the predisposition of many liquids to gel when small quantities of certain foreign matter are added has opened a world of conjectures in the minds of those chemically inclined. Abel Wolman and S. T. Powell presented in *Engineering News-Record*, July 29, 1920, p. 210, an explanation of under-water shrinkage of sand beds. Their contention is that various sands have different colloidal properties and sand should be chosen with low gel property. The questionnaire was sent out previous to the appearance of the paper although the editor had seen it. Eight men answered the one question but the experience of Messrs. Daily and Ellms has been given in the general discussion of the Wolman-Powell paper in *Engineering News-Record*, Sept. 2, p. 438.

16. Have you had any experience with the under-water shrinkage of sand beds away from the side walls? Maryland engineers have made an exhaustive study of the phenomenon and set up a theory attributing the action to colloids forming a gel which contracts the bed.

Mr. Clark, Toledo — Under-water contraction has been experienced only when softening was being done and has been attributed in part to magnesium hydrate and organic material adhering to the sand grains.

Mr. Birdsall, Minneapolis—Yes, the shrinkage has been noted. I believe the theory of the Maryland engineers is correct. The formation of jelly-like deposits along the side walls of filters at Minneapolis is attributed to the fact that holes in the strainer plates do not extend up to the side walls because of the concrete shoulders on which the ends of the strainer plates rest. I would change this design in future filters.

Mr. Eldredge, Ft. Worth — In most cases under-water shrinkage of sand beds was relieved when the filters were getting a properly treated water. Overloading the filter with "floc" has often caused such cracks to appear. On draining such a filter it usually shows low in the center.

Prof. Hyde, Berkeley—At Sacramento we propose to overcome any difficulties of this sort by battering the inside walls of the filter units.

Mr Lovejoy, Louisville—We had trouble with shrinkage of the sand beds away from the side walls in our old filter units until we removed the holding-down screens. We also had trouble with the sand caking with mud for 2 or 3 in. from the walls. Both of these troubles have disappeared since we removed the screens. My theory is that there was a lack of wash-water velocity close to the side walls, due to the fact that the mesh of the holding-down screen was more or less stopped up with concrete near the walls, thus diverting the water away from the wall during washing. This clogging of the screen also would tend to make the area of sand close to the walls a dead area during filtration, due to this sand having been caked with mud from lack of washing. This condition would tend to pull the sand away from the walls toward the center of the filter where the greater suction existed. The suction or downward pull on the sand bed is an appreciable factor in filters operating on negative head as in our case.

Mr. Waring, Ohio State Board of Health—To overcome the tendency of sand beds to shrink away from the side walls, J. M. Rice of Morris Knowles, Inc., has suggested in the design of the Elyria, O., plant battered side walls below the sand line. Experience in Ohio is lacking on this phenomenon.

State Hydro-Electric Development for South Dakota

Engineer's Report on Project to Distribute Power From Missouri River Over 1,200 Miles of Transmission Lines

POWER development and supply by the State of South Dakota by means of a hydro-electric plant on the Missouri River at Mobridge, S. D., with distribution over transmission lines covering a large area of the state, is discussed in a recent report to the State Hydro-

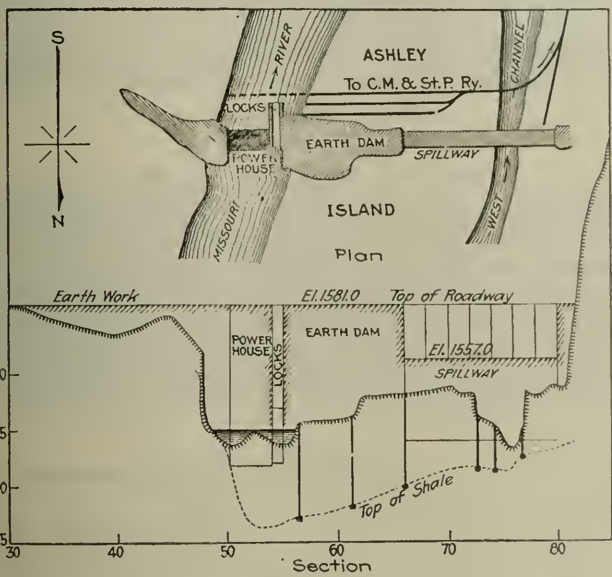


FIG. 1. PROPOSED HYDRO-ELECTRIC PLANT ON THE MISSOURI RIVER AT MOBRIDGE, S. DAK.

Electric Commission by D. W. Mead and C. V. Seastone, consulting engineers, Madison, Wis. This report is the result of an investigation of the possibilities of power development on the Missouri River, following the passage of an amendment to the state constitution to provide for state ownership and operation of power plants. In February, 1919, Governor Norbeck appointed the State Hydro-electric Commission, under whose direction the investigation has been made.

Eight sites for power development were studied, the best of which is about four miles above Mobridge, where the minimum continuous output would be about 16,000 hp. A plan and section of the proposed works are shown in Fig. 1. It is stated in the report that if this project should be undertaken at once, it can be completed probably by 1925. The estimated cost is $9,103,000 for the power plant and $7,044,000 for the transmission system, but if secondary transmission lines and substations are built by the various communities the total cost to the state might be reduced to about $13,900,000. Transmission lines would serve mainly the more populated eastern part of the state. In this section the market available in 1919 offered a load of 30,000,000 kw.-hr. per annum now developed from fuel and this market may increase at about 10 per cent per annum by the encouragement affected by cheap power.

Cost of power from fuel at various plants in the state varies from 1.7 to 10c. per kw.-hr. if based on entire station charges, or from 1 to 5c. per kw.-hr. if based on fuel costs only. With the entire output of the proposed hydro-electric plant sold, about 87,600,000 kw.-hr. per annum, power can be developed at this plant at a unit cost of 1.60c. per kw.-hr. If the state pays the entire cost, or 1.34c. if customers furnish the secondary transmission system. Charges of 1.87c. or 1.67c. per kw.-hr. respectively, would give a profit above fixed and operating costs and these prices could be increased fairly with the gradual rise in fuel prices.

For the first five years, however, these prices for the present available market would not produce sufficient to pay interest and operating expenses or depreciation charges, but a further investment of $1,500,000 would be required temporarily to meet the unearned interest. When the market increases to 53,000,000 kw.-hr. per annum the income would pay interest and operating charges, and with further increase in consumption of current it would gradually retire the development fund, establish a depreciation fund and begin to retire the capital costs. If the market should develop to 53,000,000 kw.-hr. per annum before the plant is completed, the additional $1,500,000 would not be required.

Proposed Developments

If the market should warrant the investment the Mobridge plant could be developed for a 40-ft. head at an additional cost of $2,300,000. With the resulting total output of 117,000,000 kw.-hr. per annum marketed the unit cost of current would be reduced to 1.35c. per kw.-hr. As an alternative a second plant could be constructed at the Mulehead site, near the southern boundary of the state. With both plants working at 30-ft. head and selling their entire aggregate output of 200,000,000 kw.-hr. per annum the unit cost of current would be about 1.2c. per kw.-hr. per annum.

That the state can afford to undertake the Mobridge development with every prospect of financial returns to maintain and ultimately liquidate the investment, is the general conclusion of the report, provided that a growth of 10 per cent per annum for the power market can be anticipated with good reason. It is pointed out, however, that such results can be attained only by conservative financing, economic construction and scientific management, under intelligent administration free from political interference.

As to private enterprise, the report states that in view of the high cost of development and the great length of transmission to reach the limited market, the returns would be too small to attract private capital. Only that part of the state east of the Missouri offers a market for power at present, and even there the scattered locations require a comprehensive and costly distribution system. In fact this system will cost almost as much as the development plant. In that section of the state are 29 towns or groups of towns which in 1919 had an aggregate power consumption of 38,467,000 kw.-hr. per year.

The average and minimum flow at Mobridge including the effect of pondage by the dam, is estimated at 10,000 and 4,100 sec.ft., equivalent to 25,000 and 16,000 hp. continuously at the turbine shaft under 30 ft. head.

A flood flow of 100,000 sec.ft. may occur perhaps once in five years and last for three or four days. A high flood of 180,000 sec.ft. has occurred only once since 1892.

At the selected site the low-water flow is divided by an island between the main channel and a side channel. The proposed layout includes a power house 384 ft. long across the main channel, with an adjacent lock 60 x 350 ft. having 7 ft. of water on the lower miter sill. Next to this will be 1,200 ft. of earth embankment with concrete core walls, followed by a 1,400-ft. concrete dam and spillway extending across the island and the smaller west channel. A cut-off of steel sheeting would be driven into the underlying shale stratum for the entire length of the structures, the maximum depth of this shale being through 50 ft. of silt in the main channel. The spillway crest is at El. 1,557 and the roadway and top of earth embankment at El. 1,581.

By placing the spillway at the west end, it is located where the shale comes within 5 to 25 ft. of the river bed. The power house and lock are placed in the main channel in order to provide a free flow from the draft tubes and to assure a low-water navigation channel in the tail water. Silt is not expected to have any serious effect in reducing the capacity of the pound or in causing erosion of the turbine blades. The power estimate is based on the normal flow and not on storage and it is believed that the annual floods will keep the channels secured sufficiently to supply the limited storage necessary to supplement the ordinary deficiencies of flow.

A hollow dam of reinforced-concrete is proposed for the spillway, as shown in Fig. 2. This would have the deck supported by 36-in. buttresses or walls spaced 12½ ft. c. to c. Two lines of steel sheeting 10 to 30 ft. long are provided under the upstream side of the dam, a third line of sheeting under the toe of the downstream apron will be a protection against back scouring and may help to prevent the development of uplift pressure on the dam during abnormal height of tail water. Beyond this concrete apron is a boulder fill 30 ft. long, resting on a brush mattress and retained in position by a line of timber piles. With a rise of 21 ft. of water over the crest the spillway would have a discharge capacity of 500,000 sec.ft., which is 60 per cent in excess of the greatest discharge known at this point. Ten vertical shaft turbines of 6,000 hp., directly connected to ten generators of 5,400 k.v.a. would be the main power house equipment. Alternating current generated at 6,600 volts would be transformed to 110,000 volts for delivery to the transmission lines. This would be stepped down to 33,000 volts for distribution to the smaller towns and villages. Twelve substations are provided for, spaced from 30 to 100 miles apart. The main transmission line system would aggregate 560 miles and the secondary system 600 miles.

This report was considered by the Special Water Power Committee at a special meeting of the state legislature in June, but final consideration was deferred until the regular meeting to be held in February, 1921.

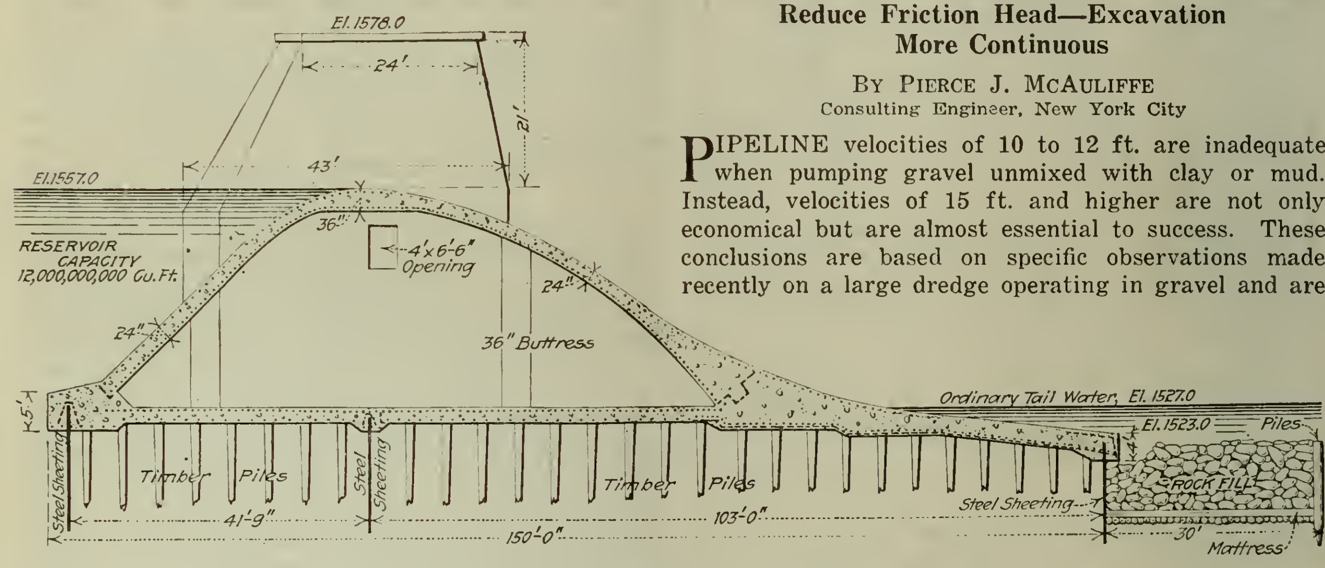


FIG. 2. SPILLWAY OF DAM FOR HYDRO-ELECTRIC PLANT

Pipe Line Velocities Necessary to Transport Gravel

Small Increases in Velocity Increase Output and Reduce Friction Head—Excavation More Continuous

By Pierce J. McAuliffe
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PIPELINE velocities of 10 to 12 ft. are inadequate when pumping gravel unmixed with clay or mud. Instead, velocities of 15 ft. and higher are not only economical but are almost essential to success. These conclusions are based on specific observations made recently on a large dredge operating in gravel and are confirmed by general experience with many pumps handling all varieties of materials. On several occasions these conclusions have been put to test, with gratifying results, although, in some instances where horse power and not peripheral speed of the runner was the limiting factor, it has called for the seemingly paradoxical action of decreasing the diameter of the entire pipe line to obtain greater output.

In the specific observations referred to, the dredge has a 20-in. suction and discharge pipe. The pump, using a 90-in. runner, is directly connected to a 1,000-i.h.p. engine (17 in. and 27½ and 42 in. x 20 in.). At a speed of 205 r.p.m. the engine has shown 1,015 i.h.p. The boilers are of ample size to maintain steam pressure at 200 lb., even when burning hard coal screenings. The condenser vacuum is held quite steadily at 25 in. The auxiliary machinery has been performing satisfactorily during the eight years that the dredge has been in operation. The crew and operation were excellent.

During the observations, the dredge was engaged in digging a channel where a large portion of the material consisted of coarse sand, heavy gravel and some stones which would not pass through a 10-in. ring. The pipeline varied in length from 1,800 ft. to 3,700 ft. and

eventually it will reach a length of 5,500 ft. The elevation from water level in the channel to the center of the end length of discharge pipe varied from 8½ to 14½ ft., depending upon the tide.

Discharging through 2,400 ft. of pipe, Fig. 1 shows the stream and Fig. 2 indicates the character of the material. Excepting the large stone the material was sand and gravel under 1 in. in size. The discharge velocity caught by Fig. 1 was about 12 ft. a second and the stream was carrying as much solid material as could be handled without choking.

Simultaneous gage readings taken at the moment the picture was snapped showed the pipe suction to be 12 in. and the pipe line pressure to be 64 lb. Corrected for gage location and static head of discharge, the friction totaled 131 ft. head; equivalent to 6 ft. per 100 ft. of discharge pipe. The dredge delivered an average of 120 cu.yd. per hour actual operating time. The discharge stream was, therefore, carrying an average of about 3½ per cent of solids. The important feature is that with this velocity of discharge the operator was unable to feed material into the suction constantly. The cutter was turning over at as low a speed as possible consistent with steady revolutions. Only sufficient strain was put on the swinging wires to pull the cutter into the material slowly. After digging for 45 to 50 min. at this rate, the operator would find it necessary to stop his cutter and swinging engine for about 10 min. in order to pump water so that the surplus material which had been taken into the pipe, but which could not be kept moving, could be picked up again and discharged. In other words, 16 to 20 per cent of the running time was fruitless as far as sucking up solids was concerned. On this score alone, a dredge, which would have delivered 400 cu.yd. per hour of mud or clay, would have its capacity cut to 320 cu.yd. per hour when it encountered material such as shown by Fig. 2. In addition, as the swinging and cutting speeds were less than half the normal, the output would be further reduced by at least 50 per cent. As this particular dredge had experienced no difficulty in delivering over 600 cu.yd. of mud and clay per hour through pipe lines of equal length, the owner might have taken the contract at a figure far too low if he had not understood the difficulties presented in moving heavy gravel.

FIG. 1. DISCHARGE THROUGH 2,400 FT. OF PIPE; VELOCITY 12 PER SEC.

FIG. 2. MATERIAL DISCHARGED BY STREAM SHOWN IN FIG. 1

FIG. 3. STREAM FROM 3,400-FT. PIPE LINE; VELOCITY 10½ FT. PER SECOND

FIG. 4. MATERIAL DISCHARGED BY STREAM SHOWN IN FIG. 3

Discharging through a 3,400-ft. pipe line, Fig. 3 shows the stream and Fig. 4, the material. On the dump the composition was estimated to be 60 per cent clean sand; 15 per cent ¼ to 1½ in. gravel; 20 per cent 1½ to 4-in. gravel, and 5 per cent stones over 4 in. in size. The engine was making 210 r.p.m.; the pipeline pressure registered 65 lb., and the pipe suction was 8 in. The friction developed in each 100 ft. of discharge pipe was equivalent to 4.4 ft. head. The writer estimated that the velocity on the basis of a full 20-in. pipe would have been 10½ ft. per second. The average output per hour under these conditions was 85 cu.yd.; the percentage of solids in suspension was, therefore, 2.84 per cent. The operator found it necessary to pump clear water for at least 20 min. after feeding as slowly as possible for a period of 35 to 40 min.

As the amount of work in view did not warrant the installation of a booster, it was decided to install a larger runner to meet the conditions imposed by the necessity of longer pipelines. A 96-in. runner was installed. The pipeline was 3,560 ft. long and the elevation the same as for the previous observation. The engine speed was from 198 to 202 r.p.m. and it was undoubtedly developing very nearly 1,000 i.h.p. The material, shown by Fig. 5, was entirely sand and gravel. A larger percentage of stones above 2-in. size was present than in previous observations.

Fig. 6 shows the discharge under normal operating conditions. The horizontal offset of the upper curve of the discharge stream was 3.75 ft. where the vertical coordinate was 1 ft. Using an arbitrary factor of 0.92, which the writer has selected after numerous rough checks, the average velocity of discharge was found to be 13.8 ft. per second.

One hundred fourteen hours actual operation produced an average of 110 cu.yd. per hour, or 34 per cent over results obtained with a 90-in. runner under similar conditions. The pipeline vacuum and pressure gage recorded 9 in. and 66 lb. respectively. The friction per 100 ft. of pipeline was slightly over 4 ft. The percentage of solids carried was about 3.6.

FIG. 5. LARGER PERCENTAGE OF STONES ABOVE 2-IN. SIZE WHEN 96-IN. RUNNER USED IN DREDGE PUMP

FIG. 6. VELOCITY OF 13.8 FT. PER SECOND—DISCHARGE OPERATING NORMALLY

FIG. 7. VELOCITY 16.2 FT. PER SECOND; STREAM HEAVILY CHARGED WITH SAND

FIG. 8. VELOCITY 15.6 FT. PER SECOND; WATER ONLY BEING PUMPED

Since the material was moving briskly throughout the entire pipeline, it would appear that the saturation point for this velocity of discharge in a 20-in. pipe, when carrying material shown by Fig. 5, is about 4 per cent of solids. The lower friction head is probably accounted for by the fact that the material was all in suspension throughout the line, so that no congestion of solids occurred at various points, which was probably the case in the two previous observations. The solids were of course traveling in the lower part of the pipe at a velocity considerably less than the average of the mixture.

Shortly after Fig. 6 was recorded the operator was signalled to stop excavation but to continue to pump water. It required 8 min. 20 sec. before all solids had been discharged from the pipeline, which, with the suction pipe, totaled 3,660 ft. The velocity of discharge increased slowly at first until it reached its maximum at about the time Fig. 7 was taken. This was 7 min. 10 sec. after digging had ceased. This picture shows the stream heavily charged with sand, as is made quite evident by the shape of the lower curve of the discharge.

The time interval was too short to make any but the roughest check on the percentage of solids carried at this maximum velocity, but the bottom section of the pipe for a depth of 6 in. was filled with a rapidly moving stream of sand. If we consider that the voids in this stream of sand represent 50 per cent of its volume, a cross-section of the discharge would have shown over 12 per cent of solids in suspension, from which it is evident that the capacity of a stream in carrying solids increases rapidly with relatively small increases in velocity and explains why dredge operators maintain high velocities when possible.

After the pipe was entirely cleared of sand and stone, Fig. 8 was taken. Attention is drawn to the difference in the shapes of the lower curves in Figs. 7 and 8. In the latter the arcs of the upper and lower curves are apparently parallel, while it is evident that the sand in the lower half of the pipe, Fig. 7, was traveling at a lower rate than the water above it. After Fig. 8 was taken, the operator was signalled to resume digging. From the instant the cutter encountered solid material until the first discoloration of the discharge appeared at the end of the pipe, 4 min. 10 sec. elapsed, showing that the average velocity through the discharge pipe during that period was 14.66 ft. per second.

Upon resumption of digging, the operator continued to feed solids into the suction at the customary rate. It is, therefore, probable that the discharge stream was saturated for at least one-half of its total length by the time the first discoloration appeared at the end, and that we are reasonably correct in supposing that the velocity found by this test was a mean between that shown when dredging normally and that found when pumping clear water only. If we put this to test it will be found that it agrees quite closely with the mean of the velocities of 13.8 ft. and 15.6 ft. per second as estimated from Figs. 5 and 8, respectively. No effort was made to bring these figures into agreement. It was only as an afterthought that some relation between the two was looked for.

Another point of interest is, that it required exactly double the time to clear the pipe of all solids that it took for the first appearance of solids to show again after the pipe had been cleared, which would seem to indicate that the velocity of the solids dragging along the bottom of the pipe was about one-half the average velocity of the total discharge.

Wisconsin Doing Much Highway Bridge Work

During 1920 a large amount of highway bridge construction was initiated in Wisconsin under supervision of the State Highway Department. Plans were prepared by the department for 540 bridges, totaling in length 15,315 ft., and to cost 2¼ million dollars. About half the total represents state-aid work, and only about one-seventh Federal-aid work, the remainder being county construction. The figures given cover only the first three quarters of the year.

Nine Years' Operation Results of the Municipal Garbage Reduction Works at Columbus, Ohio

City Reports Show Surplus for Each Year Except 1919, but Taking All Factors Into Account There Is a Deficit That Makes Net Cost 46 Cents a Ton Without Interest and 87 Cents With Interest

By James W. Follin
Engineer, Bureau of Municipal Research of Philadelphia

TEN years' operation of the municipal garbage reduction works at Columbus, Ohio, was completed on July 20. An analysis of the financial results for the nine calander years 1911 to 1919 is here presented. This plant has been of especial interest to engineers and municipal officials because it was the first municipally constructed and operated reduction plant. Frequent reference has been made to the Colmubus solution of the garbage disposal problem as worthy of emulation in other cities, and the plant has been visited extensively by engineers and laymen.

Until operating results from the Columbus plant were published, no reliable records were available concerning the expense and income from garbage reduction except those from the Cleveland plant, which had been purchased from a private company about 1905. When the first reports from Columbus indicated a surplus of production income over plant operating expense, the result was hailed by many as pointing the way to the general solution of the garbage disposal problem in furnishing a method not only providing disposal with dispatch and under conditions acceptable to all but the most fastidious, but also one actually returning a profit. Advocates of municipal operation also received these early reports with much interest and considered that they dispelled the fears that a municipality could not advantageously operate a plant which called for expert supervision and which had been almost entirely owned hitherto by private companies.

Several analyses of the operating results made by engineers soon after operation began served to correct in some degree the popular impression that the plant was making large profits. In these analyses freight and depreciation charges were added to the cost of disposal, while interest charges were also deducted from the indicated surplus to afford a comparison with privately owned plants. In connection with a survey of the city government of Columbus in 1916, the Bureau of Municipal Research of New York analyzed the plant operation and indicated an excess of receipts over operating and fixed charges of only $12,575 for the five years 1911 to 1915 and the first ten months of 1916. Operating expenses did not include a charge for water supplied from the city mains after 1912. It was estimated that water was used at a rate of 20,000,000 cu.ft. per year, which at 80c. per 1,000 ft. would total $81,350 for the period covered. Including this latter amount in the operating expenses the plant showed a net loss of $68,775 to Nov. 1, 1916.

The annual reports of operation have shown a surplus of production revenue over plant operating expense for each year of operation except for 1919, when a deficit of $20,899 is given. The 1919 report was doubtless received with disappointment by those who had misconstrued the record of operation previous to 1919 and who had thought that the plant was making an actual profit on the disposal of garbage.

Description of Plant—The Columbus plant was described in detail in articles which appeared soon after operation began, and it is unnecessary to repeat this detailed description here. (See *Engineering News*, Nov. 17, 1910 and *Engineering Record*, Nov. 19, 1910.) The garbage is cooked by live steam in 10-ton sealed steel digestors. The liquids are pressed from the cooked mass and flow to tanks where the grease is separated from the stick liquor, which is reduced by evaporation and added to the dried solids from the presses. Originally, the latter mixture was dried and sold as a fertilizer base without further degreasing, but in January, 1912, a percolator plant was put into operation. After percolation with gasoline, the tankage is again dried and then screened. Some of it is sold in this condition, but acid phosphate is added to another portion and the mixture is sold directly as a fertilizer.

The most important change in the plant equipment has been the substitution of direct-heat dryers for the steam-jacketed dryers initially installed.

The original investment in the building and equipment was about $185,000, but adding the cost of the land, railroad siding, steel tank cars and engineering, the total reached $236,881. About $26,000 additional was spent for the percolator plant. In making allowance for depreciation charges in this analysis, depreciation has been figured at 5 per cent per annum, in accordance with former reports on this plant, on an investment of $236,881 in 1910 and 1911, and of $262,881 from 1912 on. A straight depreciation charge on the entire investment is necessary in view of the non-availability of information with which to classify the investment details. Yearly interest charges in this analysis are figured at 4 per cent on the depreciated value of the plant, and not on the full investment.

Detailed Analysis of Operation—In Table I is presented a compilation of information on garbage collection and disposal taken from the annual reports, where available, and from other sources. Since a record was not obtainable for the portion of the year 1910 in which the plant operated, the table begins with the year 1911. To facilitate comparisons from the table, the percentage of increase or decrease in each item is shown between the year 1916 and each of the years 1917, 1918 and 1919, and finally between the years 1918 and 1919.

The tonnage of garbage collected increased steadily from 1911 to a maximum in 1915, but had fallen off about 5 per cent in 1916 before it took a 22 per cent drop in 1917 and declined still lower in 1918—just as the quantity of garbage collected in practically all cities decreased during the period of the war. In 1919 the collection increased 16 per cent above the 1918 quantity. The high point in 1915 represented a maximum per capita collection of 218 lb. for the year, while a minimum of 142 lb. per capita was reached in 1918. The increase in collection in 1919 raised the per capita figure to 153 lb.

Table I—Detailed Analysis of Operation of Columbus, Ohio, Municipal Garbage Reduction Plant, 1911-1919

Plant put into operation, July 20, 1910; Percolator plant in use, January, 1912

Item		1911	1912	1913	1914	1915	1916	1917	1918	1919	Percentages of Increase or Decrease 1916 to 1917	1916 to 1918	1916 to 1919	1918 to 1919
	Garbage Collection													
1	Estimated population	188,000	194,000	200,000	205,000	210,000	215,000	220,000	220,000[7]	237,031[6]	—	—	—	—
2	Number of tons collected	17,534	18,789	20,711	21,629	22,909	21,861	17,127	15,630	18,126	— 22	— 29	— 17	+ 16
3	Pounds per capita collected	187	194	207	211	218	203	156	142	153	— 23	— 30	— 28	+ 6
4	Total collection cost delivered to loading station	......	......	......	......	$41,823	$44,842	......	$54,700	$52,835	—	+ 22	+ 40	+ 15
5	Pe. ton collection cost delivered to loading station	......	......	......	......	$1.83	$2.05	......	$3.50	$3.47	—	+ 70	+ 69	—
6	Per capita collection cost delivered to loading station	......	......	......	......	$0.198	$0.208	......	$0.249	$0.265	—	+ 22	+ 23	+ 1
7	Labor cost in collecting and loading	......	......	......	......	......	$21,152	......	$25,786	$30,604	—	+ 22	+ 45	+ 19
8	Stable cost in collecting and loading	......	......	......	......	......	$16,434	......	......	$27,342	—	-	+ 66	—
	Garbage Disposal													
9	Tons garbage reduced during year	17,534	18,789	20,711	21,629	22,909	21,861	17,127	15,630	18,126	— 22	— 29	— 17	+ 16
10	Tons per day reduced (aver. for 313 days)	56	60	66	69	73	70	55	50	58	— 22	— 29	— 17	+ 16
11	Tons per day reduced (max. month)	......	......	......	......	106	100	85	63	80	—	— 26	— 20	+ 27
12	Tons per day reduced (min. month)	......	......	......	......	54	48	39	39	42	—	— 19	— 13	+ 8
13	Tons of grease extracted	391	511	548	593	507	672	388	338	352	— 42	— 50	— 52	+ 4
14	Per cent of grease extracted	2.227	2.721	2.697	2.744	2.214	3.076	2.261	2.164	1.942	— 26	— 30	— 37	— 10
15	Value of grease per 100 lb.	$4.39	$4.17	$3.75	$4.325	$3.76	$5.16	$7.50	$11.75	$6.72	+ 45	+128	+ 30	— 43
16	Total value of grease	$34,325	$42,560	$40,839	$52,672	$38,049	$69,452	$58,398	$79,492	$47,372	— 16	14	— 32	— 40
17	Tons of tankage produced	2,344	2,186	2,095	1,753	2,298	2,253	1,754	1,603	1,558	— 22	— 29	— 31	- 3
18	Percentage of tankage produced	13.37	11.64	10.10	8.10	10.031	10.307	10.214	10.258	8.60	— 1	— 1	— 17	— 16
19	Value of tankage per ton	$9.87	$8.02	$6.79	$7.41	$7.00	$7.84	$10.85	$19.80	$15.65	+ 38	+153	+100	— 21
20	Total value of tankage	$23,164	$17,537	$14,223	$12,988	$16,082	$17,672	$19,015	$31,708	$24,336	+ 8	79	+ 38	— 23
21	Total value of production	$58,722	$61,729	$56,800	$66,722	$55,364	$88,564	$79,344	$112,288	$73,248	— 10	27	— 17	— 35
22	Per ton value of production	$3.35	$3.29	$2.74	$3.085	$2.42	$4.05	$4.62	$7.18	$4.05	+ 14	77	0	— 44
23	Total cost of plant operation (1) (As given by city reports)	$32,482	$38,504	$39,560	$40,221	$44,453	$48,424	$71,911	$85,621	$94,147	+ 48	67	+ 94	+ 10
24	Per ton cost of plant operation (1)	$1.85	$2.05	$1.91	$1.86	$1.94	$2.22	$4.19	$5.47	$5.19	+ 89	+146	+134	— 5
25	Production value minus operation cost (total) (21-23)[2]	$26,239	$23,225	$17,240	$26,502	$10,911	$40,140	$7,433	$26,667	$20,899(loss)	— 84	—134	—	—
26	Production value minus operation cost (per ton) (22-24)[2]	$1.50	$1.24	$0.83	$1.226	$0.477	$1.836	$0.433	$1.71	$1.15(loss)	— 76	— 7	—	—
27	Total freight charge loading sta. to plant	$3,260 j	$3,500[4]	$3,850[4]	$4,020[4]	$4,250	$4,095	$3,185[4]	$3,545[5]	$4,137	—	— 13	+ 1	+ 17
28	Per ton freight charge, loading sta. to plant	$0.186 j	$0.186[4]	$0.186[4]	$0.186[4]	$0.186	$0.187	$0.187[4]	$0.227	$0.227	0	+ 21	+ 21	0
29	Total charge for plant depreciation (at 5%)	$11,844	$13,144	$13,144	$13,144	$13,144	$13,144	$13,144	$13,144	$13,144	0	0	0	0
30	Per ton charge for plant depreciation	$0.68	$0.70	$0.63	$0.61	$0.57	$0.60	$0.77	$0.84	$0.72	+ 28	+ 40	+ 20	— 14
31	Total charge for city water[3]	$0.00	$0.00	$12,291	$12,291	$12,291	$12,291	$12,291	$12,291	$12,291	0	+ 0	0	0
32	Total cost of garbage disposed (23+27+29+31)	$47,586	$55,148	$68,845	$69,676	$74,138	$77,954	$100,431	$114,601	$123,719	+ 29	+ 47	+ 59	+ 8
33	Per ton cost of garbage disposal	$2.72	$3.09	$3.32	$3.23	$3.23	$3.56	$5.86	$7.32	$6.82	+ 65	+105	+ 92	— 7
34	Interest charge at 4% on depreciated plant value	$9,238	$9,753	$9,227	$8,701	$8,175	$7,650	$7,124	$6,598	$6,072	— 7	— 14	— 21	— 8
35	Net profit from garb. disp. (21 minus 32 and 34)	$1,898	$6,581	......	......	......	$2,960	......	......	......	—	—	—	—
36	Per ton profit from garb. disp.	$0.11	$0.35	......	......	......	$0.13	......	......	......	—	—	—	—
37	Net expense of garb. disp. (32 plus 34 minus 21)	......	......	$21,272	$11,655	$26,949	......	$28,211	$8,911	$56,543	—	—	—	+512
38	Per ton expense of garb. disp.	......	......	$1.03	$0.54	$1.18	......	$1.65	$0.57	$3.10	—	—	—	+443
39	Per capita expense of garbage disposal	$0.01(profit)	$0.034(profit)	$0.10	$0.05	$0.12	$0.01(profit)	$0.16	$0.04	$0.24	—	—	—	+500
40	Labor cost of reduction	$21,681	$24,171	$20,744	$20,222	......	$22,691	$25,891	$31,601	$37,703	+ 14	+ 39	+ 66	+ 19
41	Fuel cost of reduction	$5,965	$7,443	$6,864	$6,777	$7,021	$9,145	$25,027	$21,291	$19,664	+174	+133	+115	— 8
42	Fuel consumption per ton of garbage, in tons	......	......	0.225	0.225	0.251	0.273	0.373	0.411	0.378	+ 37	+ 42	+ 58	— 8
43	Gasoline consumption per ton of garbage, in gals.	......	......	0.874	0.884	1.235	0.866	1.134	1.664	1.647	+ 31	+ 31	+ 92	— 1
44	Power consumption per ton of garbage, in kw. hours	......	......	5.17	4.48	4.321	5.144	7.293	9.877	7.715	+ 42	+ 42	+ 92	— 22
45	Profit from percolator operation, per ton	No percolator	......	$0.482	$0.679	......	$0.78	$1.474	......	....	+ 89	—	—	--

1 Not including charge for water used from city mains, see item 31. 2 These figures are given in the city reports as profit or loss from the operation. 3 Plant used city water, 1913–1919, metered use in 1919, used as basis for each year's charge. 4 Estimates same per ton as years 1915 and 1916. 5 Estimates same per ton as year 1919. 6 1920 Census population. 7 Population used in city report.

Based on a city ordinance passed in 1912, the campaign to eliminate private garbage collection was progressing satisfactorily until the courts held the ordinance to be invalid. It is estimated that private collectors now cut in to the extent of from 8 to 10 tons of garbage per day, which is a considerable loss in view of the average daily tonnage of only 58 tons in 1919. The plant was designed with the intention of handling the city's entire garbage production. The eight digestors have a nominal capacity of 10 tons each in 12 hours, or a total of 160 tons in 24 hours. During the maximum year 1915, the average daily tonnage was only 73, while the same for the maximum month was only 106. It is therefore decidedly to the interest of the city to get all of the garbage produced.

The percentage of grease extracted is deduced from the total grease production and the total weight of undrained green garbage as weighed in the tank cars on arrival at the plant. With the introduction of the percolation process in 1912, the recovery of grease rose from 2.227 per cent in 1911 to 2.721 per cent in 1912 and reached a high value in 1916 of 3.076 per cent. There was a sharp drop of 26 per cent from 1916 to 1917, and 30 per cent from 1916 to 1918, but the lowest grease content of record was 1.942 per cent in 1919. A drop in grease content was to be expected in 1917 and 1918, because of the preaching of conservation, but it was naturally supposed that the watchfulness over the garbage pail would be relaxed in 1919.

Prices received for grease fluctuated between $3.75 and $4.39 per 100 lb. from 1911 to 1915. In 1916 there was a sharp rise to $5.16, and in 1917 to $7.50, but in 1918 the unprecedented price of $11.75 was received, an increase of

over 200 per cent above average prices of the pre-war period. The Columbus plant received only $6.72 for grease in 1919 due to a sharp drop in the market, although some other plants managed to sell at a higher figure.

Tankage prices, which fluctuated between $6.79 and $9.87 per ton in the years 1911 to 1916, jumped to $10.85 in 1917, and to $19.80 in 1918, an increase of 153 per cent over the 1916 price. The percentage of decline in 1919 following the armistice was much less than was the case with grease, a price of $15.65 per ton being received.

Items 25 and 26 in Table I give the total and the per ton excess of production revenue over plant operating expense as found in the city reports. It is these figures in the annual reports which are designated as profit from the operation. Each year except 1919 shows an excess of revenue; the largest total—over $40,000, or $1.84 per ton—is shown for 1916. But, as has been stated previously, these figures do not show actual profit.

Item 32 gives the total cost of garbage disposal from the time that the garbage is delivered to the city loading station. To the cost of plant operation, as given in the city reports and shown in item 23, is added the freight charge from the loading station to the plant, the charge for plant depreciation, and a charge for city water used. Originally the condenser cooling water was obtained from the river, and subsequently from deep wells, but since 1912 water has been used from the city main which supplies the sewage-works. Until July, 1918, the water used at the garbage plant was not separately metered. The metered usage in 1919 was 15,195,000 cu.ft., which at prevailing rates to consumers was worth $12,291. The reports of the Water Department indicate that this sum is not greatly in excess of the actual cost of supplying the water, which is both softened and filtered. In lieu of meter readings, a uniform charge of $12,291 is made for each of the years 1913 to 1919. This charge is less than that made in 1916 in the report by the New York Bureau of Municipal Research previously referred to.

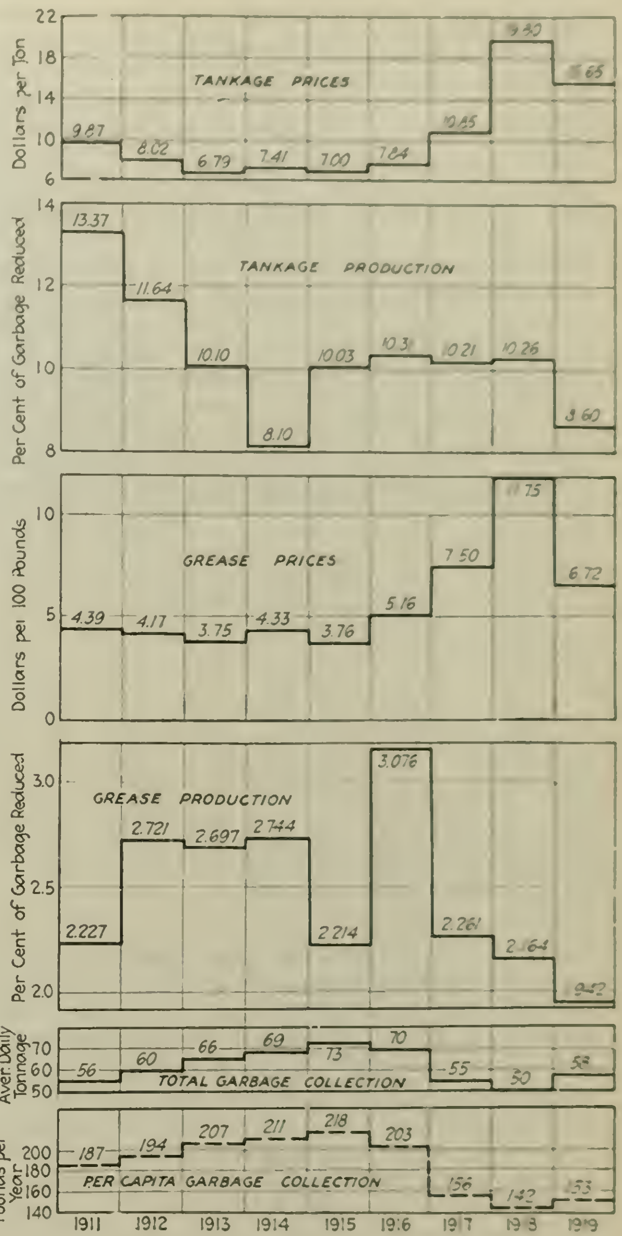
In order to compare the total expense chargeable to garbage disposal with like figures for other plants an interest charge of 4 per cent on the depreciated value of the plant (item 34) is added to item 32 and is then balanced against the production revenue to give the net profit or the net cost of garbage disposal to the taxpayers. From an examination of items 35 and 37 it will be seen that in the three years 1911, 1912 and 1916 there was an actual profit over and above all charges, but in the other six years garbage disposal did not pay for itself, the heaviest deficits occurring in 1917 and 1919. These figures are further analyzed on per ton and per capita bases in items 38 and 39.

Cost of Garbage Disposal During Nine Years—In Table II are summarized the tonnage of garbage handled per year, the total cost of garbage disposal and the production revenues for the nine years 1911 to 1919. A total deficit of $79,337 is shown, or $0.46 per ton of garbage handled, without the inclusion of interest charges. This deficit was met by general taxation and does not add to the investment in garbage disposal, so that interest charges in the last column of Table II are

TABLE II. SUMMARY OF YEARLY OPERATION OF COLUMBUS GARBAGE REDUCTION WORKS, 1911–1919

Year	Tons of Garbage Reduced	Total Cost of Garbage Disposal[1]	Total Value of Product[2]	Profit or Deficit Not Including Interest Charge: Profit	Deficit	Depreciated Value of Plant	Interest on Depreciated Value, at 4% per Annum
1910	...	......	....	.....	.....	$236,881	
1911	17,534	$47,586	$58,722	$11,136	.....	230,959	$9,238
1912	18,789	55,148	61,729	6,581	.....	243,815	9,753
1913	20,711	68,845	56,800	.....	$12,045	230,671	9,227
1914	21,629	69,676	66,722	.....	2,954	217,527	8,701
1915	22,909	74,138	55,364	.....	18,774	204,383	8,175
1916	21,861	77,954	88,564	10,610	.....	191,239	7,650
1917	17,127	100,431	79,344	....	21,107	178,095	7,124
1918	15,630	114,601	112,288	....	2,313	164,951	6,598
1919	18,126	123,719	73,248	.....	50,471	151,807	6,072
Totals	174,316	......	......	$28,327	$107,664[3] —28,327	...	$72,538 +79,337
Total deficit					$79,337		$151,875
Net cost of disposal per ton					$0.464		$0.875

[1] Includes plant operation, freight charge for city water used and 5% depreciation, but not interest charge. [2] Sale of grease, tankage, hides, etc. [3] Of this deficit for the period, $86,037 is due to city water consumed from 1913 to 1919. [4] Without interest charge. [5] With interest charge.



OPERATING RESULTS OF THE COLUMBUS GARBAGE REDUCTION WORKS, 1911 TO 1919

figured on the yearly depreciated plant values, applying a straight 5 per cent yearly depreciation on the total investment. Interest charges add $72,538 to the deficit, giving a total of $151,875, or $0.87 per ton of garbage reduced. Of this total, $86,037 is represented by charges for city water consumed from 1913 to 1919.

The 1919 Operation—In spite of greatly increased labor and fuel costs in 1918, the top prices received for both grease and tankage gave a revenue which nearly offset all charges, including interest. In 1919, while the revenue from grease fell off 40 per cent, and from tankage 23 per cent, the labor cost increased 19 per cent and the fuel cost decreased only 8 per cent. A 10 per cent increase in operating expense was therefore coincident with a 35 per cent drop in production revenue. The grease extraction fell even below 2 per cent to a value of 1.942. Grease percentages in the raw garbage for the two years are not available to afford a comparison of the actual efficiency of the grease extraction in the plant.

TABLE III. AVERAGE ANALYSIS OF COLUMBUS GARBAGE PRODUCTS IN PERCENTAGES

	Tankage					Grease			
Year	Moisture	Ammonia	Potash	B. P. L.	Ether Extract	Moisture	Impurities	Unsaponifiable	Free Fatty Acids
1919	....	...	.	...	....	.....	.....	.....	...
1918	3.39	3.77	1.08	7.94	....	1.96	0.55	4.57	...
1917	2.76	3.86	1.06	7.56	4.26	1.025	0.732	2.830	27.512
1916	2.85	3.89	1.39	7.99	3.31	1.11	0.46	3.54	.....
1915	3.37	3.62	1.12	6.83	2.90	1.56	0.196	3.37	......
1914	3.10	3.58	0.78	8.08	1.20	.....	.....	.....	......

The 1920 Operation—The plant operator expects a more favorable report at the end of 1920. Grease prices are higher than those received in 1919. At the time of the writer's visit to the plant in June, it was expected that a well water supply would be available for use in a few weeks, which would reduce the water charge and at the same time provide a colder water for summer use.

It should not be assumed, however, that the Columbus plant is unsuccessful because it is not entirely self supporting. The operation in 1919 was a big expense to the taxpayers,it is true, but this was an unusual year. When the 1919 results are averaged with those for the years 1911 to 1918, the net expense of garbage disposal is less than a dollar per ton. This figure does not compare so unfavorably with those for many other cities during the same period. From the viewpoint of service rendered—disposal of the collected garbage quickly and inoffensively—the Columbus method probably surpasses that in certain other cities.

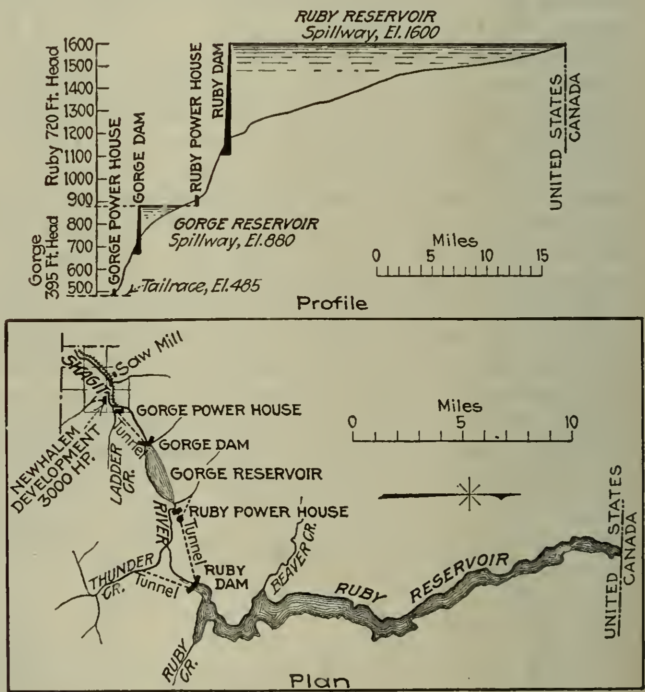
More satisfactory financial results depend in the largest degree upon the income derived from grease. It is hopeless to attempt to prophesy future grease prices, but it is within the power of the city to increase the percentage of grease extraction. Since the time that the local courts decided against the city ordinance which prohibited private collection of garbage, a similar case in Detroit has been carried to the U. S. Supreme Court where a verdict was rendered in favor of the city. This case and others referred to in *Engineering News-Record*, Aug. 12, 1920, p. 314, holds forth hope to the city of Columbus in attempting again to eliminate private collection. The estimated present private collection is probably depriving the city of at least $10,000 in yearly revenue.

Seattle Building Large Municipal Hydro-Electric Development

By C. F. Uhden
Chief Engineer, Skagit River Power, Seattle, Wash.

UNDER the supervision of its city engineer, A. H. Dimock, the city of Seattle, Wash., has made a complete study and survey of the power possibilities of its surrounding district and has chosen as the most feasible and profitable the development of the Upper Skagit River where ultimately about 500,000 hp. can be obtained. Work is now under way on the preliminaries of the project.

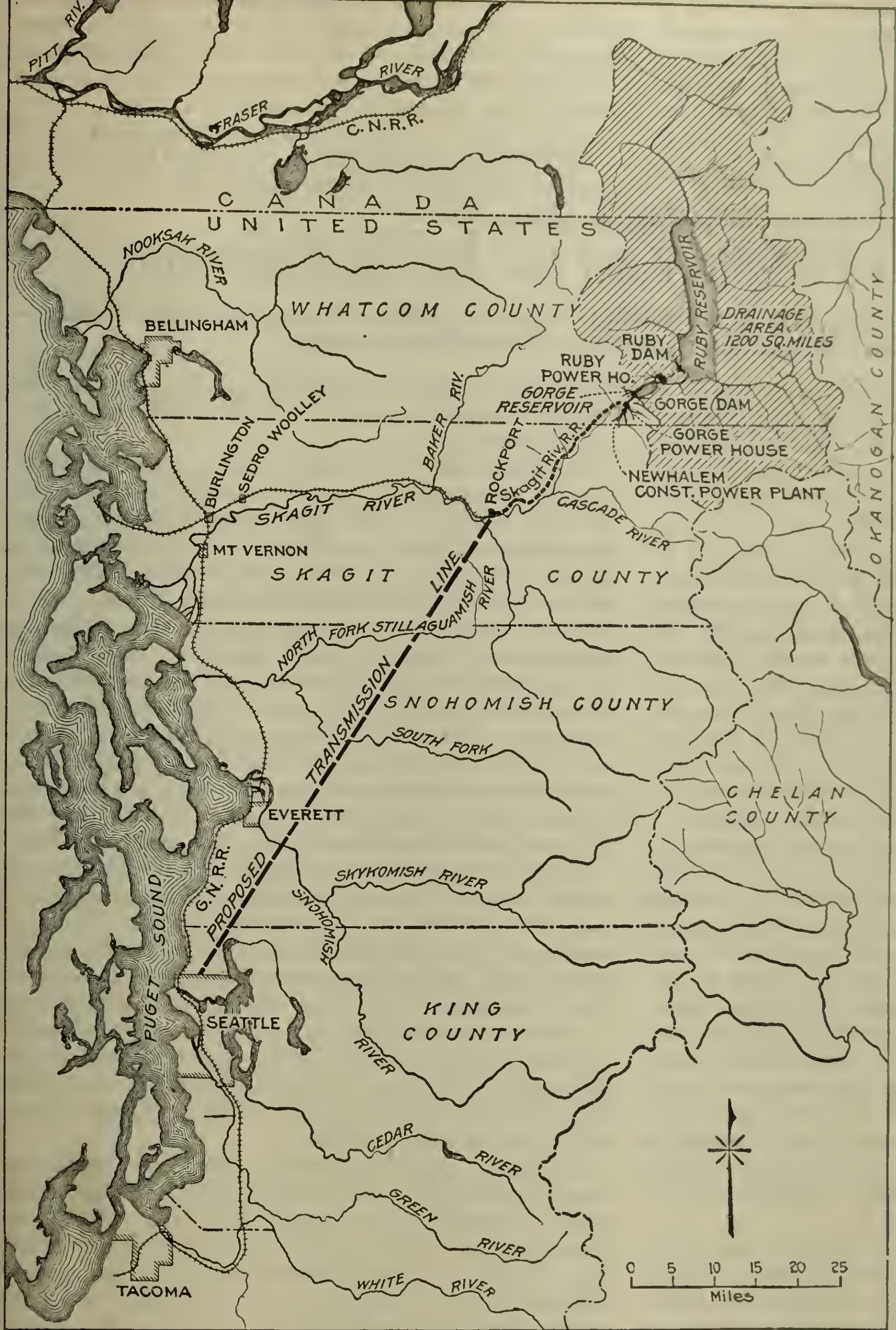
As shown on the map on p. 995 the Skagit River rises in British Columbia, somewhat southerly of a line joining the towns of Hope and Princeton. Flowing first in a general southwesterly and southerly direction, it crosses the international boundary some seventy miles to the eastward of Bellingham, and picks up Ruby Creek at Ruby, some twenty-five miles below the boundary line; continuing southwesterly for another thirty miles,



PLAN AND PROFILE OF SKAGIT PROJECT

it picks up the Cascade River at Marblemount, the Sauk River at Rockport and the Baker River at Concrete, then flows due west for 40 miles to Sedro-Woolley. Ten to fifteen miles southwest Sedro-Woolley empties into puget Sound through the many mouthed Skagit Delta which comprises the eight mile stretch of shore line between LaConner and Milltown. The Skagit River, then, is one hundred and fifty miles long, and drains an area of more than three thousand square miles.

Of this three thousand mile area, the Skagit River project will develop the entire power of the upper third which lies between two mountain ranges of the Cascades. The main range or divide of the Cascade bounds its catchment on the east and the range of which Mt. Baker is the best known peak constitutes its western boundary. The run-off of approximately twelve hundred square miles will be utilized through a total fall of approximately eleven hundred feet.



MAP OF SKAGIT HYDRO-ELECTRIC DEVELOPMENT

Extensive diamond drilling has been carried on at the two dam sites showing solid rock of exceptional quality, known as gneiss, at a maximum depth of 110 ft. at the Gorge Dam site and at a maximum depth of 30 ft. at the Ruby Dam site. These drillings show only a moderate amount of excavation as the channel in both cases is narrow and has rocky cliffs on both sides extending several hundred feet above the present water surface.

The Ruby plant, constituting the upper development, will consist of a dam approximately 450 ft. in height, a tunnel 17,000 ft. in length of about 600 sq.ft. section and an ultimate installation of six 45,000 kva. units operating under a head varying from 720 ft. to 470 ft.

The available capacity of the Ruby Reservoir, whose surface elevation will be 1,600 ft. above sea level when full, will be approximately 1,000,000 acre feet and will at times be drawn down to an elevation of 1,350, a difference of 250 ft. causing the variation in head at the Ruby plant above referred to.

The ultimate development of the Gorge plant will consist of a dam 240 ft. in height, two tunnels 11,000 ft. in length of 300 sq.ft. area and six 30,000 kva. units operating under a head of 395 ft.

Not having any available power for construction purposes within a reasonable distance of this development it was decided to put in 3,000 hp. hydro-electric plant on Newhalen Creek. This stream has a maximum flow of about 500 sec.-ft. and a minimum flow of 40 sec.-ft. This will consist of a small crib dam, 2,720 ft. of 5 x 7 ft. tunnel, 700 ft. of steel penstock and a 3,000 hp. Pelton impulse wheel, direct connected to a 2,500 kva. Westinghouse 6,600 volt generator, and will operate under a head of 500 ft.

Rockport, located on a branch of the Great Northern, is the nearest railroad point and is 23 miles distant from the Gorge power house. On account of the large tonnage that will be handled, it was decided to build a railroad from Rockport. This railroad is now under construction and will in all probability be completed to the Gorge plant by March, 1921. At present all supplies and material are being transported by three 10-ton Holt caterpillars and six 5-ton Troy trailers.

The tunnel for the Newhalen plant is now being

The flow of the Upper Skagit River varies from 800 sec.-ft. at low water to about 50,000 sec.-ft. at high water period with an average flow throughout the past ten years of approximately 3,575 sec.-ft. It is the intention ultimately to utilize, as nearly as is practical, the entire flow through the total available head. This will be accomplished by means of two plants, one in the vicinity of Stetattle Creek and one in the vicinity of Ladder Creek, the former having a dam just below the junction of Skagit River and Ruby Creek and the latter having a dam just below the outlet of Gorge Creek.

The waters of Thunder Creek will be utilized by means of a tunnel connecting it with the Ruby Dam and the waters of Stetattle Creek will also be carried in a tunnel terminating at the surge tower above the plant.

driven and it is hoped to have the plant in operation by next April. A saw mill of 25,000 board feet capacity has been put in operation, which supplies lumber for the temporary camp. This camp will consist of some 75 three-room cottages to be used by the married men, 6 bunk houses of 12 rooms each, capable of housing 24 men each. Bath houses, commissary, warehouse, hospital, mess house, etc., are also provided.

The energy will be conveyed over a transmission line of about 100 miles in length, having wooden pole structures and a pressure of 154,000 volts. The survey not being completed this line is shown on the map as a straight line and indicates the general location.

It is hoped that energy from the Gorge plant, which is the first to be developed, can be utilized by the city of Seattle some time during the year 1923.

Improve Old Freight Yard for Better Operation

Gravity and Flat Switching Combined in New Facilities for Heavy Traffic—Changes in Hump Profile—Seven Converging Lines Complicate Division Point Problem

INCREASED rapidity, economy and convenience in yard operation to meet conditions of greatly increased traffic are the results sought by the Chicago, Burlington & Quincy R.R. in undertaking the enlargement and improvement of its freight yard at Lincoln, Neb., which is an important division point. This work is an example of improvements that must be carried out at many existing terminals to make their facilities adequate for present conditions of traffic and the economical operation. In this respect the work at Lincoln differs from that of the division yards of the Michigan Central R.R. at Niles, Mich., and the Denver & Rio Grande R.R. at Soldier Summit, Utah, which were described in *Engineering News-Record*, Jan. 8 and May 27, 1920, pp. 81 and 1069, respectively. At the latter points entirely new yards of modern design have been built on a new site, unhampered by existing facilities.

Operating Methods—A combination of gravity and flat switching is a feature in the operation of the Lincoln yard, the layout of which is shown in Fig. 1. This combination method was introduced under an emergency and was not included in the original plan, but it is continued in the reconstructed yard as it is found to suit local conditions. The improvements now being made, which are based upon a modification of the original design, provide for handling the westbound business by flat switching and the eastbound business (when classification is required) by hump or gravity switching. Such a combination is unusual, but is employed also in the company's larger yard at Galesburg, Ill., where the two methods are used for handling different commodities.

The heaviest loaded movement at the Lincoln yard is eastbound and consists largely of grain, coal, stock and lumber. Stock is handled mainly in solid through trains and these are passed around the switching hump as they are not broken up for classification and are stopped only for inspection and to change engines. The westbound movement consists mainly of l.c.l. merchandise, stock and empty stock cars. All this traffic has a seasonal variation.

An explanation of the history and operating conditions is necessary for an understanding of the reconstruction work. In 1907 plans were made for a very comprehensive layout, consisting of two separate units for eastbound and westbound traffic, both arranged with gravity switching for the classification service. Each unit was to consist of a receiving yard, switching hump, classification yard and departure yard, with a storage yard serving both units. Both switching humps were graded, but in 1907, before the tracklaying was completed, a period of depression had begun and it was necessary to discontinue the work and adapt the existing trackage to handle all business. This trackage consisted mainly of the eastbound unit (as above) and the first part of the receiving yard for the westbound unit.

To utilize the existing layout for the classification of traffic in both directions necessitated introducing reverse movements for all westbound traffic. Thus, a westbound train had to travel the entire length of the site to enter the eastbound receiving yard at the west end of the site, its cars being then moved eastward over the hump to the classification yard and eastward again to be made up into trains in the departure yard at the east end of the site. From this yard the westbound trains again traveled the entire length of the site before pulling out on the main line.

Eastbound movements were made logically in sequence from the main line to the receiving yard, the switching hump, classification yard and departure yard, from which last the trains proceeded east onto the main line. Trains in either direction which did not require classification, or complete cuts of cars ready to be attached directly to outbound trains waiting for them, were passed around the hump.

Until the war, the business had not grown sufficiently

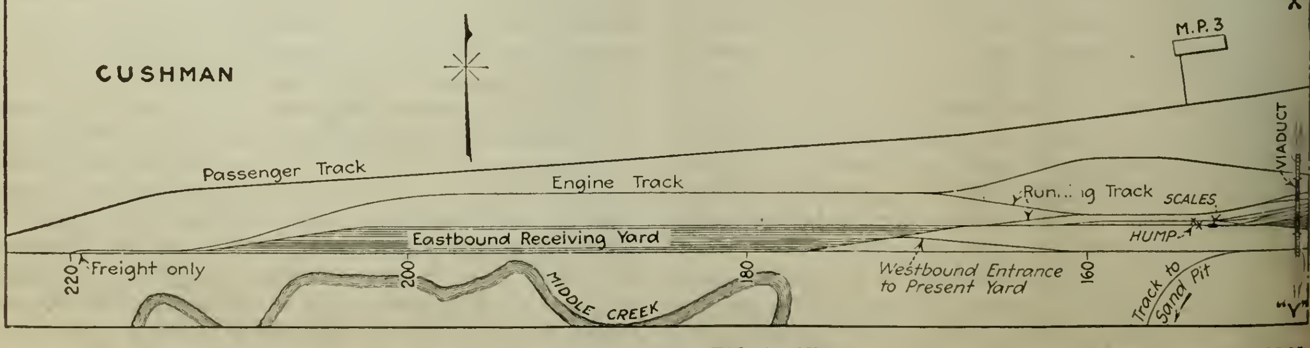


FIG. 1. NEW LAYOUT OF FREIGHT YARD AT LINCOLN.

to warrant completing the yard according to the original design, but under changed conditions and with heavy business better facilities have become highly desirable to provide for prompt movement and the reduction of delays. Owing to the smaller proportion of

TABLE I. FREIGHT YARD BUSINESS AT LINCOLN, NEB., C. B. & Q. R.R., (SEPT. 2, 1919)

Inbound	South and East	North and West	Total
No. of trains	15	10	25
Trains put over the hump	10	7	17
No. of cars	745	612	1,357
No. of cars weighed	49	65	114
No. of cuts	321	309	630
No. of through cars	528	303	831
No. of cuts of through cars	268	170	438
No. of local cars (empty stock)	309	20	331
No. of cuts of local cars (empty stock)	...	...	65
Total local cars	416	103	531
No. of cars marked bad order	...	...	63
No. of destinations of through cars	9	15	24
Outbound			
No. of trains	13	14	27
No. of cars	670	836	1,506
Cars taken from repair track	...	...	71
No. of destinations	7	3	10
Cars per train, average	40 to 60	40 to 70	...
Cars per train, maximum	81	84	...
Cars per train, minimum	9	17	...

cuts in westbound traffic, the original design was modified, the second hump being omitted and flat switching substituted for westbound movements. It is considered that under the conditions of traffic at this point the yard operation can be handled more quickly and economically by this combination of methods.

New Yard Plan—The layout of the yard as it will be when the present alterations are completed is shown in Fig. 1. Reverse movements will be eliminated, but all westbound switching movements will be handled by drill engines in one large flat yard which will comprise receiving, classification and departure tracks. The drill engines will work at both ends of this yard. To permit of the necessary extensions, the old unused hump for westbound traffic has been removed, the material being utilized for grading the additional space for the flat yard.

Eastbound freight trains will pull out from the main track onto a lead track about 800 ft. long, connecting with the ladder of the receiving yard. This yard has 10 tracks about 3,600 ft. long, with a total capacity of 760 cars. Here the engines and cabooses will be cut off and moved over a thoroughfare or running track to the engine terminal and caboose track at the east end of the site. Yard engines will push the trains up to the hump, the cars moving thence by gravity to the classification yard, which has 20 tracks, varying in length from 800 to 2,100 ft., in addition to a central track for the locomotive which carries the car riders back to the

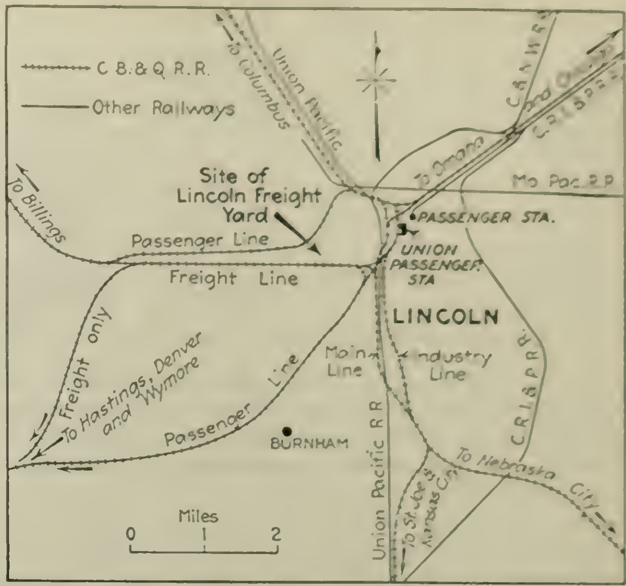
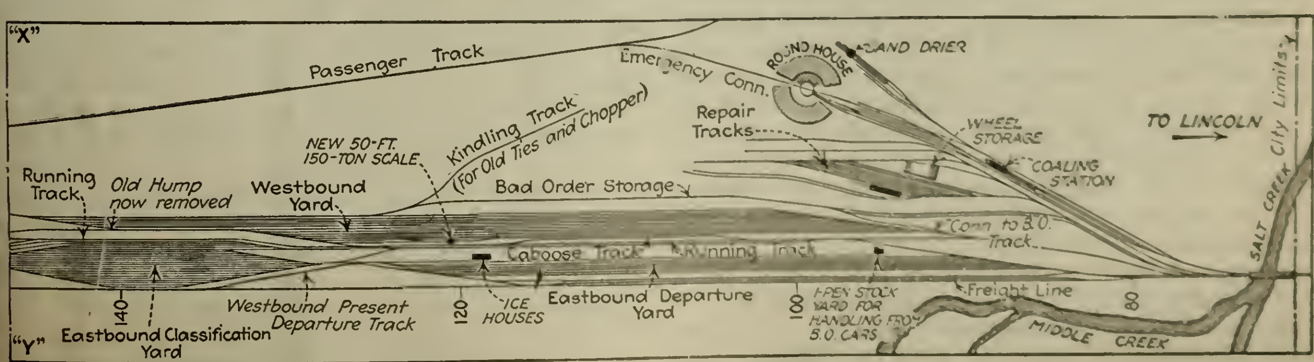


FIG. 2. RAILWAYS CENTERING AT LINCOLN, NEB.

hump. Yard engines will then take the cars to make up trains in the departure yard, which has ten tracks about 3,600 ft. long. Solid eastbound through trains and cuts which are to be made up into trains will be moved directly from the receiving to the departure yard over a run-around track. Cars held for orders, or "hold" cars, will be accommodated on six tracks in the old westbound receiving yard.

The flat yard for westbound trains has twelve tracks, seven of these being about 3,600 ft. and the others 4,500 ft. long. Trains will enter the shorter side, departure trains being made up on the longer side of the yard, the tracks on that side being used for classification or storage as may be necessary. Road engines will take their trains out over a running track north of the eastbound receiving yard.

Switching operations at Lincoln are complicated by the fact that seven lines of three divisions of the Chicago, Burlington & Quincy R.R. meet at this point, as shown by Fig. 2. There are four main lines from Omaha, Kansas City, Denver and Billings, Mont., and three local lines from Columbus, Nebraska City and Wymore, Neb. Under this condition there is an unusual amount of switching and classification for destinations. Four other railways pass through Lincoln and involve a certain amount of interchange or transfer movement. The yard operating conditions are illustrated by Table I, which gives the record for the 24-hour period of Sept. 2, 1919.



NEBRASKA; CHICAGO, BURLINGTON & QUINCY RR

TABLE II. CHANGES IN PROFILE OF SWITCHING HUMP AT LINCOLN, NEB.; C., B. & Q. R.R.

	Proposed for Westbound Hump	Eastbound, Hump: Present	Eastbound, Hump: 1914	Eastbound, Hump: As Built	Eastbound, Hump: Original Design
Approach	2.67% for 60 ft.	2.67% for 60 ft.	1.64% for 100 ft.	1.6 and 2% for 74 ft.	1.0% for 207ft
Summit	0.33% for 50 ft.	0.33% for 30 ft.	0.44% for 25 ft.	0.4% up for 25 ft.	Level for 10 ft
Starting grade	2.0 % for 125 ft.	2.0% for 20 ft.	0.36% for 25 ft.	2 % for 25 ft.	1.0% for 25 ft.
Starting grade	....	3.84% for 60 ft.	....	3.6% for 25 ft.	....
Starting grade	....	2.0% for 20 ft.	3.16% for 50 ft.	2.8% for 25 ft.	....
To scale	....	1.6% for 25 ft.	0.8% for 12 ft.	1.5% for 20 ft.	2.0% for 14 ft
On scale	1.0 % for 50 ft.	0.8% for 50 ft.	0.9% for 35 ft.	1.2% for 50 ft.	2.0% for 50 ft.
On scale	....	....	1.3% for 15 ft.	....	....
Off scale	2.0 % for 20 ft.	2.0% for 26 ft.	0.9% for 12 ft.	....	2.0% for 8 ft.
Accelerating	4.0 % for 75 ft.	5.0% for 20 ft.	3.12% for 25 ft.	2.4% for 25 ft.	3.0% for 28 ft
Accelerating	....	1.33% for 15 ft.	3.64% for 50 ft.	2.8% for 25 ft.	....
Accelerating	2.9 % for 110 ft.	5.0% for 26 ft.	3.46% for 50 ft.	3.2% for 25 ft.	3.5% for 150 ft
Accelerating	....	2.92% for 130 ft.	2.84% for 50 ft.	2.8% for 100 ft.	....
Through ladder	1.2 % for 142 ft.	1.2% for 142 ft.	2.26% for 50 ft.	2.2% for 50 ft.	....
Through ladder	0.51% for 118 ft.	0.51 % for 118 ft.	1 and 0.8% for 250 ft.	1 and 0.8% for 250 ft.	0.8% for 318 ft

Hump Profiles—The profile of the switching hump has been changed from time to time to meet actual requirements of operation, as shown in Fig. 3 and by Table II. In this respect it resembles many other existing hump profiles. An unusual and rather unfavorable feature is the short distance from the scale to the first switches of the classification yard, this distance being only about 75 ft. The first change was to give a higher summit with starting grades of 2 and 3.5 per cent, reduced to 1 per cent over the scale and then increased to 2.8 and 3.2 per cent to the ladder. In 1914 the hump was raised again to give steeper grades, with 3.36 and 3.16 per cent above the scale and 3 to 3.64 per cent below it. A profile suggested at that time for the westbound hump called for a 2 per cent starting grade. 1 per cent over the scale and 4 per cent to the ladder.

In 1917 the summit was raised to a still higher elevation and shifted farther back in order to increase the length of the starting grade. At present this grade is 3.6 per cent, followed by 1 per cent over the scale, and then by an accelerating grade of 3.6 to 2.8 per cent to the ladder, along which the grade is carried at 0.8 to 1 per cent. This present profile will be continued, as it is found to be satisfactory in both hot and cold weather. The steep grades of the hump are connected by vertical curves of the cubic parabola type laid out approximately in accordance with the Henck method.

Tracks and Lighting—The yard is laid with 85-lb. rails for the leads and running tracks and 75-lb. rail for the body tracks. The sharpest curves are of 7½ deg. Turnouts have No. 9 frogs and 15-ft. switch rails. Ladders are 1 in 7, or at an angle of 8 deg. 10 min. with the body tracks. The classification yard has No. 7 frogs on a ladder of 6 deg. 20 min. Hand operation of switches is employed for the classification movements, about four switchmen and twelve car riders being required during the busy hours. The car riders are returned to the hump by a yard engine which runs back and forth on the middle track of the classification yard. Flood lighting is used for the hump and the classification and flat yards, the lamps being on 20-ft. poles placed along both ladders and along the running tracks.

The yard has a single track connection at each end and its total length is about three miles between end switches. An unusual feature of the layout is that no passenger tracks are required, the site being located between two converging lines. A single main track along the south side provides for through freight movements. The ground is level at the east end of the side and then rises at a flat slope of 0.1 to 0.2 per cent towards the west.

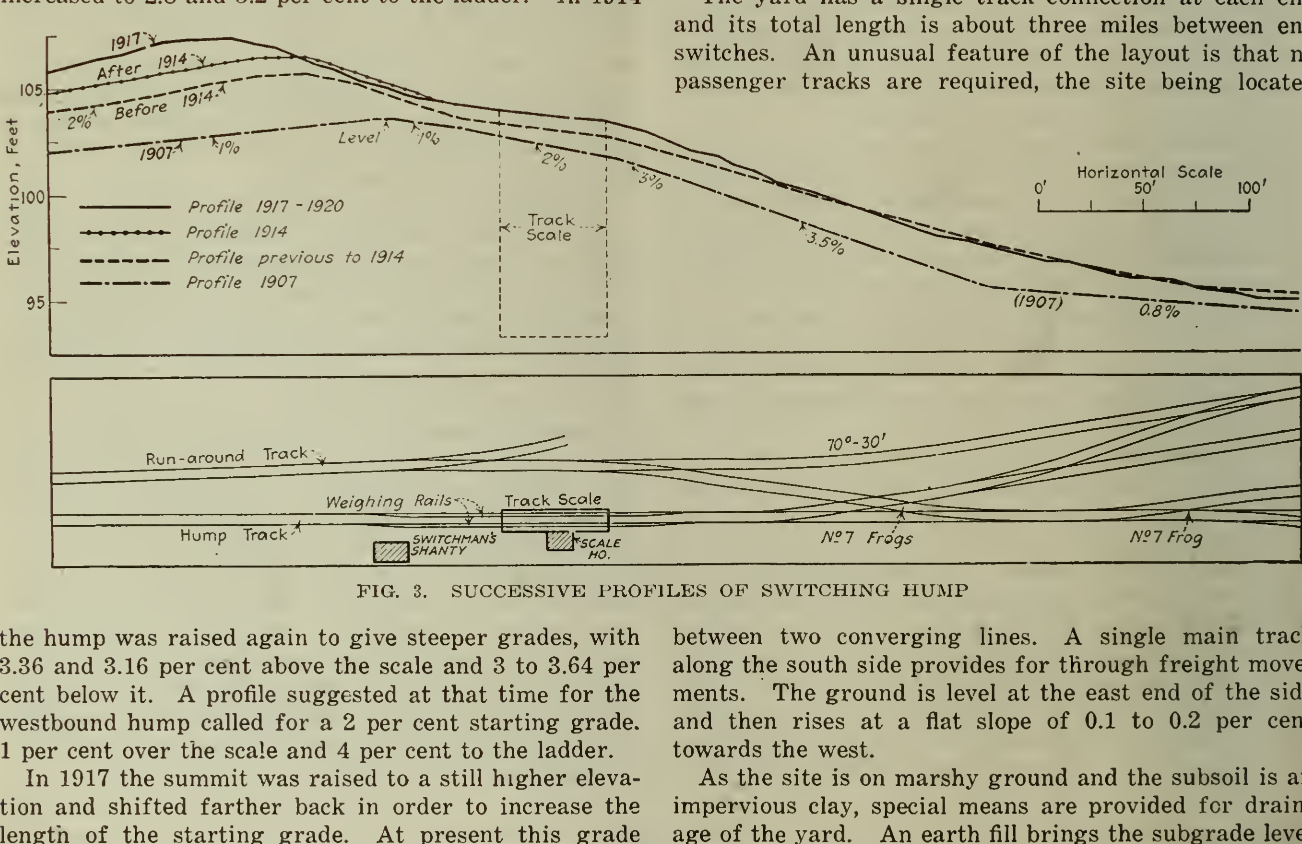


FIG. 3. SUCCESSIVE PROFILES OF SWITCHING HUMP

As the site is on marshy ground and the subsoil is an impervious clay, special means are provided for drainage of the yard. An earth fill brings the subgrade level about 8 ft. above that of the natural ground, and in the top of this fill are formed transverse French drains. These are trenches about 4 ft. wide and 4 ft. deep, filled with broken stone, brick and loose rock and covered with sand. Over the entire surface of t[illegible] ped of clean sand about 12 in. deep, so that [illegible] ass freely through this bed to the drains. [illegible] ast about 12 in. deep is laid upon the san[illegible] his the ties are embedded.

Engine Terminal — Locomotives and [illegible] are changed on all trains, as Lincoln is a [illegible] nt. Engine terminal facilities and a car re[illegible] re provided at the east end of the layout, inc[illegible] es

in the westbound yard being shifted onto a running track and moved back to the yard entrance, where the switch connection to the engine terminal is located. Incoming engines of eastbound trains are run to the east end of the yard for the same purpose. Caboose cars from trains in both directions are placed upon a track near the east end, from which they can be switched conveniently to both departure yards.

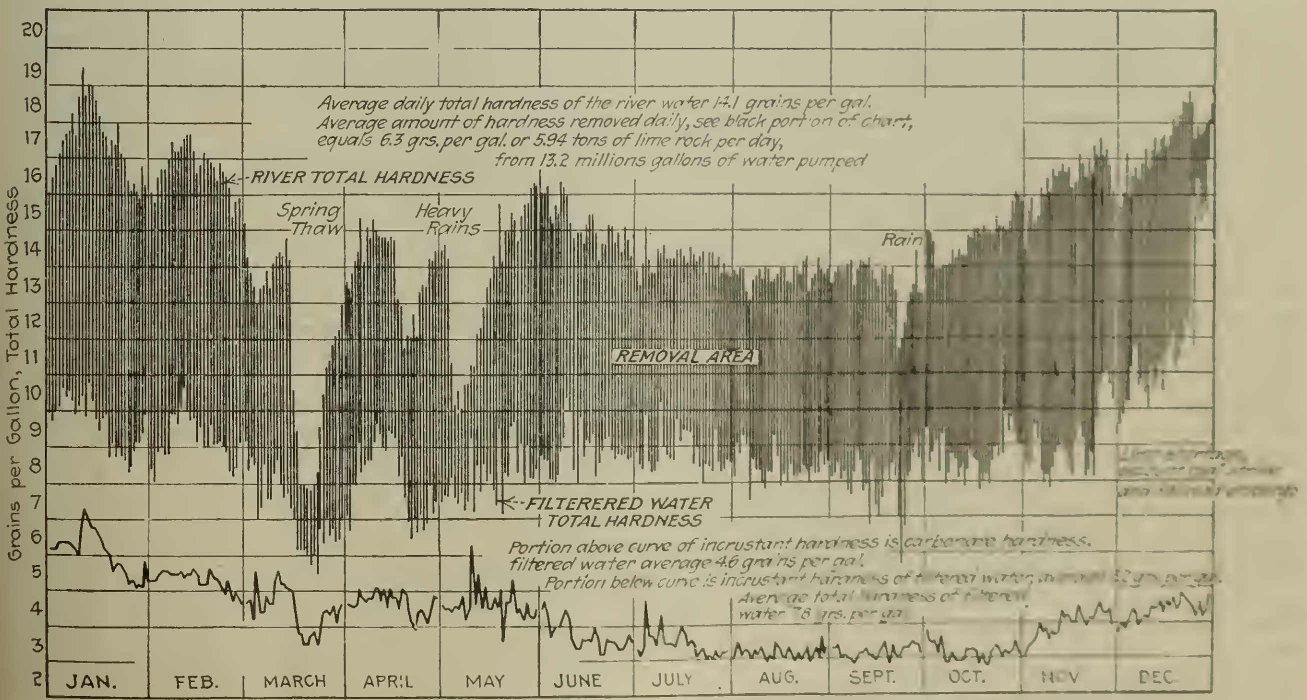
An ice house is provided for serving refrigerator cars in both directions. Owing to the large amount of stock traffic a stock pen is provided for stock unloaded temporarily from a bad-order car. A long storage track can hold 70 bad order cars waiting to be sent to the repair yard. All departure tracks are equipped with compressed air for testing the train brakes before the road engines are attached. Track scales are provided on the switching hump and on a weighing track near the west end of the flat yard. Each is of 150 ton capacity, with a table 50 ft. long.

The revised layout of the Lincoln yard, with the improvements now being carried out, was planned under the direction of A. W. Newton, chief engineer, and F. T. Darrow, assistant chief engineer of the Chicago, Burlington & Quincy R.R.

Intermittent Reduced Lime Feed

THE filter plant at Grand Rapids, Mich., is still being operated on the intermittent plan of reduced lime feed, as described by Walter A. Sperry, chief chemist, in *Engineering News-Record*, Nov. 27-Dec. 4, p. 923. In his annual report for fiscal year ended Mar. 31, 1920 (not printed), he states that the standard of hardness maintained has been that of Lake Michigan, 7.5 to 8 gr. per gallon. The standard is reasonably acceptable to the users and the intermittent plan continues to act more effectively in reducing after deposits than any other method tried. Never before has the small scale in the water cylinders of the high service pumps been so thin or scant. This year it was possible for the first time to omit the usual cleaning and overhauling of the sand beds. The filters were free from the usual mud deposits, the gravel was found unpiled and the sides free from caked masses of sand and sludge. Finally there have been no complaints because of deposits in heaters and furnace coils.

On the black portion of the accompanying chart is shown the amount of hardness removed, an average of 6.3 gr. per gallon or 5.94 tons of lime rock per day from the average consumption, 13,200,000 gal. The portion above the curve of incrusting hardness, an average of 3.2 gr. per gallon, is carbonate hardness. In the filtered water the latter averages 4.6 gr. per gallon. The average total hardness of the river was 14.1 gr. per gallon and of the filtered water 7.8 gr. per gallon.



HARDNESS REMOVAL RESULTS AT GRAND RAPIDS PURIFICATION PLANT, 1919

Sells Water at 2½ Cents Per Ton

WATER is the cheapest commodity the public buys today, according to the latest annual report of George N. Schoonmaker, assistant commissioner of water, Toledo, Ohio, in a plea for increased rates. Under the present domestic rate water if sold by weight would cost 2½c. per ton. Receipts over expenses in 1918 increased 5.25 per cent but expenditures increased 15.95 per cent. Per capita the consumption was 107 gallons. D. H. Goodwillie, director of public service, summed up the financial solution thus: "While the Division of Water has been able to meet its operating expenses, interest on bonds, retire bonds and invest nearly $500,000 of earnings in extensions and improvements and at the same time close its business with a reasonable balance, the anticipated cost of operation and the unusual demand for water pipe extensions all combine to make necessary an increase in the revenue or a curtailment of its activities."

Engineering Literature

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

British and American Technical Books

Sir—I was much interested in R. Fleming's review in your issue of Sept. 16, p. 568, of a British textbook on "Structural Steel Work." Although I do not intend to pose as the "competent engineer whose appraisal of the relative merits of literature on British and American practice would be welcome," I am tempted to venture a few remarks based on an experience which covers both sides of the Atlantic. Having been for many years designing engineer of the largest bridge company in Canada, and intimately connected with the office, shop and field work of many large structures, including the greatest bridge on this continent, I believe I may claim a reasonable acquaintance with American practice, past and present.

I have not seen the book referred to by the reviewer, but I can readily understand that it would strike him as very different from the majority of the American books, whether of the older types, such as Green, Dubois, Burr and Falk, or of the more modern, as Merriman and Jacoby, Johnson, Bryan and Turneaure, or Molitor. British books on bridges and structural work are few in number, and, excepting perhaps Claxton Fidler's, are quite recent. Books are not used to anything like the same extent in the universities and technical schools of Great Britain or in the office of consulting and manufacturing engineers, as here. Very much more importance is attached to experience, both the experience of men and the experience with structures. Furthermore, bridge and structural work does not, or did not until very recently, constitute a specialized branch of engineering over there as it does here. A great deal could be said upon the advantages and disadvantages of extreme specialization, but this is not the occasion for saying it. The fact remains, however, that a very considerable portion of the leading engineers of Great Britain are not specialists in one line but are engineers generally, grounded in broad principles, trained in various directions, and actually carrying out engineering works of many descriptions. For these and similar reasons, a literature on bridge and structural work is not really existent. The best American books are usually recommended for students in colleges who wish to study texts, and the writer well remembers enjoying one of the early editions of Merriman and Jacoby whilst an undergraduate.

The few books that do refer to actual designs simply state what is the practice of certain shops, and seldom, if ever, attempt to "figure" a bridge or compile a stress sheet. In fact, it is very doubtful if stress sheets are made for the majority of structures, and it is generally understood that none can be found even for the Forth Bridge. The same profound faith in "figures" and "figurability" that characterizes, standardizes, and unfortunately cramps the designing of bridges on this side, does not so entirely govern over there. On the other hand, it is true that many of their structures, if figured according to our methods, show strange results. Particularly is this the case in riveted connections, such as those between the flange angles and web plates on shallow floor beams.

The published papers describing bridges built to purely British or European practice, do not, as a rule, indicate the details of connections. For example, in the case of a very important and really huge undertaking, the Hardinge Bridge over the Ganges (*Proc.* Inst. C. E., vol. 205, 1920), there is characteristically little information given on the steel work of the fifteen 350-ft. double-track spans, approach girders, or erection trusses. In structural work, as in the other branches of the great engineering trades, a great deal of importance is placed upon workmanship. "The little things" are given attention and are looked upon as being essential parts in the "harmonious whole." There is a disposition to treat a bridge as a unit, and not so much as a conglomeration of units—stringers, floor beams, laterals, web members, chords, and so on, each with distinct duties. These items are regarded as working together, mutually helping, rather than as each item unloading its responsibility on to the next until finally the bridge unloads altogether on to the substructure. The short stringers, shallow floor beams, wide truss members, etc., of the British designs, seem to the writer to be conceived in this spirit of participation, whereas our practice very definitely forbids a stringer to help the bottom chords, for instance, or the truss verticals to help the floor beams.

This is a personal view, of course, and may not appeal to all or even many engineers on this side—and indeed might not be acknowledged by many on the other—but from such considerations I would suppose that Mr. Fleming is quite right in saying that to an American engineer the book reviewed is of little value for practical guidance. At the same time, it must be remembered that labor conditions govern the practice more than any other single item. The bending of angles, for example, is done in Europe because there has been a sufficient supply of capable angle smiths. There is no structural argument against bent angles. As connections and stiffeners they would be often convenient and are certainly efficient.

The writer is at present engaged in investigation work where English deck plate girders, built sixty or more years ago, are found in excellent condition and alignment today. These have the regular bent angle or bent tee stiffeners of the British practice, using small flange angles, about 4 x 4 in. and 24-in. cover plates. Incidentally, the metal is without exception much better preserved and much freer from corrosion than American steel of ten or twenty years' life in similar service.

The quoted comments of the technical press are no serious guide to the intrinsic worth of this or any other book. A review like Mr. Fleming's is really of more value, although in this case taken from a viewpoint not, I suppose, even dreamed of by the authors of the book or press comments. The publication evidently was not intended to satisfy the wants or describe

the practice of engineers on this side, and apparently does not do so. Personally, I do not know any British book that does, or that mentions in more than a casual way the distinctive features of American practice. This same American practice is changing with the years and with conditions, and is not drawing further away from, but nearer to, the British and European. Witness the abandoning of pin bridges in favor of riveted joints, the use of continuous spans and even of continuous transverse frames composed of floor beams and truss verticals. "Minutiæ to the *n*th degree" is a rather vague expression, and it is not evident to what particular point the reviewer addresses this phrase.

Regarding stress sheet calculations, the boot is surely on the other leg. It is in America that the German thirst for "all kinds and conditions" of stresses has been cultivated. It is in America where such an unnecessary amount of detail is crammed into all specifications.

Regarding failures of steel buildings, there are very few anywhere, and I believe that actually there may be fewer in Britain than on this side, and for such reasons as the following of safe precedent, the building for admittedly longer life, and the more rigid inspection of workmanship.

"Why are British engineers, writers and manufacturers so slow to adopt things American?" Here is the kernel in the nut. The answer lies perhaps in two words, conditions, convictions. Things American do not always suit conditions outside the United States and it is not everybody who can be convinced of the essential superiority of things American. He would be a "bold, bad Britisher" who undertook to discuss at length such questions in an American magazine today, for many things have happened these last few years, and are still happening, to affect conditions and convictions on both sides of the water.

P. L. PRATLEY,

Late Designing Engineer, Dominion Bridge Co.; now Engineer of Bridges, Grand Trunk Arbitration, Department Railways & Canals.

Montreal, Sept. 25.

"Earthwork and Its Cost"

Sir—Technical book reviews usually belong to one or more of three classes: (1) Those that tell what the book contains; (2) those that tell what the book should have contained; (3) those that are essays suggested by the book. Mr. Hammond's review of the second edition of my "Earthwork and Its Cost" (*Engineering News-Record*, Sept. 16, p. 567), falls mainly unler the second and third classes of reviews, for a reader would gain, from the review, little or no more knowledge of the contents of the book than could be had by reading the title. In fact, the reader would probably be misled by the reviewer into thinking that the book is primarily one on costs, whereas 85 per cent of its 1,346 pages relate to methods, machines, etc., and not to costs. This misleading feature of the review may be attributed to the reviewer's belief that the primary function of a reviewer is to write an essay. Had his essay been entitled "The Futility of Published Cost Data on Earthwork" it would have at least had the merit of not misleading the reader; and at the same time it would have made it more likely to start a general debate.

An author seldom feels like defending his own book, although he does not hesitate to defend a principle from attack. I should be glad to debate the question of the uselessness of published cost data, but I do not care to do so in a letter of this sort. If "Earthwork and Its Cost" is so utterly useless as Mr. Hammond pictures it to be on matters pertaining to cost, then all I can say is that the guilt is not mine, but that of the entire civil engineering profession; for two of my assistants spent two years searching the technical literature and abstracting all that seemed worth-while on earthwork and its cost. The matter thus abstracted would have made three books of the present size of "Earthwork." Probably errors of judgment were made in boiling it down to 1,346 pages, but I feel confident that the writing of very few engineering monographs has involved as much search for information as this writing has involved. This statement will also serve to answer Mr. Hammond's remark that "The next most serious fault is the too great dependence upon Mr. Gillette's own paper, *Engineering and Contracting*. A page count would perhaps reveal far more than half the book is quotations and extracts from that journal." This "fault" is assignable to the fact that, for sixteen years *Engineering and Contracting* has been so edited as to miss very little new and valuable information on excavation.

Mr. Hammond shows a rather surprising lack of knowledge of what is to be found in the private records of contractors when he imputes the alleged deficiency of published cost data to the reluctance of contractors to put their data in the hands of incompetent contractors and engineers. "Costs, in the hands of such," says Mr. Hammond, are useless as Granville's 'Calculus' is to a Hottentot."

Very few contractors have any cost data so analyzed that they will be of use. Fewer still have any such fear as Mr. Hammond imagines them to have. I shall be the last to claim that published cost data are completely satisfactory, but why should published cost data be singled out from all engineering data as a special object of ridicule? Are costs the only things that lack completeness? Listen to what Prof. J. W. Richards (professor of metallurgy at Lehigh) recently said:

> The engineer is confronted with a woeful lack of data on specific heat of substances at moderate and high temperatures, also of specific heats of liquids and gases. It would be making a liberai statement to say that the tables contain 10 per cent of the accurate information in this line which engineers and technologists could use. . . . "The writer is convinced, perhaps because of his greater activity in this field, that data of the class (1) [physical and chemical], are woefully deficient and fragmentary. The best compendium of such information is in the revised Landolt and Bornstein 'Physikalische and Chemische Tabellen,' revised up to 1912. This has been supplemented by the 'Tables Annuelles des Constantes Physiques et Chimiques,' of which three volumes have appeared to date and the fourth is in preparation. These, and similar books and tables, are collections of the most reliable data accumulated in the last century or more by industrious scientific men. The data are of all degrees of reliability and of all degrees of incompleteness in any particular line. The quickest way to get an idea of the state of matters is by discussing a few concrete examples."

Yet, does Prof. Richards rail at the books that contain the available compilations, or at their authors for not entirely recasting the matter that they have abstracted, or at the futility of attempting to enlarge the existing fund of data until some supposedly wise men condescend to make public their wisdom? Prof. Rich-

ards, in strong contrast to Mr. Hammond, does no such thing; but he urges scientific men to gather more data and to publish them for the public benefit.

There are a few minor parts of Mr. Hammond's "review" that might merit discussion, were not the whole of it less a review than an attempt to make the reviewer's opinions appear more important than the author's collection of facts. HALBERT P. GILLETTE.

Chicago, Nov. 1.

Ketchum's Highway Bridges Revised

THE DESIGN OF HIGHWAY BRIDGES OF STEEL, TIMBER AND CONCRETE: By Milo S. Ketchum, C.E., M. Am. Soc. C. E., Professor-in-Charge of Civil Engineering, University of Pennsylvania, etc. Second Edition Rewritten. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co. Flexible: 6 x 9 in.; pp. 550; illustrated. $6.

REVIEWED BY WALTER R. MARDEN
Vice-President and Chief Engineer the United Construction Co., Albany, N. Y.

It is frequently the case that the second edition of a technical book is more useful than the first, and the volume under consideration exemplifies this in a marked degree. In the twelve years since the first edition was issued the current practice of highway bridge designing has improved more than in any similar period of its history. The conditions generally governing the designing of and awarding contracts for highway bridges have frequently been such as to offer a premium on light designs with insufficient and often very faulty details; and this edition of Prof. Ketchum's book should be of interest to every highway bridge engineer as one of the first concrete evidences that these conditions are being overcome. [The first edition was reviewed in *Engineering Record*, Feb. 6, 1909, p. 167, and in *Engineering News*, Feb. 18, 1909, on p. 13, "Engineering Literature Supplement."]

The makeup of a book is usually considered last, if at all, by a reviewer, but whatever the inner qualifications that recommend our friends to us, we first recognize them by external characteristics and first impressions are sometimes as cogent with book users as they are in social amenities. The present volume is as much of an improvement over the first edition in respect to makeup as it is in the treatment of the topics presented.

The introduction of much new material made it necessary to rewrite and rearrange the chapters and divisions, correspondingly modifying the sequence of treatment in many cases, but the total number of pages and approximate size of the first edition have been maintained by the use of smaller type and narrower margins throughout the book. The more important additions are the general specifications for concrete highway bridges and foundations and the examples of standard designs for steel and concrete bridges prepared by the highway departments of several states; but the latter for some reason are limited to Iowa, Illinois and Wisconsin. It would seem to the writer that the homogeniety of treatment, the value of the book for reference and as an exponent of the advance in highway bridge designing mentioned at the beginning of this review would have been enhanced by the omission of the chapter on railway bridge trusses and the inclusion of examples of the standard steel bridge designs of more of the state highway departments—New York and Pennsylvania, for instance. Some of the types of pony trusses shown were practically obsolete in 1908 and are now twelve years more so. Examples of these are the pony Warren and Pratt trusses with top chords formed of two angles separated by the thickness of the gusset plates, shown on pp. 177 and 178; also those shown on pp. 188 and 189. The same might be said of the chord sections of three plates and two angles shown in Table 16, p. 508, the use of which now is faulty designing. This is the type of top chord and end post section almost always used in the earlier examples of double and multiple intersection through lattice trusses, and the writer has found it necessary to reinforce many of them now in use by adding angles to the lower edges of the vertical plates, which usually crumple up under overloads unless they were originally stayed by lattice bars.

About the only thing in connection with highway bridges that persists in perpetual and pristine vigor, never becoming obsolete, is the practice of finding a new name for some slight modification of any type of truss. Our author, to say the least, has not made any effort to better this condition. There seems to be no good reason why a pony Pratt truss should not remain such whether it rests upon a substructure of steel or concrete. On account of the lack of stone and timber in some localities, steel posts with steel plate backing have been used as a foundation for small spans. In the New England States, timber was generally used in the same way, when old railroad rails were not available. By strict analogy to the former case we should then have a "leg bridge" with a wooden leg. To carry this a little farther, why should a through Pratt truss, because it is so long that a curved top chord is economical, become a "camel"; and if such an appellation is proper why should not a Pratt truss deep enough to have overhead bracing become transformed from pony to a "horse"? An example of this tendency is shown on p. 189 where the pony Pratt truss becomes "fish-bellied" because the designer found it convenient to raise the shoes enough to bring the bridge seat to the level of the joists. Considering the particular bridge illustrated here one is tempted to ask whether the name is in deference to the whale or Jonah.

The chapter on timber bridges and trestles contains data enough to give the young engineer some idea of what can be done with this material, and also gives some interesting examples of the work of the highway departments in the western states. The reviewer is reminded that the first time he was called upon to design a timber bridge there was nothing at hand from which any precedent could be gleaned; and it happened to be a design wanted for the same man whose name appears on the cut on p. 262, O. E. Peppard, Missoula, Mont. This lack resulted later in the preparation by the reviewer of a series of standard plans for spans up to 150 or 175 ft. long so that when Mr. Peppard wired for fittings for a span, bills could go to the shop as soon as blueprints could be made and dried.

Chapters 24 and 25 are new material necessary to complete the story of a highway bridge installation and give some suggestions on the preparation of surveys and profiles of sites, forms for contracts, bonds and other legal papers; also fourteen or fifteen pages of cost data. Many of these data are undated and, without corresponding labor rates, must necessarily be considered relative rather than indicating any present figures.

The specifications for bridges do not mark any radical departure in specification writing or call for any ex-

tended review. The requirements are generally clearly and concisely stated. The sections covering live load concentrations might possibly be improved in this respect. The frequency of motor truck loads in many localities make it advisable to state clearly whether one truck or two or more trucks are to be considered on the bridge at one time. In the loading specified for class A, the covering width for two trucks is mentioned but anything beyond this must be inferred. Under class D1 the limiting length of the covered space and the width of rear wheel tires are given but these limitations are not mentioned for classes A and B.

A number of useful designing tables have been added in Appendix III which tend to make it more complete for reference, although any bridge engineer would have the data supplied elsewhere; and in writing the statement which heads the list of these tables on p. 489 the author must have overlooked the fact that fifteen or sixteen of them are reprinted from the "Carnegie Pocket Companion."

There are many new cuts and some new inset plates illustrating detail plans, all of which are excellent, but the halftone work reflects to some extent the unfortunate condition of the paper market. The table of contents is full and better arranged for quick reference than in the first edition. The headings at the top of each page indicate the general subject under consideration and are convenient in locating chapters; the chapter number appears at the top of each left hand page. The index seems to be full and cross-referenced sufficiently to enable any particular topic to be located without waste time. This may seem like a small matter, but many a good reference book has been discarded by busy engineers for no other reason than an incomplete and unhandy index, or no index at all.

Every bridge engineer who has spent many years designing highway bridges must have his own modes of procedure fully developed, and any such will necessarily see in this book many things differing quite widely from his practice. But perhaps because of that fact, rather than in spite of it, he should welcome it the more.

Revised Tunnelbau a Valuable Book

VORARBEITEN, ERD-, GRUND-, STRASSEN- UND TUNNELBAU: Handbuch der Ingenieurwissenschaften I. Teil; Funfter Band Tunnelbau Bearbeitet von Dr.-Ing. und Dr. phil. e.h. Karl Brandau, Dipl.-Ing. Karl Imhof und Dr.-Ing. e.h. Ernst Mackensen; mit einem Nachtrag von Dr.-Ing. Erich v. Willmann herausgegeben von L. von Willmann, Geh. Baurat und ord. Professor a. D. der Techn. Hochschule zu Darmstadt. Mit 607 Textabbildungen, vollstandigem Sachverzeichnis und 14 lithographierten Tafeln sowie kurzen Lebensbeschreibungen und Bildren des seitherigen Bearbeiters Dr.-Ing. e.h. Ernst Mackensen und des wahrend der Drucklegung verstorbenen Dr.-Ing. und Dr. phil. e.h. Karl Brandau. Vierte, vermehrte Auflage. Leipzig, Germany: Verlag von Wilhelm Engelmann. Cloth; 7 x 10 in.; pp. 712; illustrated as stated above. Paper; 44 M; cloth; 56 M.

Where the engineer finds his hardest tasks, there his art is carried to its highest development. Thus shield tunneling developed in those regions in which much work had to be done in soft ground under water—first in England and later, more fully, in America. In the same way rock tunneling has reached its highest perfection in the great mountain ranges of the Alps; and, as the knowledge gained in any advance of the art tends to remain in the region of its origin, we must turn to continental literature for a record of the methods used in Alpine tunneling and the difficulties under which these methods either failed or succeeded. The work under review supplies the fullest and most recent presentation. While in form a revision of a prior edition, now nearly twenty years old, it is essentially new. In fact, many of the most difficult European tunneling enterprises, such as the Simplon and the Gottico tunnels, were carried out during the last two decades.

Though the book covers the whole field of tunneling, much of it has no special interest to the American engineer. What is given on explosives, on drills, on tunnel location and gradients, on surveys and the like will have only incidental value at best, and the section dealing with shield tunneling is sadly deficient. On the other hand, that part of the book which deals with the methods of rock tunneling merits a high rating.

An important omission mars the treatment of rock tunnel excavation: The brilliantly original Rogers Pass work is not mentioned, though it represents the outstanding contribution to the art made on this side of the Atlantic in half a century. Of course the American reader will not find it difficult to supply this omission and to co-ordinate the Rogers Pass methods with those developed abroad. In the treatment of lining operations there is an equally weighty omission, neglect of concreting, including deposition and blowing methods. In most practical cases the choice of lining method is so intimately interwoven with the determination of the tunneling procedure itself that this omission—based, of course, on the all but exclusive use of stone and brick masonry for tunnel lining in European practice—has much more far-reaching influence than might at first be supposed.

The sections of essential value for our purposes are: (1) Those describing the timbering of headings, methods of drifting in bad rock or soft ground, and the four classic methods of tunnel driving together with a further one which the authors call the Italian method. (2) those analyzing the points of merit, the weakness and the limitations of the several tunneling methods, and a special discussion of the problems presented by full-section excavation in swelling ground, and (3) a chapter on cases of tunnel collapse and how they were handled. In each instance an ample selection of practical cases is reported in detail. They evidence strikingly the growing favor of the so-called Austrian method of driving and timbering (especially with the two-center radial strutting that has displaced the earlier substrutting system, and the decline of the other methods.

There is also valuable information on the high temperatures of rock and water encountered in very long tunnels, especially the Simplon, and on the possibility of predicting temperatures. Ventilation, spray cooling and refrigeration are also well treated. Because of the influence exerted by temperature and ventilation questions on the adoption of the lateral heading system in the Simplon tunnel and the fact that quite different reasons led to the use of the same expedient at Rogers Pass, this part of the subject is likely to engage special interest.

Should our future needs call for low-grade mountain tunnels much longer than any yet built in America, it is possible that they will contain problems whose solution will lead to changes in the current methods of constructing tunnels of moderate length in sound rock. The present treatise supplies the basic information on how similar problems have been handled successfully in the Alps. The same information, however, has value

also in relation to work of less extreme magnitude, and the tunnel engineer may well accord the book a permanent place on his reference shelf.

Industrialism and War

COAL IRON AND WAR: A Study in Industrialism Past and Future—By Edwin C. Eckel, Assoc. Am. Soc. C. E., Fellow, Geol. Soc. America, Late Major, Engrs., U. S. A. New York: Henry Holt & Co. Cloth; 6 x 9 in.; pp. 375. $3.

The breadth of this interesting and suggestive study is better indicated by the subtitle than by the main title, and still better by the headings to the four parts of the book: (1) The Growth of Modern Industrialism; (2) The Material Bases of Industrial Growth; (3) The Causes and Effects of Industrial Growth; (4) The Future of Industrialism. Chronologically, the book deals with the last century and half; geographically, it is world wide; topically, the author considers population, natural resources (by no means confined to coal and iron), manufacturing industries, invention and discovery, price changes, the worker, the corporations, the state in relation to industry, political beliefs, and world competition. The closing chapters are on Industrialism and War and The Forms of Future Progress. A moderate amount of statistical evidence in the form of tables and diagrams is given.

The use of the word "war" in the title leads one to expect from the author a conclusion as to the relation between war and industry in the future. For the immediate present, the author sees more liklihood of nationalism than of internationalism, but with hopes of "co-operation of strong national units, each freely developing along its individual line." The concluding paragraphs of the book sum up the author's conclusions as follows:

Finally, partly as the result of the fiscal necessities of the nations, we seem likely to witness an intensified nationalism everywhere, and this will be expressed in its industrial relations by high tariffs and by attempts to make the respective nations self-supplied. This implies, however, some degree of decentralization of industries, as compared with their present localization in a few countries; and it implies also a lessening importance of transport as compared with manufacture. In place of using a third of our coal merely to carry goods up and down the earth, we will be able to use this fuel in more directly economic ways.

All of these factors work together toward lessening the pressure upon our coal and iron resources; toward readjustments of the balance of power between localities and between nations; and toward throwing the trend of our future development into other lines than those which have been heretofore pre-eminent. The capital and labor which would formerly have been employed in transport and the cruder manufactures will in future be free to take up other lines of activity. As to the direction of such activity, we can only suggest that the trend of future development is likely to be along chemical rather than mechanical lines.

In areas favored by abundant natural resources, and protected by strong industrial and military power, future industrial growth will tend to lessen class friction, rather than to increase it. But the fact that France, Britain and America, under such conditions, are likely to develop politically as pure democracies, with a large measure of individual freedom and activity, should not blind us to the fact that there are other nations, not so favored, whose development may take other courses. It is questionable, for example, if the reaction from a broken-down autocracy in Russia, Germany or Japan will result in a government democratic in form, for in each case there are natural or artificial limitations, at present, on the economic possibilities of these nations; and these limitations tend to lower the average of well-being, and to increase class friction. We are likely, then, in the future to face wide differences in political ideas as well as in prosperity, between the members of two powerful groups of nations.

In the end, then, we come back to the fact that there are very serious material difficulties in the way of future peace. These difficulties are of natural origin, being ultimately dependent upon the unequal distribution of important natural resources. They may act directly, as in the case of the coal of Westphalia and China, the iron of Lorraine, the oil of the Caspian and Caribbean—all of which may serve as immediate causes of war or as the bases for that competition which is in the end more crushing and deadly than war. Or they may act through their effects upon political development, so as to create the possibility of international conflicts.

The book should have a special appeal to all broad-minded persons, and especially to engineers who wish to visualize world actions and reactions in the light of the industrial, political and social development of the last one hundred and fifty years and especially of the Great War.

Water-Power Resources of India

PRELIMINARY REPORT OF THE WATER POWER RESOURCES OF INDIA: Ascertained During the Season 1918-19 by the late G. T. Barlow, C. I. E., Chief Engineer, Hydro-Electric Surveys, Government of India, Assisted by J. W. Meares, M. Inst. C. E., M. I. E. E., M. Am. I. E. E., Electric Adviser to the Government of India—Compiled by J. W. Meares, Chief Engineer, Hydro-Electric Survey of India. Calcutta, India: Superintendent of Printing. Paper; 8 x 13 in.; pp. 108; illustrated. 3-2 Rupees.

In the first attempt to gather and compile comprehensive data on all the water-power sites in a territory so large as India, much pioneering work was required. Circulars outlining "practical conditions in determining the value of water power for electrical purposes" were distributed and the report itself contains much matter apparently intended for those not specially trained in water-power development, but whose aid would be valuable in compiling further data. Future plans and the needs in carrying the power survey further are given much space because of the difficulties involved in the work. On the latter point the report states: "Very little is known about the water-power resources of India and Burma because they mostly lie in the hills and jungles which are sparsely inhabited and rarely visited by any officials; only rough survey maps exist of many parts." It might also have been noted that absence of means of communication and the danger of disease increased the difficulties of the survey. Mr. Barlow contracted smallpox during the course of the investigations in the interior and died very suddenly. The work was then taken up and the report completed by his assistant, J. W. Meares.

All power sites on which data were gathered, whether favorable or unfavorable, are listed in paragraphed descriptions arranged by states. A table of existing hydro-electric plants in India gives data on 18 plants developing a total of about 108,300 hp. Of this total, 67,000 hp. is in the Tata development in the western Ghats.

Weather and climatic conditions are discussed in detail. In some districts monsoons, which cause highly concentrated precipitation, make for unusual problems in getting rid of the surplus water. Locations where as much as 35 in. of rainfall in one day are recorded, as well as an annual precipitation of over 400 in., which occurs in a small portion of the western Ghats. The larger part of the area examined, however, has moderate or low precipitation.

No estimate of the total water power available in India is hazarded because of the fragmentary nature of specific data, but in districts where comparatively complete data were available a few developments of large size are reported feasible. An example of this is the 50,000 hp. found available on the Jaldaka River in Bengal, within easy transmission distance of the tea area of the Duars. Here "some 90,000,000 lb. of tea are prepared in a season requiring the equivalent of 85,000 tons of coal, of which 60 per cent is used for drying purposes—to heat air, driven through the leaf at a temperature of 220 deg. F." The tea industry, however, requires power only from April to December.

The report is supplemented by a large general map of India on a scale of 1 in. to 64 miles, on which lines of equal rainfall are plotted and locations of power sites are shown by conventions that classify them as follows: Developed, under construction, investigated, and probable and possible sites.

PUBLICATIONS RECEIVED

AIR FORCES ON CIRCULAR AXES NORMAL TO THE WIND, WITH SPECIAL REFERENCE TO DYNAMICAL SIMILARITY—By Hugh L. Dryden, Assistant Physicist, Bureau of Standards. Washington, D. C.: The Bureau. Paper; 7 x 10 in.; pp. 30; illustrated. 5c. from Superintendent of Documents.

A study of wind pressure coefficients made with cylinders of from 1 to 6 in. diameter with velocities from 15 to 80 miles per hour made in the 54-in. wind tunnel of the Bureau of Standards.

AMERICAN RAILROAD ASSOCIATION: Proceedings, 1919—New York and Chicago, Ill.: The Association. Cloth; 6 x 9 in.; pp. 737; illustrated.

CAPILLARY MOVEMENT OF SOIL MOISTURE—By Walter W. McLaughlin, Senior Irrigation Engineer. Washington, D. C.: U. S. Department of Agriculture. Paper; 6 x 9 in.; pp. 70; illustrated. 15c. from Superintendent of Documents.

THE CHEMICAL ANALYSIS OF STEEL-WORKS' MATERIALS—By Fred Ibbotson, B.Sc., F.R.C. Sc.I., F.I.C., Joint Author of Brearley and Ibbotson's "Analysis of Steel Works' Materials." New York: Longmans, Green & Co. Cloth; 6 x 9 in.; pp. 296; illustrated. $7.50.

THE COLUMBIA BASIN IRRIGATION PROJECT; A Report by Columbia Basin Survey Commission, State of Washington, 1920—Olympia, Wash.; The Commission. Cloth; 6 x 9 in.; pp. 185; illustrated.

Report on studies for a gravity irrigation project to serve 1,753,000 acres of land in Washington. An article based on the report appeared in *Engineering News-Record*, Nov. 11, 1920, p. 944.

ELEMENTARY FORGE PRACTICE: A Text-Book for Technical and Vocational Schools—By Robert H. Harcourt, Instructor in Forge Practice, Leland Stanford Junior University. Second Edition. Enlarged. Peoria, Ill.; The Manual Arts Press. Cloth; 5 x 8 in.; pp. 154; illustrated. $1.50.

ELEMENTARY MACHINE SHOP PRACTICE—By T. J. Palmateer, Instructor in Machine Shop Practice, Leland Stanford Junior University, Palo Alto, Calif. Peoria, Ill.; The Manual Arts Press. Cloth; 5 x 8 in.; pp. 123; illustrated. $1.50.

HANDBOOK OF PIPE: Comprising Tables, Charts and Other Useful Information Relating to the Subject of the Carrying of Fluids and Gases by Pipe; Pipe Installation and Test Data. etc. New York: The East Jersey Pipe Company. Paper; 5 x 7 in.; pp. 213; illustrated.

Interspersed with and following matter relating to the pipe made by the publisher are tables and other useful data on pipe, conduit design and related topics.

HISTORY OF THE TWENTY-SIXTH ENGINEERS (WATER SUPPLY REGIMENT) IN THE WORLD WAR: Sept., 1917—March, 1919—For Sale by H. J. Angell, Gould Manufacturing Co., 16 Murray St., New York, N. Y. Cloth; 6 x 9 in.; pp. 258; illustrated.

Reprinted from the December, 1919, Journal of the New England Water Works Association. Besides the story of the regiment as a whole there are sketches of each of the six companies, of the headquarters and medical detachments, and of various officers. Halftone plates, maps, diagrams and cartoons add to the interest of the History.

AN "IDEAL SECTION" ON THE LINCOLN HIGHWAY: A tabulation, with Summary and Comments, of the Replies Received in Response to the Lincoln Highway Association's Questionnaire Regarding Plans and Specifications for An Ideal Section—Detroit, Mich.: The Association. Paper; 6 x 9 in.; pp. 16; illustrated.

INDUSTRIAL SURVEY IN SELECTED INDUSTRIES IN THE UNITED STATES, 1919: Preliminary Report, Prepared under the Supervision of Allan H. Willett, Professor of Economics, Carnegie Institute of Technology, Pittsburgh, Pa. Washington, D. C.; Bureau of Labor Statistics. Paper; 6 x 9 in.; pp. 119; illustrated.

A study of hours and wages in 28 industries located in 41 states and including 2265 establishments, 740 occupations and 404,758 wage earners.

LEHRBUCH DER EISEN-UND STAHLGIESSEREI: Verfasst Fur Den Gebrauch Beim Unterricht Beim Selbststudium Und in Der Praxis—Von Bernhard Osann Ordentl. Professor and der Bergakademie in Clausthal Geh. Bergrat Ehrenmitglied Des Vereins Deutscher Giessereifachleute. Vierte, Neue Bearbeitete Und Erweiterte Auflage. Paper; 7 x 10 in.; pp. 672; illustrated 42m; cloth, 54m.

THE MAKING, SHAPING AND TREATING OF STEEL—By J. M. Camp and C. B. Francis. Second Edition. Pittsburgh, Pa.; The Carnegie Steel Co. Leather, 5 x 8 in.; pp. 614; illustrated. $5.

THE MERCHANTS' ASSOCIATION OF NEW YORK. Year Book, 1920—New York: The Association, Woolworth Building. Paper; 7 x 10 in.; pp. 334; illustrated.

Contains annual reports and alphabetical and classified membership lists.

NEW JERSEY BOARD OF PUBLIC UTILITY COMMISSIONERS: Annual Report, 1918 and 1919—Trenton, N. J.: The Board. Cloth: 6 x 9 in.; pp. 131 and 189.

NEW YORK STATE CONSERVATION COMMISSION: Report, 1918—Albany, N. Y.: The Commission. Cloth; 6 x 9 in.; pp. 426; illustrated.

NEW YORK STATE ENGINEER AND SURVEYOR: Report for 1918-1919—Albany, N. Y.: Office of the State Engineer and Surveyor. Cloth; 6 x 9 in.; pp. 363; illustrated.

PRESERVATIVE TREATMENT OF WOOD POLES—By R. V. Achatz. Lafayette, Ind.: Engineering Experiment Station of Purdue University. Paper; 6 x 9 in.; pp. 54; illustrated.

Based on available printed matter and experiences with poles in Indiana, the latter gathered by correspondence and by inspection in situ.

PUBLIC HEALTH AND HYGIENE: In Contributions by Eminent Authorities—Edited by William Hallock Park, M. D., Professor of Bacteriology and Hygiene, University and Bellevue Hospital Medical College, and Director of the Bureau of Laboratories of the Department of Health, New York City. New York and Philadelphia: Lea & Febiger. Cloth; 6 x 9 in.; pp. 884; illustrated with 123 engravings. $10.

RAILWAY COMMISSIONERS OF NEW SOUTH WALES: Report, 1920—Sydney, Australia: The Commissioners. Paper; 8 x 13 in.; illustrated.

RAILWAY EARNINGS IN 1919: Compiled from Reports to the Interstate Commerce Commission of Railways Having Annual Operating Revenues above $1,000,000—Washington, D. C.: Bureau of Railway Economics. Paper; 6 x 9 in.; pp. 18.

REFORESTATION PROGRESS IN PENNSYLVANIA—By Jacob L. Crane, Jr. Reprinted from The American City, N. Y. Cambridge, Mass.: The Author, 1 Frost Terrace. Paper; 7 x 10 in.; pp. 4; illustrated.

THE RELATION OF FLOOD CONTROL TO DRAINAGE—By Thorndike Saville, Associate Professor of Hydraulic and Sanitary Engineering, University of North Carolina. Paper; 6 x 9 in.; pp. 7.

STATISTICS OF RAILWAYS IN THE UNITED STATES: Report, 1918. Prepared by the Bureau of Statistics—Washington, D. C.: The Bureau. Paper; 9 x 12 in.; pp. 91.

STEAM POWER—By W. E. Dalby, F. R. S., Member of Council Inst. of Mechanical Engineers, London University Professor of Engineering at the City and Guilds Engineering College of the Imperial College of Science and Technology. Second Edition. New York: Longmans, Green & Co. London: Edward Arnold. Cloth; 6 x 10 in.; pp. 760; 250 diagrams. $12.

Apparently a reprint (without change except in price, which has been doubled) of the book as it first appeared in 1915. The book was reviewed at length by Prof. Carl C. Thomas, Johns Hopkins University, in *Engineering News-Record*, Feb. 17, 1916, p. 320.

UTILITY REGULATION AND RATE OF RETURN—By Cecil Y. Elmes, Chicago Manager Sanderson & Porter, American Electric Railway Association, Annual Meeting Oct., 1920. Paper; 8 x 11 in.; pp. 37; illustrated.

Holds that utilities are completely regulated and other industries are entirely unregulated to the detriment of utilities, and appears to argue for regulation of the other industries. Urges also that money market is not regulated and although utility commissions may "specify a rate of return, the utility has no certainty of receiving it." Favors "progressively greater profit" to utilities "for progressively improved service to the public."

THE WESTERN FARMER'S WATER RIGHT—By R. P. Teele, Irrigation Economist, U. S. Department of Agriculture. Washington, D. C.: The Department. Paper; 6 x 9 in.; pp. 14.

WINGS OF WAR: An Account of the Important Contribution of the United States to Aircraft Invention, Engineering, Development and Production During the World War—By Theodore Macfarlane Knappen; With an Introduction by Rear-Admiral D. W. Taylor, Chief Constructor, U. S. N. New York: G. P. Putnam's Sons. London: The Knickerbocker Press. Cloth; 5 x 8 in.; pp. 289; illustrated. $2.50.

Suspiciously like an "inspired" review of our war-time airplane activities. Turns the searchlight on certain fine accomplishments but ignores dangerous mistakes and particularly the lack of co-ordination in aircraft production.

LETTERS TO THE EDITOR

The Worm Turns

Sir—As a subscriber to *Engineering News-Record* I wish to enter a respectful protest against both the matter and the manner of the articles which have appeared from time to time in your columns under the caption, "What Is Art?"

To your editorial judgment it may seem profitable to permit the discussion of points concerning which there is a difference of opinion between the architectural and engineering professions. If these questions can be discussed amicably both sides of the debate will be profited thereby; but when the discussion is permitted to evince the spirit apparent in some of the late articles, it would seem to the writer to be a serious mistake to publish any portion of it. For however much we may disagree upon moot points, architects and engineers are members of the one great family of builders, and must perforce "get together" for the furtherance of their common objects.

In the writer's estimation the worst offence is that in your issue of Sept. 23 over the signature of John C. Trautwine, Jr.

His vicious attack upon the time-worn puppet reminds one for all the world of a familiar stunt of childhood days, when we used to show the neighbor's little girl how brave we were by vanquishing a snow dragon which we had previously been at much pains to set up. I doubt very much if Mr. Trautwine could furnish a single example of either bridge or building design in which an architect would succeed in combining "meaningless pylons," "meaningless rock fortresses," a "meaningless sheet iron arch across each panel," and "a meaningless cast-iron cauliflower at each panel point." In the first place, an architect of sufficient repute to be entrusted with so important a commission would not be a designer capable of producing a design so meaningless; and secondly, if such a thing were possible, no client would pay for it. The paying public are not all afflicted with damphoolitis, Mr. Trautwine apparently to the contrary notwithstanding.

The fact that when a structure is to appear in "some place where large numbers of . . . persons foregather, an architect must be called in" is pretty conclusive proof that the majority of people have not yet arrived at that point of development where they are ready to subscribe to the creed that "the difference between the engineer's and the architect's training, which makes the engineer the authority on strength, makes him also the authority on beauty." And judging from the history of the last few thousand years, with which Mr. Trautwine does not seem to be particularly familiar, few of us will live to see the time when they will. As a matter of fact, with the costly failure of a certain Canadian bridge still fresh in our minds, there is a substantial majority among the older members of both the architectural and the engineering professions who would hesitate to go on record as believing that the engineer is invariably "the authority on strength." When it comes to professional blunders, the architects can hardly be said to possess the monopoly.

The man who can argue that a thing is beautiful because it fitly performs its function should spend his next vacation by the seashore catching devil-fish. Like the man who has to be told when to laugh, he lacks a very essential bone in his anatomy. If it were not for the overworking of Brother Trautwine's pet adjective, I would be tempted to retort that that is what his criticism is.

In a later number Rudolph Hering, consulting engineer, cites a horrible example from the wild and woolly days of American building as an instance of what "the Romans would never have endorsed and Americans will never repeat." Aside from the demerits of the particular design to which he refers, if the writer is not at fault in matter of architectural history, it was the Romans themselves who first invented the system of decorating structural members with "meaningless" ornament applied to the exterior for the sole purpose of making their otherwise severely plain arches and vaults interesting. And the civilized peoples of the world have "endorsed" their scheme by repeating it throughout a couple of thousand years. Perhaps consulting engineers have ways of knowing what the ancients would endorse which plain architects and engineers wot not of. Or it may be that they are more expert in the use of the Ouija board. Be that as it may, after having viewed the remains of certain Roman structures which were erected centuries before the slide rule and the testing machine were even dreamed of, the writer is quite willing to believe that few of the Roman designers would have been ready to subscribe to the thesis that "the greatest beauty of form in a structure and its parts is secured by giving the required resistance to every attacking force with the least amount of material, and in the simplest and most direct way." At least they would be likely to accept with reservations.

For a term of years the writer has been engaged with both architects and engineers in work upon various projects, and he credits himself with a mind sufficiently broad to enable him to see and to appreciate the better qualities of both; but that same experience long ago cured him of the notion that either the one or the other possessed the mentality sufficient to constitute one an infallible authority upon every question connected with his own and allied professions.

Winthrop Highlands, Mass. GEORGE E. DORMAN.
Oct. 29.

On Throwing Bricks

Sir—In your issue of Sept. 16, p. 572, you publish my letter of Sept. 4, with an editorial comment following it which seems to me to indicate that you gathered from said letter that I was about ready to heave a brick. Such is not the case.

However, I maintain my point, "that force is the one thing that counts in the case of large industrial corporations dealing with their employees." The comparatively few exceptions do not disprove the rule. It is not always a case of heaving bricks; but it is potential force, which may or can be exerted, that is respected. That is why the A. A. E. succeed with the railroads. We do not need to "sink to a very low order" to be able to recognize the fact that force rules industry today; and I think it is rather the labor unionists who "keep their heads" and their self respect, rather than the technical engineers.

I would like to dispel from your mind, and the minds of your readers, the thought that I in any way advocate or tolerate throwing bricks—except as a last resort. I stopped shooting rabbits for fun soon after my first vote.

CHARLES A. MULLEN,
Montreal, Nov. 10. Consulting Paving Engineer.

Recovery of Vortex Energy in the Niagara Turbines

Sir—Mr. Horton's article on "Modern Developments of Hydraulic Turbine Design," Oct. 7, 1920, p. 683, contains a rather glaring error in his portion under "Minimum Constraint Desirable," in which he says, "as everyone knows, water can only enter the buckets without shock when it approaches the wheel with a tangential component of velocity equal to the peripheral velocity of the runner." Everyone knows this is not so except in case of a runner with entrance angle 90 deg., and is far from so in the case of the high-specific-speed turbine.

Mr. Moody with the "Center cone" and Mr. White with the "Hydrau cone" both claim to recover part of the tangential component of the water leaving the runner, under part or overgate. They no doubt do, but they give no reason for change of this vortex energy to pressure energy. Mr. Horton blames it on De Vilamil and Helmholtz. The writer believes this is nothing more than a free vortex between approximately parallel plates, similar to that which has been used for thirty years around the impellers of centrifugal pumps for identically the same purpose, i.e., changing the energy of vortex motion to pressure energy, some of the energy being lost in friction. The path of a particle through such a free vortex is the equiangular or logarithmic

spiral, both the radial and tangential components of the velocity decreasing inversely as the distance from the center of the vortex. The coinical draft-tube fails to recover the vortex energy and there is no reason why these new devices should not be very successful and their application to turbines become more general.

Philadelphia, Oct. 29.

W. S. PARDOE,
University of Pennsylvania.

Shrinkage of Earthwork

Sir—The experiments made by the Chicago, Burlington & Quincy R.R. under the direction of Mr. Marshall, reported in *Engineering News-Record* of Oct. 21, 1920, p. 782, concerning the influence of the density of the earth upon the shrinkage of the embankments are not conclusive because not complete, and are based on a certain assumption. The assumption is that the embankments were built with earth taken alongside the fills and that consequently the material both in the cuts and in the fills is of the same identical quality. Such an assumption is not correct, especially in old embankments where the disintegrated ballast has found its way to a considerable depth into the soil of the fill, so that after many years the earth in the bank is different from the original cut. A comparison of the density of these two materials has no significance since the earth in the embankment has been greatly modified by the ballast and reballast of the roadbed. The discussion of the theories is generally based on assumptions, but not the experiments. Besides the experiments made by Mr. Marshall are not complete since the physical and mineral examination of the materials taken from the cuts and fills was neglected. Notwithstanding these objections which may have altered the results, the experiments prove my contention that the earth removed from the natural banks when deposited in embankments swells, and if the measure does discover a decrease of volume, this must be attributed to the losses in transportation and by rain erosion.

The diagram on p. 782 indicates that the earth of 103 lb. weight does not swell or shrink, and consequently is at the neutral point, while a heavier one swells and a lighter one shrinks. Curve "B" shows that all the earths below 4 ft. from the surface are heavier than 103 lb. and consequently swell. Now a material that shrinks or swells according as it is taken above or below the 4 ft. line proves that these phenomena are independent of the nature of the material, but caused by the particular condition of its particles as found at various depths. The apparent strange phenomenon is easily explained. When the cohesion is destroyed the particles get loose, the unit of volume becomes lighter on account of the larger number of voids which are formed. When such a material is subjected to pressure, the particles get close together and the earth shrinks. The earth, however, does not shrink when its particles are more compact and have not been disturbed from their natural position.

The result of the experiments is that the earth taken from a cut at a depth of more than 4 ft. swells, while if it is taken at a smaller depth it shrinks. This means that the earth down to the frost line should not be considered as in its original natural condition, because its cohesive force has been destroyed by successive freezing and thawing. The particles have been disturbed from their original natural position, many voids are now encountered in the mass, which tend to reduce the weight of the material as shown in curve "B" which also indicates that below the frost line the earth is not only heavier, but its weight is almost constant.

Any earth in which the force of cohesion has been destroyed (no matter if by removal from its natural position, or by freezing and thawing) will not be able safely to support any structure, and for this reason we are taught that "in any soil the foundation of any structure should be below the reach of the frost." No wonder that an embankment supporting a railroad track built above the frost line will sink under the pressure of the traffic. This is the so called subsidence of the embankment estimated tentatively by Mr. Marshall at 3 per cent. Curves "A" and "B" clearly indicate that the earth taken from the cuts above the frost line or down to 4 ft. from the surface have lost already their natural cohesive force although apparently they are in their natural position, a fact which was well known and admitted by everybody.

Besides, the experiments show that the volume of the earth in the embankment is always larger than in the cut. In fact, curves "C" and "D" indicate that humidity at any depth is greater in the fills than in the cuts. Difference in humidity in two materials considered equal and taken from the same locality proves that one has more voids which are filled with water, and one with larger number of voids weighs less and under equal weight or metallic content has a larger volume, hence it swells and does not shrink.

Mr. Marshall has not attached importance to the losses in transportation and by rain erosion during construction, and by the continuous erosion during the life of the embankment. These items, he says, may be covered by "adding some small percentage based upon opinion of many competent minds." This is not very instructive. Mr. Tratman, for instance, says: "One of the great troubles from heavy rainfalls is the gullying out of the slopes and the breaking down of the corners of cuts and banks." Heavy rains are an ordinary occurrence and consequently a great deal of material is carried away from the embankments and requires the continuous clearing of the ditches. No one has mentioned the ballast continuously added to the roadbed, which, when disintegrated, is incorporated in the embankment. Taking into consideration what has been added to the embankment since its construction, and comprising the original volume of the earth deposited with the present volume, it will be seen that the losses by erosion are not so insignificant.

The "shrinkage" of the earth in embankments is discussed under two different points of view, technically and practically. My contention is only theoretical. Earth is considered as one of the materials used in engineering construction, and the shrinkage and swelling are discussed as properties of the material itself. The railroad people discuss the question from the practical point of view of determining the actual value of the embankment, and have based some of their claims on the shrinkage of the earth, and in this I claim they are in error. CHARLES PRELINI.

New York City, Nov. 9.

Loss of Head in 12-in. Gate Valve; Correction

Sir—In an article by Thomas E. Lally on loss of head in a 12-in. gate valve in a 16-in. pipe line, in your issue of Sept. 23, p. 608, there is an apparent error in paragraph 3, in which he says that carbon tetrachloride (specific gravity, 1.60), when used in a U-tube, is eleven times more sensitive than mercury (special gravity, 13.56). This should read 20.9, as the formula for the use of the differential gage is loss head = gage deflection x (specific gravity of liquid—one) or

$$\frac{13.56 - 1}{1.60 - 1} = 20.9$$

I hope and believe this is an error in statement and does not effect the results quoted, which seem to check very closely the loss of head curve shown on p. 589 of the same issue. W. S. PARDOE.

Engineering Department, University of Pennsylvania, Philadelphia, Sept. 28.

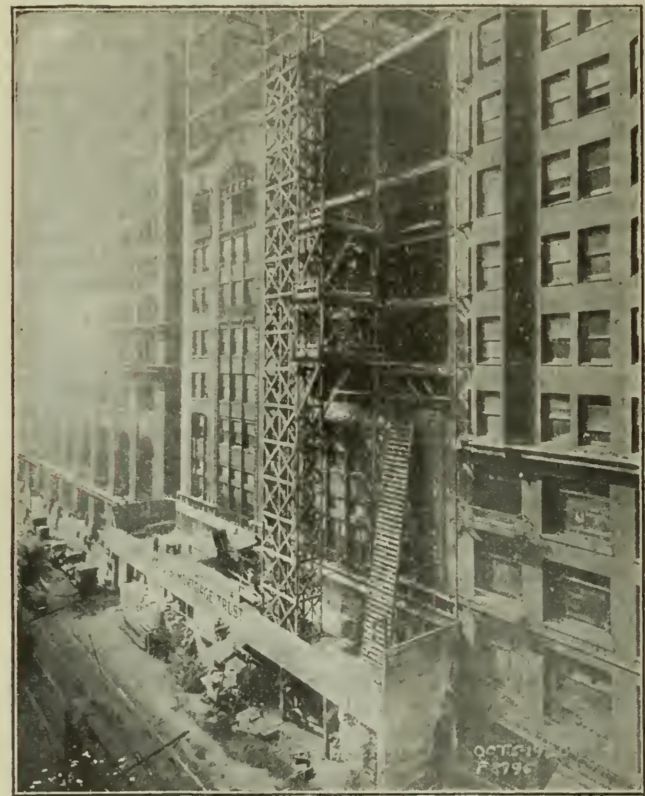
Sir—I wish to thank Professor Pardoe for calling attention to the mistake mentioned above. In the hand-written draft of the paper 21 was written in numerals. This was typewritten eleven, probably due to poor figures. As my calculations were made independent of the paper the error of statement does not affect the results of the tests.

Boston, Nov. 3. THOMAS E. LALLY.

HINTS FOR THE CONTRACTOR

Building Plant on Sidewalk Provides for Convenience of Traffic

BY PARTIAL occupation of a sidewalk with construction plant and material building alterations on a narrow street in the congested loop district of Chicago are being carried on with a minimum of obstruction to vehicular traffic and to occupants of the building. This work is at the Hamilton Club on South Dearborn St., the original building being part nine and part three stories high, all to be built up to fifteen stories without interfering with occupancy except at the top floor.



CONSTRUCTION PLANT FOR BUILDING WORK ON BUSY STREET

About 10 ft. of the width of sidewalk is utilized for a distance of 100 ft., leaving a 6-ft. space along the front of the building for pedestrians. The partition extends up to a substantial working platform which is built over the full width of the sidewalk at the second story level, this platform being used for power saws and storage. The tunnel thus formed is painted and well lighted in order that stores on the first floor may suffer as little as possible. Signs for these stores are displayed also on the street side of the working platform.

A two-compartment hoisting tower is erected on the sidewalk, its maximum height being 220 ft. In one compartment is a concrete hoist, the 1-yd. bucket being charged by a ¾-yd. mixer on the sidewalk and discharging into a hopper for filling wheelbarrows at the floor levels. In the other compartment is an elevator for materials. Platforms erected between the tower and the building and on the north side of the tower provide for handling material on two sides of the elevator. These platforms are supported by inclined struts framed against the posts of the tower. Access to the lower part of the work is by a wide Jacob's ladder reaching from the working platform to the fourth floor. Similar ladders extend from floor to floor in the upper portion.

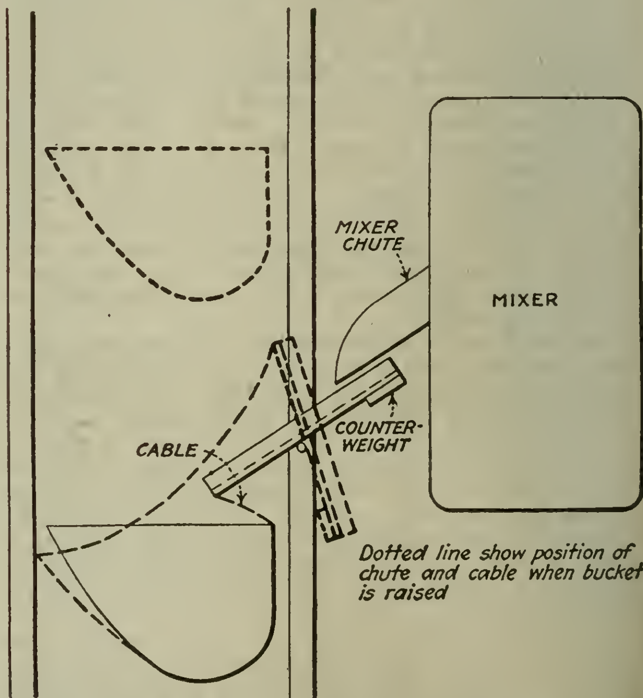
The new steel framing is erected by means of a steel derrick with 80-ft. boom which hoists structural material directly from the street. Lumber and reinforcing steel which cannot be handled conveniently in the elevator are hoisted by a short boom on the tower.

This work is being done by the Wells Brothers Construction Co., Chicago. E. E. Roberts is architect, the Westcott Engineering Co. acting as structural engineers and the Condron Co. as mechanical engineers.

Automatic Chute Connects Mixer and Hoist Bucket

By S. Warren
New York City

IN DUMPING concrete from a mixer into the hoist tower bucket, a chute must be used. The accompanying sketch shows a simple method of making this chute automatic in operation.



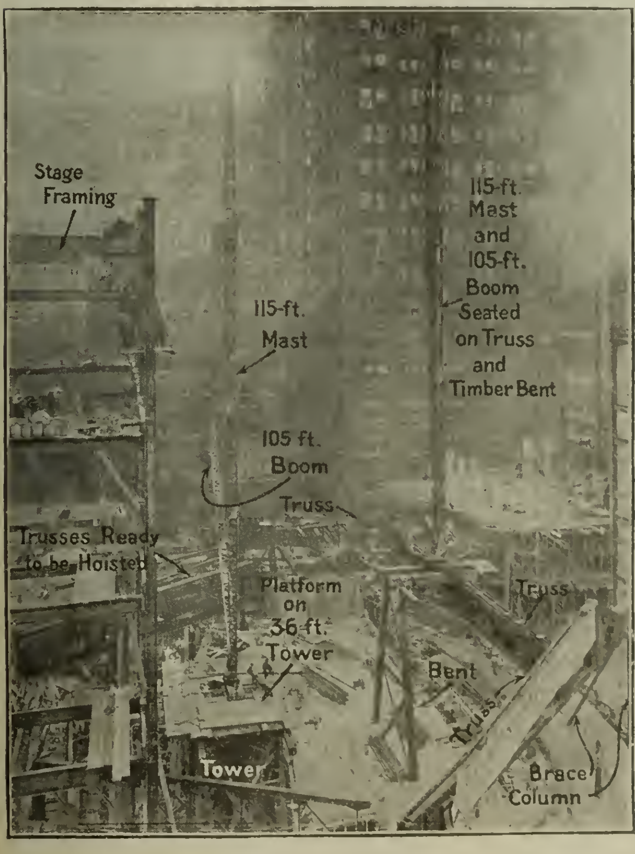
RAISED AND WORKING POSITIONS OF AUTOMATIC CHUTE

The chute, fastened to the hoist tower, is set slightly off center and counter-weighted so that the heavier end is outside the tower. When the bucket is raised it lifts

this chute to a vertical position, so that the bucket clears the chute when the bucket is again lowered. To bring the chute back to an operating position a cable is fastened to the end of the chute inside the tower. The other end of this cable is fastened to the other side of the tower. When the bucket is lowered it hits the cable and brings the chute into the proper position for dumping.

High Set Derricks Erect Building From Single Position

FOR the steel erection of the Ambassador Theater at State and Lake Sts., Chicago, two large steel guyed derricks were installed in the open space of the main floor, and were placed at a sufficient height to handle the entire work at one setting. One derrick was mounted on a timber trestle tower 36 ft. high, standing on the basement floor. The other derrick rested on bolsters having one end supported by a truss framed between two balcony trusses, and the other end by a single timber bent, as shown in the accompanying view.



HEAVY STEEL ERECTED BY TALL ELEVATED DERRICKS

The site is 170 x 155 ft. and the height from basement to top of steel is 120 ft. Each derrick has a 115-ft. mast and 105-ft. boom, the maximum working reach of boom being 100 ft., with a hoisting capacity of 20 tons at that reach.

Trusses supporting the balcony had to be erected in advance of other steelwork to permit of concreting the columns, these columns being braced temporarily by timber struts. Each of these trusses was shipped in one piece, two weighing 65 tons each and the other 48 tons. They were hauled by teams from the railway yard to the site. Some of the large stage trusses, in the framing at the left of the view, were assembled at the basement level and hoisted complete, the heaviest trusses weighing 75 tons each.

This erection work was done by the Overland Construction Co., Chicago, the steel work being built by the Federal Steel Bridge & Structural Co., Waukesha, Wis. The architects were C. W. and Geo. L. Rapp, and the structural engineers were Lieberman, Klein & Hein.

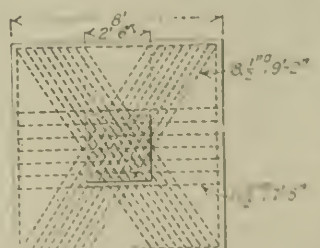
Handle Steel and Timber with Care

ROUGH handling of structural material is a practice about which foremen should be cautioned carefully and persistently, as it is a rather common condition in spite of the obvious chances of more or less serious injury to the material. As an instance, at a building of steel frame construction the columns and beams have been unloaded from motor trucks by throwing them off with crowbars and allowing them to drop upon the paving or upon material previously unloaded. Riveted connections are likely to be bent or loosened by such treatment, but more serious is the possible injury to the members themselves. The necessity of careful handling and unloading of steel rails in order to avoid shocks and sharp blows is generally understood, but it is not so well recognized that the same necessity exists in the case of steel beams and columns. Plate girders, also, are sometimes subjected to unintended stresses when laid on their sides for handling, or when laid flat upon blocking in such a way as to sag and bend, being used sometimes in that position as platforms for storing other material. Further, large structural timbers and wood piles are liable to damage when thrown from cars or trucks, especially if the timbers have been treated by a preservative process. Two points to be guarded against, therefore, in construction work, are careless unloading by material men or truckers and careless handling in storage or erection.

Simplifying Three-Way Reinforcement

By George Oxford
Detroit, Mich.

A NOVEL arrangement of reinforcing bars in rectangular bases for concrete columns was used recently in a Detroit factory building, as sketched herewith. Only two different lengths of bars were required for square bases, and only three for rectangular ones were straight, and wired together in the bar shop they formed rigid units, easily handled and placed.



SQUARE BASE WITH SIMPLE REINFORCEMENT

The design of such reinforcement is as simple as its use. Moments are taken about any line adjoining the projection of the shaft of the column, and the required amount of steel and concrete apportioned as usual. Care is taken, naturally, to consider only that component of the stress in the bar which is normal to the axis of moment. Since diagonal bars are longer than bars placed otherwise there exists a better condition for development of bond.

NEWS OF THE WEEK

New York, November 18, 1920

National Research Council Forms Comprehensive Highway Investigating Body

Advisory Board on Highway Research to Co-ordinate All Research Agencies—Federal Aid to Be Sought

In the hope of soon securing sufficient funds from the Federal Government with which to employ highly trained and experienced research men, in order that that mass of fundamental data which underlies the economic construction of the modern type of highway may be secured and distributed among roadbuilders throughout the country, representatives of twelve technical and other organizations, as well as men from five engineering colleges, met at the call of the Engineering Division of the National Research Council, Nov. 11 in the Engineering Societies Building, New York City, and formed the Advisory Board on Highway Research, appointed a permanent chairman, an interim secretary, a number of committees and formulated a definite plan of action.

Those bodies represented by one or more members at the organization meeting included the following: American Association of State Highway Officials, American Society of Testing Materials, Society of Automotive Engineers, Bureau of Public Roads, National Automobile Chamber of Commerce, American Society of Civil Engineers, American Institute of Consulting Engineers, American Society of Mechanical Engineers, Association of State Geologists, Western Society of Engineers, American Concrete Institute, and the American Automobile Association. In addition, engineering professors from Harvard University, Yale, the University of Maryland, the University of Illinois and Iowa State College, were present and took part in the discussions and organization of the research board.

NATIONAL PROGRAM OF RESEARCH

The general highway conference was called after the National Research Council had been convinced of the necessity of co-ordinating all research agencies for the early accumulation of data necessary to the economic design and construction of hard-surfaced highways. Quoting from by-laws of the new board it will exist to "assist in outlining a comprehensive national program of highway research and coordinating activities thereunder; to organize committees for specific problems; to deal with ways and means; and to act in a general advisory capacity." As committees to handle specific problems are those on (1) Bibliography; (2) Economic Theory of Highway Improvement; (3) Structural Design of Roads; and (4) Character and Use of Road Materials. After these committees have surveyed their respective fields of activity, reports will be made back to the General Advisory Board as to what specific subjects should be taken up.

It is the intention of the Advisory Board on Highway Research to secure a definite assignment by Congress of a certain portion of the unexpended balance of Federal-aid road money to some agency which will administer the funds under the direction of the advisory board. It is hoped that sufficient funds may be immediately made available to allow the research work to begin at once, and to admit of the employment of a corps of highly trained

(Continued on p. 1014)

Pasadena Adopts Commission-Manager Form of Government

The commission-manager form of city government was adopted by the voters of Pasadena on Nov. 2. Seven "directors," elected by popular vote, will appoint a city manager who in turn will select all other city executives.

"Transportation" To Be Keynote of A. S. M. E. Session

The "keynote" session on Transportation which will occupy an entire day of the annual meeting of the American Society of Mechanical Engineers, to be held at the Engineering Societies' Building, 29 West 39th St., New York City, Dec. 7-10, will include an address by Daniel Willard, president, Baltimore & Ohio R.R., on the railroad situation. Charles A. Morse, chief engineer, Chicago, Rock Island & Pacific Ry., will speak on the development of railroad feeders, and Maj.-Gen. Frank T. Hines, chief of embarkation during the war, who is now chief of transportation in charge of all army transport, will speak on the development of waterways. Motor truck transportation problems will be outlined by Francis W. Davis, transportation engineer, Pierce-Arrow Motor Car Co., and the railroad terminal problem will be presented by Col. William Barclay Parsons. The freight situation of New York City will be discussed by Gustav Lindenthal.

An announcement of the meeting appeared in *Engineering News-Record*, Oct. 21, p. 819. The transportation session is to take place Dec. 9.

New York Board of Examiners Named

A board of five members has been appointed by the University of the State of New York to administer the engineers' registration law passed by the State Legislature last summer. It consists of Col. W. J. Wilgus, P. A. Barhour, H. G. Reist, V. M. Palmer, and E. H. Hooker, representing respectively the civil, mining, electrical, mechanical, and chemical branches of engineering.

Shandaken Tunnel Work Assigned By Degnon Company

The contract for the Shandaken tunnel, which is being built under the direction of the Board of Water Supply of the City of New York to deliver water from the Schoharie watershed to the Ashokan reservoir, has been assigned by the contractors, the Degnon Contracting Co. of New York City, to a corporation specifically organized for completing the work. The assignee is the Shandaken Tunnel Corporation, incorporated by the Ulen Contracting Corporation of New York, the Fidelity and Deposit Co. of Maryland, and the National Surety Co., with a paid-in capital of $750,000.

The Ulen Contracting Corporation is associated with Stone & Webster and has done a large amount of work in the Middle West and in South America.

The Degnon Company is leaving the Shandaken job with approximately $2,000,000 worth of work completed. The seven construction and the one intake shafts have all been sunk and turned. The new contractors will take over all rights, titles and interest in the Degnon equipment at Shandaken. The original contract was let to the Degnon Co. Nov. 10, 1917, the contract price being approximately $12,000,000.

State Highway Engineers Inspect Maryland System

With a view to co-ordinating the engineering work of the Maryland State Roads Commission and at the same time giving to the new members of the commission and the several resident engineers a comprehensive view of the entire Maryland highway system, John N. Machall, chairman and chief engineer of the commission, has inaugurated a series of inspection trips. The first of the trips begun the week of Nov. 8, included the Western Maryland section. Members of the commission, chiefs of the seven road districts, and representatives of the Bureau of Public Roads make up the inspection party. The second trip, to be made the week of Nov. 15, included visits to most of the Eastern Shore counties.

Nelson P. Lewis Retires From Municipal Service

Nelson P. Lewis, chief engineer of the Board of Estimates and Apportionments, New York City, will retire next month from the municipal service, in which he has been employed thirty-four years. In recognition of his work the Municipal Engineers of the City of New York, of which he was the first president, will make its sixteenth annual dinner, to be held at the McAlpin, New York City, Dec. 18, a testimonial to Mr. Lewis.

In the field of civil engineering, both in this country and in Europe, Nelson P. Lewis is a well known figure. In addition to his duties with the Board of Estimate and Apportionment of New York City, he has been active in engineering society affairs, having served as vice-president and director of the American Society of Civil Engineers, as president of the American Road Builders Association and as president of the National Conference on City Planning. He is author of the book "Planning of a Modern City."

Mr. Lewis was born in Red Hook, N. Y., in 1856, and after graduation, in 1879, from Rensselaer Polytechnic Institute he went to Colorado, devoting his time to railroad work in that state and in Louisiana until 1884, when he came to Brooklyn, N. Y., to become leveler in the Department of City Works. Since that time, with the exception of a period from November, 1886, to July, 1889, when he was engaged in railroad work in Alabama and Georgia, Mr. Lewis has been continuously in the service of the City of New York.

Mr. Lewis' early work with the city was in the highway department of Brooklyn, where he advanced from assistant engineer to chief engineer. In recognition of his efficient work he was promoted to become chief engineer of the New York Board of Estimate and Apportionment when that office was established in March, 1902. Through many changes in municipal administration Mr. Lewis has occupied this post and has passed upon the engineering features of public works improvement involving expenditures of many millions of dollars. On account of his extensive experience in problems of municipal engineering his services on special commissions have been frequently sought. In 1904 Mayor McClellan named him as a member of the New York City Improvement Commission and in 1905 he was appointed to the Commission on Municipal Electric Lighting. Later he served on the Heights of Buildings Commission, a body whose work lead eventually to the adoption of the zoning scheme in New York City. His most recent commission duties have related to snow removal and garbage disposal of New York.

Mr. Lewis has always displayed a keen interest in the design, construction, and economic features of highway improvement and was a United States representative at the International Road Congresses on three occasions—at Paris in 1908, at Brussels in 1910 and at London in 1913. His contact with foreign affairs was further strengthened in 1913 by attendance at the International Congress of Cities held in Ghent, and in December, 1918, he was one of nine engineers invited by the French Society of Civil Engineers to visit France and study its engineering problems under war conditions.

As an authority on city planning Mr. Lewis has received wide recognition. In

NELSON P. LEWIS

addition to his book, previously mentioned, he has written many papers on the subject and delivered numerous lectures at engineering colleges and technical societies.

In retiring from the arduous duties as chief engineer of the Board of Estimate and Apportionment Mr. Lewis has stated that it is not his intention to open a consulting office. It is possible, he explained, that where his advice is sought on city planning and general municipal problems he may give opinions as a consultant, but his plans do not contemplate any large scale work along these lines.

Research Information Service Begun

A research information bureau has been established by the National Research Council to act as a general clearing house in supplying information. Ordinarily this service will be rendered without charge, but where difficulties will be involved the enquirer will be furnished with an estimate of cost of obtaining the desired matter. Much of this material will be issued in the publications of the Council but it is intended to maintain complete files relative to special subjects. Inquiries should be addressed to the Research Information Service, 1701 Massachusetts Ave., Washington, D. C.

Further Details of Bond Issue Votes

Colorado Tunnel Project Defeated—Philadelphia's $33,000,000 Loan Allotted to Many Projects

Details of the $33,000,000 Philadelphia Loan—The items in the $33,000,000 loan bill noted in these columns last week as having been voted by the people on Nov. 2 are: Buildings, $7,520,000; sewers and sewage disposal, $4,500,000; streets, $3,850,000; elevated railway and subway, $3,600,000; docks and wharves, $3,500,000; water supply, $3,105,000; damages for street openings, etc., $2,000,000; street cleaning equipment, $1,000,000; bridges, $900,000; bathing beaches, $800,000; parks and playgrounds, $1,675,000; fire apparatus, $550,000. Some of the items were characterized on the ballots as being "towards" the improvements specified. The loan was approved by a vote of 182,506 to 54,983. Press and other local comment indicates that had the vote been on specific items the negative vote for most of the purposes listed would have been lower.

Reading Votes $1,940,000 Loan but Defeats Parks and Playgrounds—A bond issue of $1,940,000 for sanitary and storm sewers, paving and public comfort stations was carried at Reading, Pa., Nov. 2, but items (amounts not reported) for parks and playgrounds and the "Bingaman St. bridge lamp" were lost.

Water Bonds Voted at Vallejo; Salary Raises Defeated—A $1,250,000 bond issue to bring water from Gordon Valley to the city of Vallejo, Cal., and Navy Yard was approved on Oct. 28, by a vote of 3,612 to 359. The project includes a 2,000,000,000-gal. reservoir and a 5,000,000-gal. pipe line 12 miles long. On the same date proposed salary increases for the mayor, city commissioners and auditor were defeated by majorities of 500 to 1,000.

South Dakota Authorizes State Aid for Home Building—An amendment to the constitution of South Dakota authorizing state aid for home building appears to have been carried by a substantial majority.

No State Tunnels for Colorado—More complete returns on the vote for a constitutional amendment to permit the issue of $18,550,000 in bonds for the construction of mountain tunnels in Colorado have reversed the apparently favorable result noted in *Engineering News-Record* of Nov. 11, p. 961, the bond issue being defeated by a considerable majority. The earlier returns included Denver and the northwestern section of the state which would be benefited most directly by the proposed improvement in transportation facilities. The six-mile Moffat tunnel under James Peak, to eliminate the present high-level, steep-grade, open-pass summit section of the Denver & Salt Lake R.R., was the main feature of the project. The city of Denver at one time voted to issue bonds for this tunnel, but

the state supreme court held this to be unconstitutional. Other tunnels were to be on lines of the Denver & Rio Grande R.R., but one of the objections to the amendment was a doubt as to whether the railroad could be compelled to use the tunnels. Another argument was that if the financial prospects were as good as estimated by the advocates of the measure the projects would have been undertaken by private capital. There was also the same opposition to the system proposed for the carrying out of the project.

Pasadena Again Defeats Municipal Railway to Los Angeles—For the second time the voters of Pasadena have refused approval of a project for building a ralway to Los Angeles. The vote on Nov. 2, was 10,831 for to 3,897 against a charter amendment authorizing a $4,500,000 bond issue for the purpose, whereas a favorable two-thirds majority was necessary for approval. A charter amendment which carried authorizes 6 instead of 5 per cent interest on city bonds.

Arizona Probably Defeats Road and Irrigation Bonds and Carries State Institution Bonds— News as to constitutional amendments in Arizona is belated. Early returns indicate that $15,000,000 of road and $20,000,000 of irrigation bonds were defeated and $5,000,000 of bonds for state institutions carried.

Arkansas Road Bond Amendment Lacks Two-Thirds Majority—Although receiving a plurality, the proposed Argansas constitutional road bond amendment lacked the two-thirds majority of the gubernatorial vote. Some doubt has been expressed as to the need for more than a bare majority.

Colorado Votes Road Bonds—A constitutional amendment passed by a substantial majority on Nov. 2 provides for a bond issue of $5,000,000 at 5 per cent for road work, under the direction of the state highway department. Half of the amount is to be used upon federal aid projects, in co-operation with the U. S. Bureau of Public Roads. The remainder is to be expended within the different counties in the ratio which the mileage of state roads in each county bears to the total mileage of state roads. Federal aid may be used also, if it is available. Bonds for this second class of work are to be issued to the amount of $1,000,000 only in 1921.

Kansas Passes Good Roads Amendment — Adoption of the constitutional amendment permitting state aid for highway construction in Kansas appears assured. This amendment is merely an enabling act. It gives power to the Legislature to provide laws whereby the state may aid in highway construction to the extent of 25 per cent of the cost, not to exceed $10,000 per mile for no more than 100 miles in any county, except in counties having an assessed valuation of more than $100,000,000 in which aid may be extended to 150 miles of highway.

State Road Bonds Defeated—The adverse vote against Carlyon $30,000,000 road bond bill in Washington noted in our issue of Nov. 2, p. 961, was 122,000 to 73,000. Other defeated state bond issues or constitutional enabling amendment thus far indicated are: *Florida*, amount unknown; *Idaho*, $2,000,000; *Montana*, $15,000,000; *Utah*, $2,000,000.

Chester County, Pa., Road Bonds Fail—A proposed Chester Co., Pa., $3,000,000 road bond issue is reported to have been defeated on Nov. 2, by 3,000 majority through the farmer vote.

Faherty Chosen President of Road Builders' Association

At its annual meeting held at the Automobile Club of America in New York City, Nov. 15, the American Road Builders Association elected as president M. J. Faherty, chairman of the Chicago Board of Local Improvements, and as secretary E. L. Powers, editor of *Good Roads*, New York City. All of the other candidates for office selected by the nominating committee, as listed in last week's issue of this journal, p. 965, were elected.

The next convention and exhibit of road building machinery and materials will be held in the Coliseum, Chicago, next February.

Water Epidemic of Typhoid Fever at Salem, Ohio

Pollution of the public water supply by leakage into an old gravity line of terra cotta pipe leading from wells to the pumping station of Salem, Ohio, is believed to be the cause of a typhoid epidemic in that city. Some 750 cases and nine deaths had been reported up to Nov. 12. Investigations are being made and restrictive measures carried out by W. H. Dittal, chief engineer of the Ohio State Department of Health and a medical and engineering staff, with the co-operation of the U. S. Public Health Service.

British Institution to Increase Dues and Avoid Deficit

With a threatened annual deficit of more than $50,000 due to increased expenses for publication and administration, the council of the Institution of Civil Engineers (London) has concluded that membership dues should be raised to provide an additional income of about $60,000 (at normal rate of exchange). It is proposed that the increase in dues shall be higher for the senior than for the junior classes of membership and that the present difference between resident and non-resident members shall be extended to make distinction between non-resident members at home and abroad. Under the proposed schedule the annual dues will be $35, $27.50 and $22.50 for resident members, non-resident members in the United Kingdom and non-resident members abroad respectively. For associate members the annual dues will be $22.50, $20 and $17.50, respectively. For students the dues will be $10 annually.

Editor Addresses Societies and Engineering Students

E. J. Mehren, editor of *Engineering News-Record*, has returned from a two weeks' trip in which he spoke before engineering societies and students of engineering colleges in the Middle West. With the exception of one address, his topic was his impression of political and industrial conditions in Europe. The addresses before the Detroit Engineering Society, the Engineers' Club of Kansas City, the St. Louis Engineers' Club the Engineering Society of Milwaukee, and the students of Purdue University were illustrated with lantern slides. The members of the Western Society of Engineers were addressed at their usual monthly public-topics luncheon. At Northwestern University Mr. Mehren spoke on "Some Elements in Engineering Success."

Ashtabula Retains Present Charter

By a vote of 2,775 to 2,336, the voters of Astabula, Ohio, decided to retain present commission-manager and proportional representation charter.

Rivers and Harbors Convention

The National Rivers and Harbors Congress will hold its sixteenth annual meeting at the New Willard Hotel, Washington, D. C., Dec. 8 to 10. The announcement states that the speakers will include men who are using or have tried to use water transportation and who will tell of difficulties met and results secured. John H. Small is president, and S. A. Thompson, 824 Colorado Building, Washington, D. C., secretary.

Southern Pacific Company Orders Manganese Steel Rail

The purchase of 2,000 tons of manganese steel rail, at a cost of $375,000, was approved by the Executive Committee of the Southern Pacific Co., Nov. 11. This rail is to be used on curves of from 6 to 12 deg. between Kern Junction and Tehachapi, Cal., a distance of 47 mi., and between Truckee and Blue Canyon, Nev., a distance of 41 mi. It is understood that the decision to use manganese rail for curves on these divisions is primarily a safety measure and is based on the experience of the Delaware, Lackawanna & Western R.R. The Southern Pacific Co. will use the manganese rail both for outer and inner rail.

The rail will be produced by the electric furnaces of the Illinois Steel Co., and ordered through Manganese Steel Rail Co. The manganese content is 10.5-15.0 per cent, carbon running 0.92 to 1.10 per cent. The rail is quenched in water immediately after passing the hotsaws. The rail webs at the ends are drilled with high-speed drills and copper plugs are pressed and sweated in to provide for rail bonding since track drills are not capable of drilling the steel.

Utility Commissioners Meet in Washington

Sentiment Against Government Ownership and Centralized Regulation—Valuation Report

Limitation of the authority of state railway and public utility commissioners by current interpretations of the Transportation Act was the principal topic under discussion at the meeting in Washington last week of the National Association of Railway and Utility Commissioners, at which the state commissioners expressed strong sentiment against government ownership as well as "over-centralized" regulation by the Interstate Commerce Commission. An out-and-out declaration against government ownership of railroads by T. J. Lucey, of the Illinois commission, was received with bursts of applause. In 1914, sentiment among some commissioners inclined toward government ownership. The efforts of the railroads to escape state regulation very evidently had put each state commissioner on his mettle. The determination to fight against the loss of rate-making powers, or any other limitation of the authority of the state commissions was at all times evident.

Valuation Report

The valuation committee took a stand against the cost of reproduction method on the ground that it "now leads to unwarranted and unreasonable values which offer little guidance in determining the fair value of the property of public utilities, and the continuance of the cost of reproduction theory as the controlling factor in public utility valuation will in the future undoubtedly cast a burden upon those utilities which were required by public necessity to make substantial plant investments during the high price period." It was not intended, however, that "fair value rule should be abandoned or impaired but rather that under the fair value rule and in view of abnormal conditions prevailing, a greater measure of justice and equity will be secured by giving greater weight to the honest and prudent investment and less weight to the cost of reproduction or cost of reproduction less depreciation."

The matter of car distribution was one of the principal topics of the meeting. It was precipitated by an address by Commissioner Clyde B. Aitchison, of the Interstate Commerce Commission. Issue was taken with the Interstate Commerce Commission's policy, both in the handling of grain and of coal cars. At the invitation of the Association of Railway and Utility Commissioners, representatives of the public utilities were in attendance. M. H. Aylesworth, of the National Electric Light Association, and George W. Elliott, of the National Committee on Gas and Electric Service, told how the utilities throughout the country have been kept in a state of continual uneasiness, due to the piece-meal fashion of coal deliveries. Only good luck and the extended period of good weather have avoided numerous suspensions of service, they declared. Mr. Aitchison said the Commission had withdrawn assigned cars for public utility coal because the utilities abused the privilege. Since there were not enough cars to go around, he said there was no avoiding the use of priorities.

Officers elected for the ensuing year are: James A. Perry, of the Georgia Commission, president; Carl D. Jackson of the Wisconsin Commission, first vice-president; Dwight N. Lewis, of the Iowa Commission, second vice-president. James B. Walker, of the first district New York Commission, was re-elected secretary of the Association.

President Perry appointed the following executive committee: Carl D. Jackson, Wisconsin, chairman; Joseph B. Eastman, Interstate Commerce Commission; E. I. Lewis, Indiana; Clyde M. Reed, Kansas; R. H. Burr, Florida; A. M. Barrett, New York; J. J. Murphy, South Dakota.

The following were named on the committee on litigation: Fred W. Putnam, Minnesota, chairman; Dwight N. Lewis, Iowa; W. D. B. Ainey, Pennsylvania; Allison B. Mayfield, Texas; J. A. Kellogg, New York; William G. Busby, Missouri: R. H. Burr, Florida.

Manitoba Engineers To Enforce Salary Schedule

A pledge not to accept a salary lower than a specified schedule is being asked of members of the Manitoba branch of the Engineering Institute of Canada. Minimum salaries from $3,600 to $10,500 per year are listed in the schedule prepared by the remuneration committee for different branches of professional service; a maximum is suggested also, except for the highest positions. It has been decided that any engineer who fails to receive the salary recommended for his class of service will be assisted to obtain other employment at adequate remuneration and will receive moral and financial support. Records are to be kept of all engineers in the employ of large corporations and industries, with their positions and salaries. Where the salary is below the schedule, the employer will be requested to appoint a representative to discuss the matter with the committee, with a view to adopting the schedule rate.

Federal Aid Sought for Ohio River Bridge Project

Representatives of the Chamber of Commerce of Evansville, Ind., have planned a trip to Washington in an effort to obtain federal aid in building a bridge across the Ohio River. The State Highway Commissions of Indiana and Kentucky will be asked to lend assistance to the project and the next step will be to have the legislatures of the two states lend financial aid to the enterprise. Business interests in Evansville have for a number of years urged a bridge across the river at this place.

Wanaque Dam Contract Let To Walter H. Gahagan

Walter H. Gahagan, Inc., of Brooklyn, was the successful bidder on the construction of a portion of the Wanaque dam, let Nov. 9 by the North Jersey District Water Supply Commission. The contract was let on a cost-plus-a-percentage basis, the contractor to share in any reduction in unit costs up to a certain per cent, or to bear a share of added expense through an increase in cost of materials and wages named in the contract, as explained in *Engineering News-Record*, Nov. 4, p. 878. However, no matter what the expense of the work may be, the contractor is assured of a 4 per cent fee

As against the cost-plus bid, the Rollin Construction Corp., of New York City, tendered a bid on a straight unit price basis, agreeing to do the work for $1,421,227, which was the low bid, being under the engineer's estimate and the bid of the Gahagan company by $7,889. The Rollin Corporation being the lowest bidder, believed itself entitled to the contract. As the members of the commission apparently think that the cost-plus contract will prove the less expensive method of doing the work because of some indication of a fall in material prices and a possible decrease in the price of labor named in the contract, that bid was made the successful one.

Officers of the Rollin organization see in the award of the contract to the Gahagan Co. a contest between the cost-plus and unit price methods of bidding. They point out that though there may be a saving through a reduction of material prices and wages, there is greater possibility that the ultimate cost will exceed the bid price and that that situation could have been avoided through the acceptance of theirs, the lowest bid. Some of the reasons why they believe that a cost-plus contract would not be the better in this case are given herewith:

1. A decided increase in overhead due to enlarged auditing, checking and inspecting forces employed by the contractor and similar expense on the part of the owner.

2. The inability of the contractor to secure the best results from his labor because of the impossibility of offering either a bonus or increased pay without subjecting himself to the criticism of the engineer that he is paying more than the prevailing rates.

3. The feeling of the contractor that he lacks freedom to employ special construction methods which would subject him to severe criticism of the engineer, if they failed, but would result in great saving if they were successful

4. The natural inhibition set up against the purchasing forces trying to secure the best in material prices.

Bids were called for on two classes of construction: Class 1 and Class 2, the former containing 26 items of actual construction and Class 2 including overhead, freight charges, miscellaneous materials, supplies, buildings, etc. The engineer's estimate on the first class of construction was $1,124,154 and on Class 2, $250,000. Added to these prices is the 4 per cent fee, which total made up the successful bid.

National Research Council

(*Continued from p. 1010*)

research men, the best obtainable, so that results may be obtained as quickly as possible. One of the outstanding features of the conference was the feeling that a certain per cent of all moneys now available for highway construction could be saved were more research work done, and that the work must be done quickly and the results widely spread.

Though few of the organizations present had formal instructions from their individual bodies as to what specific action they should take in the organization of the advisory board, Col. F. A. Molitor and Samuel Whinery, representing the American Institute of Consulting Engineers, had been instructed to carry to the conference the information that the board of direction of the consulting engineers had passed a resolution calling for the setting aside by Congress of a certain sum from the unexpended balance of Federal-aid money with which to employ trained and experienced men in the field of highway research. The resolution will be acted upon by the consulting engineers regardless of what action the advisory board takes in the matter, and they will carry their fight to secure such an appropriation through the Chamber of Commerce of the United States, and its constituent membership. However, the conference agreed that the course of action taken by the consulting engineers would be, in effect, its action.

Plan of Organization

Membership in the Advisory Board of Highway Research is to be open to "those organizations of national importance interested in design, construction, maintenance, economics and financing of highways, in materials and equipment therefor and in vehicles used on highways; governmental departments and bureaus of similar interests, and higher educational institutions, each acting through one duly appointed representative with authorization to name an alternate, serving until his successor is appointed."

It is the plan to employ a highly paid director under whom the corps of research men will operate, and who will manage the affairs of the board. Such a director is to be a professional engineer of experience and ability. The board is also to have a chairman and a vice-chairman and these two, acting ex-officio with three members of the Division of Engineering of the National Research Council, are to form the executive committee. Anson Marston. Dean of Engineering, Iowa State College, was named the chairman of the permanent board to serve for one year, and the interim director is A. D. Flinn. The annual meeting is to be the second Thursday in November, at such a place as the chairman may designate.

Inasmuch as the Advisory Board has been given the moral support informally of the organizations attending the conference, it will lack a permanent, definite character until representatives of all technical bodies present have reported back to their various societies and have secured definite expressions as to what final action these societies will take. This procedure, it is hoped, will be early accomplished and the organization immediately begin its important functions.

During the conference three committee reports of the Division of Engineering of the National Research Council were heard, as well as several short discussions as to the need for research in highway matters. Thomas H. MacDonald, Chief of the Bureau of Public Roads, pointed to the fact that but 1 per cent of the Federal budget for the fiscal year ending June 30, 1920, had been expended upon research and of that amount 63 per cent had gone to the Department of Agriculture. Of the total budget 3 per cent represented money available for public works and of that amount 59 per cent was to be spent for highway construction. With a program calling for the expenditure of more than $1,000,000,000 on highways now under way, he stressed the necessity of making as clear as possible the fundamental problems upon which the economic expenditure of this money rested.

Both Prof. C. A. Adams, and Prof. Anson Marston emphasized the need for co-operation in research matters.

Proposed Work Outlined

Some of the work that was to be taken up was outlined in the reports of two committees of the engineering division. Prof. T. R. Agg, of Iowa State College, and chairman of the committee on the economic theory of highway improvement, reported that the Kansas Agricultural College was making experiments upon wind pressures on motor vehicles; that the Motor Transport Corps of the United States Army was doing important research work and that a report from its chief, Colonel Ireland, was forthcoming; and that other organizations were investigating the effects of grade and curvature on gasoline consumption. A. T. Goldbeck, engineer of tests, U. S. Bureau of Public Roads, and chairman of the committee on structural design of roads, explained what tests were now being made to determine the relative bearing power of various subgrade materials and what was being done to strengthen the bearing power of soils either through mechanical or chemical means. He also explained that through impact tests results carried on, road slabs of many designs and upon varying subgrades had been broken down with the exception of a 10-in. slab under certain tests. He said it was the intention of the Bureau of Public Roads to build next year, test sections under conditions that will accelerate the tests made and that impact results already secured will govern the design, to a certain extent, of such test sections.

The morning session of the conference was given to a temporary organization, the discussion of the general situation and the appointment of committees. At the afternoon session committee reports were heard, the following committees having been named at the morning session, when Dean Marston was elected temporary chairman, and C. D. Curtis, of the Bureau of Public Roads, secretary: On organization and by-laws; membership and officers of general advisory board; and research committees.

A roster of these present is given herewith:

Representative	Organization
Prof. C. A. Adams	
Prof. T. R. Agg	State Highway Department at Iowa. American Association of State Highway Officials. Engineering Division Committee on Economic Theory of Highway Improvement.
A. Blanchara	A. S. T. M. Highway Engineering Department, University of Michigan.
C. J. Bennett	American Association of State Highway Officials. State Highway Commission of Connecticut.
David Beecroft	S. A. E., Chairman of their Meetings Committee.
H. W. Crane	S. A. E., Chairman of their Research Committee.
Robert A. Cummings	A. S. C. E.
C. D. Curtis	Bureau of Public Roads.
A. D. Flinn	Secretary, Engineering Council.
A. T. Boldbeck	Engineering Division Committee on Structural Design of Roads. Bureau of Public Roads.
M. C. Horine	S. A. E., member of their Committee on Science of Truck Operation.
P. Hubbard	A. S. T. M.
Prof. H. J. Hughes	Harvard University.
Pyke Johnson	National Automobile Chamber of Commerce.
A. N. Johnson	A. S. T. M. University of Maryland.
R. D. Chapin	President of Hudson Motor Car Co.
J. F. Langthorn	A. S. C. E. Director.
Anson Marston	Dean of Engineering, Iowa State College.
T. H. MacDonald	Bureau of Public Roads
E. B. Mathew	Association of State Geologists.
F. A. Molitor	American Institute of Consulting Engineers.
D. E. Moran	A. S. M. E.
H. DeB. Parsons	A. S. M. E.
I. W. Patterson	Rhode Island State Board of Public Roads.
N. B. Pope	S. A. E.
H. H. Porter	A. S. C. E., Member Engineering Division.
C. S. Reeve	A. S. T. M. representing their Committee D-4 on Engineering Division.
A. N. Talbot	Division Committee on Character and Use of Road Materials Western Society of Engineers. University of Illinois.
G. S. Webster	Department of Public Works, Philadelphia, A. S. C. E. Member of Division.
S. Whinery	American Institute of Consulting Engineers. American Automobile Association.
F. R. McMillin	American Concrete Institute.
M. O. Eldridge	A. A. A., Good Roads Committee.

Manufacturers Plan Big Exhibit at Road Builders' Convention

Representatives of fifteen industries identified with highway construction held a meeting at the Automobile Club of America, New York City, Oct. 22, to complete the organization of an advisory committee of manufacturers to co-operate with the American Road Builders' Association in holding a great exposition of highway equipment and materials at the association's annual convention which will be held at the Coliseum, Chicago, during the week of Feb. 7, 1921.

The industries represented at the forthcoming exposition will include the sand and gravel industry; crushed stone; portland cement; asphalt and and oil; tar; granite block; paving brick; slag; road building machinery; quarrying machinery; excavating machinery; trucks, tractors and trailers; concrete mixers; engineering instruments and explosives. It was developed at the meeting that upward of $1,000,000,000 is annually available for highway and street work and that a genuine necessity exists for capacity production and distribution of highway materials and equipment.

An executive committee to represent the producers and manufacturers was appointed consisting of J. E. Pennybacker, Secretary, Asphalt Association; B. H. Wait, District Engineer, Portland Cement Association, New York City; W. T. Chollar, Lakewood Engineering Co.; D. C. Fenner, International Motor Truck Co.; and P. P. Sharpless, Barrett Co. A Chicago committee was also appointed with S. F. Beatty of the Austin-Western Road Machinery Co. as chairman.

Construction Interests To Hold First Congress Next Year

As the result of a recent meeting of the organization committee for the formation of a congress of the building and construction industry, a decision was reached to convene the first national congress of building and construction in Chicago, Feb. 1, 1921. This congress will consist of 160 members made up of twenty representatives of the following eight interests which go to form the construction industry: Labor, finance, general contracting, subcontracting, engineering, architecture, manufacturers of equipment and material, and dealers in equipment and material. The recent meeting of the organization committee was its third one and was held in Pittsburgh, Oct. 29.

Forty members of the congress will act as an executive committee, each of the eight elements previously named having five members on it. The following ten men have been selected so far to serve in the first national congress: Robert D. Kohn, Sullivan W. Jones, W. G. Luce, Walter Stabler, and L. K. Comstock, New York City; Morris Knowles, Pittsburgh; John Donlin, Washington; Col. J. R. Wiggins, Philadelphia; Thomas R. Preece, Indianapolis; and Wharton Clay, Chicago.

The preliminary organization committee consists of the following men: Robert D. Kohn, New York City; M. B. Medary, Jr., Philadelphia; E. J. Russell, St. Louis; General R. C. Marshall, Jr., Washington; Colonel John R. Wiggins, Philadelphia; W. A. Rogers, Chicago; L. K. Comstock, New York City; Oscar A. Reum, Chicago; F. W. Howard, Boston; Wharton Clay and W. L. Hodgkin, Chicago; Morris Knowles, Pittsburgh; F. C. Shenehon, Minneapolis; Thomas R. Preece, Indianapolis; John Donlin, Washington, D. C.; J. Willison Smith, Philadelphia; and Walter Stabler, New York City.

The permanent headquarters of the executive committee has already been established at 19 W. 44th St., New York City.

Belle Isle Bridge Bids Rejected

Bids for the proposed Belle Isle bridge at Detroit were opened by the Department of Public Works on Oct. 29, but no contractor bid on the complete job. Ten contractors bid on one or more of three (out of four) groups work required in the erection of the bridge. No bid was received on group C, which includes excavation, piling, reinforced concrete, concreting after the placing of the steel, sewers, paving base, electrical work, and miscellaneous. If the lowest bids for the construction of the other three groups were accepted the cost of the bridge would run considerably over the $3,000,000 originally appropriated for its construction. Of these three groups, A includes removal of old bridge piers, excavation, footings, docks, cofferdams; B includes 3,300 tons of structural steel and 10 tons of bronze bearings; D includes metal hand railing and lamp frames.

After first recommending that the $1,951,850 bid of Geo. R. Cooke, a local contractor on A, be accepted, and all other bids rejected, the commissioner of Public Works later recommended that all bids be rejected. This recommendation was made after the Corporation Counsel expressed the opinion that it would be a breach of faith to the public to contract for any portion of the construction when the amount approved by the people is sure to be exceeded. It is claimed that the bridge will cost nearly double the amount authorized. The council therefore rejected all bids, although the bid for Group A was considered satisfactory. Later, however, it reconsidered this action and decided to hold a hearing.

The total of the low bids on the three out of four groups of construction advertised is $2,682,000. This would make the total cost of the bridge more than $5,000,000.

H. H. Esselstyn, of Esselstyn, Murphy & Hanford, engineers for design and construction of the bridge, maintained that the council itself accepted a bid tending to place the total cost above $3,000,000, when it awarded a contract for the construction of the subway approach at a cost of $200,000. The estimated cost of the approach made by the engineers in 1917 was $192,000 and it was on this estimate along with the others that the $3,000,000 bond issue was placed on the ballot.

Canadian Society Officers Named

The nominating committee of the Engineering Institute of Canada has selected the following candidates for office for the year 1921: President, J. M. R. Fairbairn, Montreal; vice-presidents, Walter J. Francis, Montreal; Arthur Surveyer, Montreal; A. A. Dion, Ottawa, and E. G. Matheson, Vancouver.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

FEDERATED AMERICAN ENGINEERING SOCIETIES, New York; Washington, D. C., Nov. 18-19.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Washington, D. C., Dec. 13-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City, Jan 19, 1921

ASSOCIATED GENERAL CONTRACTORS, Washington D. C., New Orleans, Jan 25-27

The Oklahoma Highway Engineers' Association, at a recent meeting, elected the following officers: Will M. Clarke, president; Pearl Little, vice-president; Floyd Frazier, second vice-president; Frank Herrman, secretary-treasurer.

The Texas Section, Am. Soc. C. E. held its fall meeting at Austin, Oct. 20 and 21. The following officers were elected: President, J. H. Brillhart, Dallas; 1st vice president, F. E. Giesecke, Austin; 2nd vice president, J. C. McVea, Houston; secretary-treasurer, E. N. Noyes, Dallas. A number of technical papers were presented. General R. C. Marshall, general manager, Associated General Contractors of America, discussed the relation between the engineer and contractor. A standing committee was appointed to work out details on a standard form of contract with arbitration clause and submit the same to the members by letter-ballot for approval. A committee on redistricting of the American Society of Civil Engineers reported in favor of the present District No. 11 and against any change. Committees were appointed to work on an Engineers License Law and present the same to the Legislature, and to bring in a resolution on the water power bill now before Congress. A copy of this resolution as approved by the meeting is enclosed.

The Boston Society of Civil Engineers, Sanitary Engineering Section,

was addressed by T. Chalkley Hatton, chief engineer Milwaukee Sewerage Commission, on Nov. 10. Mr. Hatton described the activated-sludge tests and the plans for the activated-sludge plant at Milwaukee. The plans have now reached the final stage. (See *Engineering News-Record*, May 20, 1920, p. 990, for article on this subject by Mr. Hatton.)

Personal Notes

J. A. HEAMAN, formerly resident engineer, Western Lines, Canadian National Railways and Grand Trunk Pacific Ry., Winnipeg, Canada, has been appointed assistant chief engineer.

JOSEPH GASTON LEGRAND, who has been with the Grand Trunk Pacific Ry. since 1906, has been appointed bridge engineer, Western Lines, Canadian National Railways and Grand Trunk Pacific Ry., Winnipeg, Canada.

D. L. REABURN, who was superintendent of Mount Rainier National Park from June, 1915, to April, 1919, and later with the Western Willite Road Construction Co., Los Angeles, has been appointed superintendent of the Grand Canyon National Park. He has served as locating engineer on the Alaskan Railway and the Argentine Government Railways and as division engineer on the construction of the Los Angeles Aqueduct.

CARL NYMAN, formerly resident engineer, State Road Commission, Utah, has resigned to enter private practice in general engineering in the coal fields of Carbon County, Utah, with headquarters at Castlegate.

V. H. CLEMENTS has taken a position as assistant engineer in the office of the Irrigation Engineer, Bureau of Public Roads and Rural Engineering, U. S. Department of Agriculture, San Antonio, Tex.

FRANK MUTH, Manitowoc, Wis., has resigned as highway commissioner of Manitowoc County to engage in highway and bridge contracting.

A. H. MARKWART has been appointed director of engineering with the Pacific Gas & Electric Co., San Francisco, and will have supervision over the organization's hydraulic, production, transmission and distribution engineers. He will also be in charge of designs on all company plants and equipment. He is a member of the firm of Galloway & Markwart, consulting engineers, San Francisco, and during the Panama-Pacific Exposition he was assistant director of works.

W. G. VINCENT, JR., formerly valuation engineer, Pacific Gas & Electric Co., has been appointed executive engineer in charge of rate schedules and collection of data on company property. He will undertake an intensive study of economic features affecting the development of the company for the guidance of the engineering, construction and operating departments.

HARRY C. WILLIAMS has resigned as chief construction engineer, Louisville & Nashville R.R. to become president and general manager of the Campbell Coal Companies, Knoxville, Tenn.

JOHN J. HAASLER, formerly office engineer, Nueces County Highway Department, Tex., has accepted a position as field engineer with the Power Department of San Antonio, Tex.

W. H. CORDDRY of the Harrisburg office of Gannett, Seelye & Fleming, Inc., engineers, has been placed in charge of the Memphis office of that company.

J. G. JOHNSON, formerly with the Milwaukee Gas Light Co. and engineer-inspector of the Milwaukee Sewerage Commission, has been engaged as city engineer and superintendent of waterworks, Milwaukee, Wis.

J. T. GILLESPIE has resigned as engineer in charge of equipment, Milwaukee Highway Commission, to accept a position as assistant to the president of the Marquette Cement Manufacturing Co., Chicago.

U. STEPHENS, formerly resident bridge engineer, Runnels County, Tex., has been appointed county engineer of the same county.

H. C. WEBSTER, for several years estimating engineer for Schmidt Brothers Construction Co., Chicago, has accepted a position as estimating engineer for H. Schmitt & Son, Milwaukee.

HENRY H. WILSON, Hughesville, Pa., for the past eight years connected with Winston & Co. of New York City and Richmond, Va., has been elected president of the Associated Pennsylvania Highway Contractors.

MAJOR LEON L. CLARKE, formerly electrical and mechanical engineer for the Chicago Subway Commission and Captain E. A. Clark, civil engineer, have organized the Subway Engineering Co. with office in Chicago. The company will engage in engineering and contracting in subway, tunnel, bridge and foundation construction.

WILLIAM M. ROSEWATER, formerly commercial engineer with the Bucyrus Co., South Milwaukee, Wis., and for 21 years connected with that organization, is now consulting mechanical engineer for the Pacific Metals Corporation, New York, engaged in designing and building a placer dredge for work on the properties of this company in Colombia, South America.

E. M. ARNOLD, formerly county engineer, Boone County, Ky., has accepted a position as assistant division engineer in the Second District, State Highway Department of Georgia.

H. L. KYLE, formerly roadmaster at Sacramento, has been appointed engineer of the Western Division, Western Pacific.

EMERY WELLS, formerly with the Turner Construction Co., New York, is now with Berkebile Brothers, engineers, Johnstown, Pa., as specialist on reinforced concrete construction.

J. S. GOODMAN, formerly division engineer of the Philadelphia & Reading Ry., at Tamaqua, Pa., has been appointed division engineer with headquarters at Reading, Pa.

N. W. H. SCHAFER, division engineer, Philadelphia & Reading Ry. at Harrisburg, Pa., has been transferred to Tamaqua, Pa., as division engineer to succeed J. S. Goodman.

Obituary

JOHN R. ALLEN, heating and ventilating specialist, died at Pittsburgh, Pa., Oct. 20. He was born in Milwaukee, 1869, and was graduated from the University of Michigan, engineering department, in 1892. He was connected with the college of engineering, University of Michigan, for about 21 years. In 1917 he resigned to become dean of the college of engineering and architecture, University of Minnesota. Later he was appointed director of the research laboratories, American Society of Heating and Ventilating Engineers, at Pittsburgh. At the time of his death he was acting as consulting engineer on ventilation to the chief engineer of the New York and New Jersey commissions in charge of the construction of the Hudson River vehicular tunnels.

ARTHUR M. WAITT, consulting engineer and railroad specialist, died Nov. 10 at Sharon, Conn. He was born in Boston in 1858 and was graduated from the Massachusetts Institute of Technology in 1879. Mr. Waitt had been engaged in railroad work for about 40 years: 1879-1884 he was connected with the Chicago, Burlington & Quincy R.R. as draftsman; 1881-1884, Eastern R.R. (Mass.) as draftsman, chief draftsman and foreman car department; 1888, assistant manager, Pullman Car Company's works at Pullman, Ill. In 1889 he entered the service of the Lake Shore & Michigan Southern Ry. as assistant general master car builder and later became general master car builder. In 1899 he was made superintendent of motive power and rolling stock, New York Central & Hudson River R.R. Co. From Sept. 1903, to March, 1904, he made a study of heavy electric traction in Europe and the United States. At the time of his death and since 1905 he was engaged in private practice as consulting engineer and railway specialist. Mr. Waitt had reviewed a number of books on locomotives for *Engineering News-Record.*

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

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Let Highway Contracts Early

WITH the experiences of this year in mind one would expect that highway engineers would plan to let their next season's contracts early. Inquiry, however, indicates that such is not the case. Only here and there is next season's program determined. The reasons given vary. In some cases the departments are waiting for lower prices and will not determine their programs until the decreases appear. In other cases, no reasons are given. If departments propose to do work next year, they should definitely arrange to invite bids in January and February. That requires that the program be at once determined and the letting details be taken in hand. What important decrease there may be in prices will probably materialize by Jan. 15. Early letting not only will insure an early spring start, but will allow materials to be put on the ground in advance and will give the materials producers and equipment manufacturers early warning of what the road program will demand of them. If work is to be done at all next year, wisdom demands early letting. Lower prices secured by delay are likely to be offset by losses due to inability to get the work done within the season's limits.

An Active Society

HOW engineering societies can grow and flourish is shown by a recent circular of the Western Society of Engineers. It listed for the period between Nov. 4 and Nov. 18, both inclusive, no less than nine meetings. Six of them were regular evening meetings, the variety of subjects being aimed to attract different groups in the membership. One was a luncheon gathering. another a Saturday afternoon "young men's forum," and one an informal "ladies' night." Such activity, of course, requires a large membership and a lot of hard work, but it shows what can be done when the combination is obtained.

Engineers and Labor

GENERAL interest was excited last week when it was reported that the American Federation of Labor had asked Mr. Hoover to discuss with its executive council the present economic and industrial conditions as affecting labor. The incident, however, is but one step in a two-year development in labor ranks, that development being a growing appreciation by the leaders of the federation of the need for adopting and pursuing a sound and broad industrial policy. The movement can be said to have begun when a small group of eastern mechanical engineers successfully argued with officers of the federation the responsibility and interest of labor in an increased production program. Following that came a production plank in the federation's "bill of rights," upon which radical forward step the *Engineering News-Record* commented at the time. More recently has come the best indication of labor's changing point of view—in the publication, under the joint auspices of officers of the federation and of a number of engineers, of the September number of the *Annals* of the American Academy of Political and Social Science. The volume was devoted to a discussion of labor and industrial problems. Production was the keynote and it was emphasized by federation leaders as well as by the engineers. Mr. Hoover's invitation to labor's conference is evidence, also, of the growing appreciation by labor of the place the engineer holds in the industrial structure. All of which is a hopeful sign indeed. If the federation's leaders are wise they will continue to work along these sound lines. If they can induce their members to give of their best the unions will win such public support that they can sweep all before them.

Ousting the Radicals

ANOTHER favorable movement in the federation is the determination to depose the radicals. The latter had bored from within during the war. Mr. Gompers was forced to assent to policies of which he did not approve. In labor circles, as elsewhere, opinion and action are now swinging away from war radicalism. The conservatives, or should we say the non-radicals, are again in control. Fitzpatrick and Foster, of steel-strike notoriety, have been ousted and saner heads installed. Importation of foreign radicals is opposed, indicating that Bolshevistic infection is no longer to be courted or tolerated. It is reason for congratulation.

An Industrial Symposium

REFERENCE has been made above to the September number of the *Annals*. Everyone interested in labor problems should read it. Morris L. Cooke, of Philadelphia, Mr. Gompers and Fred T. Miller, president of the American Society of Mechanical Engineers, are the editors. An attempt has been made to present forward-looking thought on labor, management and production. The contributions are by well-known labor leaders, industrial engineers, managers and economists. As is to be expected, there are some articles tinged with the old spread-eaglism regarding "labor's rights" and, on the other hand, some of the long-haired variety. These are overbalanced, however, by contributions that go with unusual clearness to the core of the industrial problem and mince words neither for the employee nor the employer. The prefaces by Mr. Cooke and Mr. Gompers, and the articles by Arthur J. Todd, William M. Leiserson, Leon Ardzrooni, W. A. Appleton and Horace B. Drury, are especially worth reading. All in all, the articles leave one with the impression that engineers can do much, working with labor, in the formulation of a sound industrial program, and that the recognition has become clear that wages alone are becoming less and less a permanent motive for high production. The beginning made in the liaison between labor and the engineer is promising.

The Public's Dollars

COMMENT has been made in these columns on the passage on Nov. 2 of large bond-issue measures. One other observation, though, needs to be made—that while many issues carried, there was evidence that indicated a change in attitude on the part of the public. Take, for example, the Missouri case. A $60,000,000 highway bond issue was before the people. In a total vote of little over half a million the favorable majority was only about 10,000. Contrasted with the overwhelming votes in northern states one year and two years ago this is an indication that the public's dollar is being more closely scrutinized than before. The attitude is in tune with the spirit of these recent months, when the public generally has been counting its pennies more closely than for some years. Without a doubt, too, this presages a more careful scrutiny of what the people get for their public expenditures.

Concrete in Cold Weather

THIS is the time of the year when warnings about frozen concrete should be most freely given. When it is definitely and continuously cold only the most ignorant and careless will attempt to make concrete and remove forms without due respect for freezing, but now the warm mid-day is apt to make the constructor forget the cool mornings and cold nights which retard setting just enough to reduce strength below the safe limit. An added warning may be worth while. The only certain way to insure against cold weather in concreting is to provide heat—heat in the aggregate and in the water and heat in the structure during the setting period. There are chemicals which lower the freezing temperature of concrete, but their advantage is indeterminate and at best small. Little dependence can be placed in them as a total defense. They may serve as a partial defense when temperature reductions are small, but if their use leads to neglect of more certain precautions they inspire an unwarranted confidence.

Huge Profit-Sharing Scheme

REPORTS regarding the basis of settlement of the British coal miners' strike, commented on in the *Engineering News-Record* of Nov. 4, were correct. The whole coal-mining industry of Great Britain is to go on a profit-sharing basis—and that with government approval and co-operation. A scheme for the regulation of wages "having regard, among other considerations, to the profits of the industry and to the principles upon which any surplus profits are to be dealt with" is to be prepared for submission to the government as soon as possible, but not later than March 31 next. Meanwhile wage increases of two shillings per shift are granted, but beginning Jan. 3 wages are to be decreased or increased in accordance with the total value of export coal produced, the increment being sixpence per shift for each excess of £288,000 over the value for the September quarter. For maintenance of the value of the September quarter an increase of one shilling is to be allowed. Export coal is taken as the basis because domestic coal is sold practically at cost. Adjustments of wages are to be made monthly. The mine owners, at the same time, go on a sliding scale as to profits. At present, under government control, the owners receive 10 per cent of the excess profits. They agree to a deduction therefrom, or are to receive an addition thereto, of one-quarter of said 10 per cent for every sixpence by which the men's advance is reduced or increased. In other words, the owners have the same interest as the men in increasing production. The step is an important one in labor history. With government sanction, labor in a great industry in a nation of 40,000,000 people has been placed on a profit-sharing basis.

Activated-Sludge in England

APPROVAL by the British Ministry of Health of plans submitted by an eminent consulting engineer for an activated-sludge plant for Reading, England, is taken by our London contemporary, *The Surveyor*, as equivalent to placing the "final official seal of approval" on "a comparatively new process of sewage treatment." There are a number of activated-sludge installations in England, but they are of small capacity in comparison with the presumable size of the projected plant for Reading, which is to treat all the sewage of that town of nearly a hundred thousand people. The adoption of the new process at Reading is all the more interesting because that town long had and perhaps still has, one of the notable sewage farms of England. When visited by one of the editors of this journal in 1904 the farm comprised 869 acres, of which 450 received sewage, but with only 380 acres underdrained. An average of 70 men and boys were employed on the farm, with 100 at harvest time. The wage for all-the-year employees averaged 16 shillings or $3.90 a week, besides house, garden and 80 shillings ($19.40) extra at Michelmas. The working hours were from 6 to 5:30 in summer and 7 to 5 in winter. The farm showed a profit occasionally, but was carrying a debit balance. ("British Sewage Works," by M. N. Baker.) If sewage farming has been continued at Reading all these years it is no wonder that a change is now to be made, in view of the high price of labor and presumably the difficulty of getting sufficient labor at any price. In any event, the adoption of the activated-sludge process for all the sewage of so large a British town, with sanction of the necessary loan by the Ministry of Health (successor to the Local Government Board) is something that may well be noted by American engineers.

Winter Storage for Road Construction

ADVICE to accumulate and store road-building materials ahead of construction deserves greater consideration this winter than it has previously received. In nearly every section of the country, this year, highway-construction programs have been curtailed by transportation shortage. While improvements in railway service may be expected, no contractor who faces the facts squarely can risk the chance that this improvement will be great enough to meet in 1921 the requirements of a mileage much greater than that recorded in 1920. Other means than increased car service must be developed to keep next season's highway contracts supplied with materials; one of these means is winter stock-piling.

Winter stock-piling is an attractive idea. It creates visions of intensive utilization of railway equipment at a season when it is free from other service; of increased profits from greater speed and continuity of construction, and of a frequent turnover of capital. These visions, moreover, can be made realities, not always, but under favorable conditions. To determine the proper conditions is as definitely an engineering problem as is

any other in highway construction. In a sentence, winter stock-piling is not a panacea; it is merely an efficacious remedy, under certain conditions, for well-diagnosed ills.

The possible gains from success have been summarized. But success depends upon realizing certain influencing factors and in estimating in advance their force. Can the sources of materials supply naturally tributary to the work be called upon for winter shipments? If the contractor must go farther abroad his costs are increased. Winter storage costs extra in handling charges, and (for cement) in warehousing and the risk of loss or damage. Admitting that these extra costs are returned with a profit because of greater speed and continuity of construction, a different plan of financing the contract is nevertheless required. If aggregates can be secured and stock-piled, can the cement be secured and warehoused or may current shipments of cement be depended upon to keep the work progressing? Instances can be cited where full stocks of aggregate placed on the job last winter have remained unused all summer because cement shipments failed. Will the state or county pay full or partial estimates on materials in stock? Is it physically possible under the plan of operations to accommodate extensive stocks? This list of queries can be extended, but it is sufficiently long to indicate clearly the thought which must be accentuated.

Winter stock-piling for highway construction involves the preparation in advance of a definite plan for storage and the co-ordination of this plan with the broad plan for financing, equipping and proceeding with construction. Stock storage in large volume is not an operation which can at will be successfully grafted onto a construction plan devised originally without the thought of stock storage in mind. This truth explains, partially at least, why, with work under way, contractors last winter responded with scant enthusiasm to the efforts of certain state highway departments to encourage winter stock-piling by offering to pay estimates on materials put in storage.

Will it pay contractors to store road materials ahead of construction? The question cannot be answered by a categorical yes or no. In general, under the conditions which today limit progress in highway construction, any means which will largely reduce the periods of delay will show a profit on any reasonable investment. Winter stock-piling is a possible means.

A Profitable Investment in Steel-Bridge Practice

PROPOSALS have recently been made by a committee of the American Railway Engineering Association that the carrying capacity of existing bridges be rated on the basis of unit-stresses ranging up to 26,000 lb. per square inch. Such stresses represent a very thorough utilization of the material. It is gratifying that such high efficiency should be within reach, but it may be said that in its faith in high stresses the committee is quite in line with modern tendencies of structural thought. Steel is the civil engineer's most costly material, and its price will not permit of any waste. However, high unit-stresses are safe only so long as all the stress effects arising in service are known with a satisfactory degree of precision.

There is none too great a margin between 26,000 pounds per square inch and stress figures at which a bridge would become crippled or would fail. What margin remains is needed to cover contingencies of material and service, and leaves no room for ignoring any tangible stress elements. Under these circumstances an essential part of the dead-load stress in a bridge claims renewed attention, particularly so because means are available, at very small cost, by which definite knowledge concerning this element of stress can be obtained. We refer to the secondary stresses created during the erection of the bridge, the stresses which are caused by the distortion of the structure from the shape in which its parts are joined together to its free or unsupported shape.

Ordinarily the bridge engineer finds his greatest difficulties in connection with the stresses developed by live load. But these stresses are all susceptible of measurement, work that is fairly simple and can be done at any time during the life of a bridge. If, then, careful theoretical analysis of a structure is supplemented by field measurements of stress under loads, the engineer can reach very satisfactory assurance that the effects produced by traffic are all accounted for. The case stands otherwise with dead-load stresses, and for this reason, though ordinarily regarded as least serious, these latter are the essential critical factors when the utilization of steel approaches the elastic limit.

Since dead-load stresses cannot be measured after the structure is in service, they can be known by presumption only. We have fairly good reason for depending on the correctness of calculation with regard to the primary dead-load stresses. On the other hand, complete uncertainty envelops us in the matter of the secondary dead-load stresses. They cannot be computed —partly because the starting point, the unstrained shape of the structure, is not known. It follows almost as an inescapable conclusion that they should be measured. Only by this means can high unit-stresses be employed with safety, and the steel utilized with maximum efficiency.

Gage points for the measurement of dead-load stresses must be applied to a structure before its erection. However, engineers charged with building and maintaining structures have not yet generally accepted the idea that it is a justifiable expenditure to provide such gage points and make the initial measurements on them. It was brought out recently in the discussion of the reinforcement work done on the Niagara railway arch that gage points can be established on bridge members for as little as a dollar or two per pair (or per single gage length.) Since the initial measurements would not add heavily to this cost, it is quite clear that the preparatory work for giving complete future knowledge of dead-load stresses in a bridge (and consequently of the total stresses) can be done at a cost so low as to be completely negligible.

To secure a given degree of strength or safety in a bridge will cost very much less when initial gage points are established on the members than when this preparatory step is omitted and the resulting uncertainty is covered by adding more metal. This statement, briefly summarizing the known facts of the case, gives the answer to the problem of attaining structural efficiency by high working stresses. It means also that gage points and initial measurements on bridge members will always prove a profitable investment, and that bridge practice may well make them part of its standard equipment.

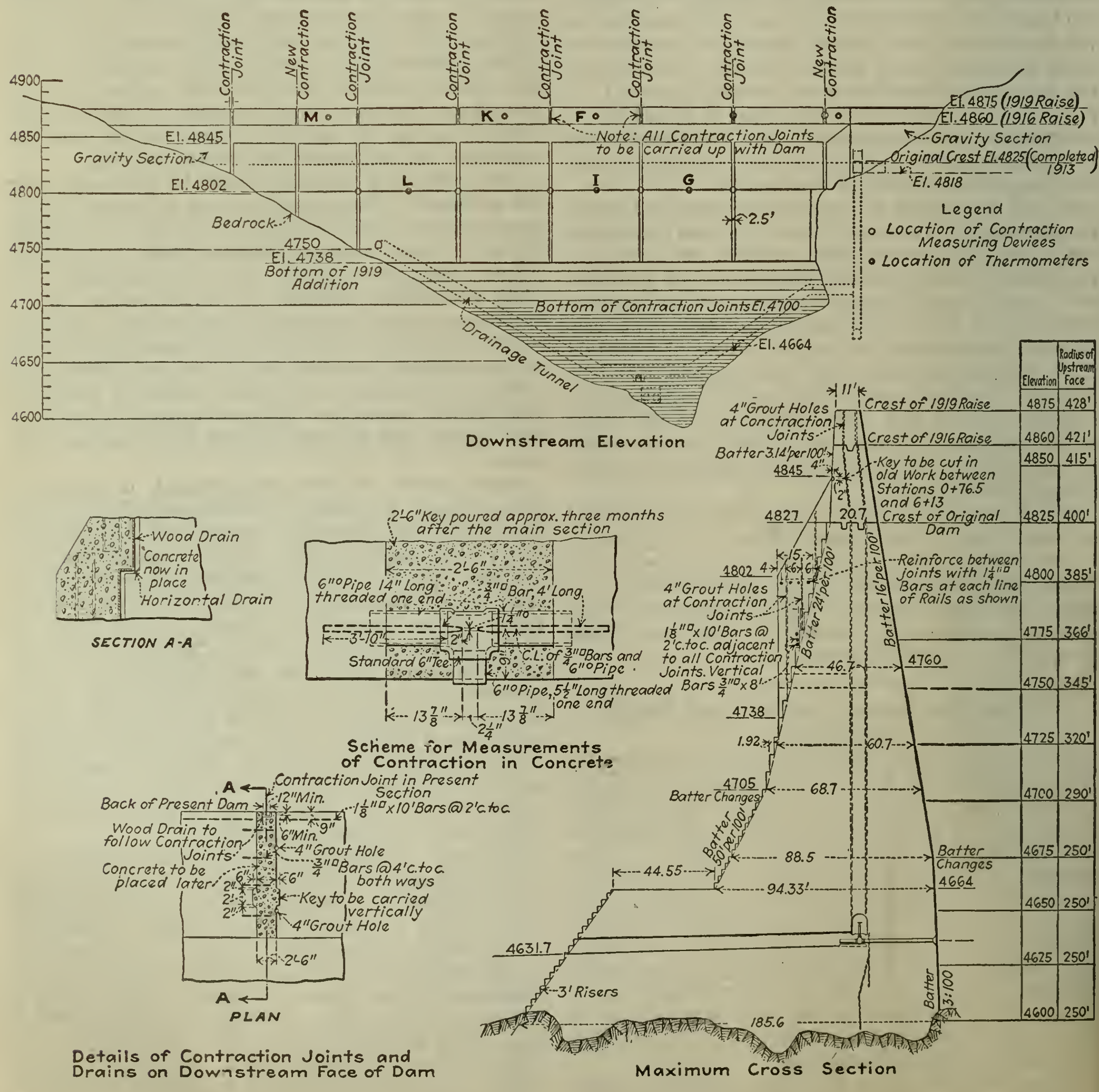
Making the Final 15-Ft. Raise of the Spaulding Dam

Dam Is Now 275 Ft. High—Careful Measurements Taken to Observe Shrinkage of Concrete in the Section Added Downstream for Increasing Strength

By I. C. Steele
Civil Engineer, Pacific Gas & Electric Co., San Francisco, Cal.

An ADDITION of 15 ft. in height has recently been made to the Lake Spaulding Dam of the Pacific Gas & Electric Co. Lake Spaulding is located in Nevada County, California, on the South Fork of the Yuba River. It is impounded by the main dam flanked by a chain of smaller dams known as dams 2, 3, 4 and 5. The stored water is passed through a series of four power houses with an aggregate head of 2,430 ft. and is then used for irrigation purposes. This raise brings the dam up to a total height of 275 ft. above the bed of the river and provides a storage of 74,000 acre-feet.

The original plans called for a dam 305 ft. high, as described in *Engineering Record*, Aug. 9, 1913, p. 150, and *Engineering News*, Dec. 11, 1913, p. 1163. The dam was constructed to a height of 225 ft. in December, 1913, the foundation being built to carry the ultimate section as planned. During 1916 the dam was raised 35 ft. by an addition to the top of the dam, bringing its height up to 260 ft. The addition recently completed will undoubtedly be the last because of the fact that storage can be developed more economically at other places on the watershed. Any further additions in the height



DETAILS OF LAKE SPAULDING DAM SHOWING METHODS OF ADDING TO HEIGHT

of the present Spaulding dam would probably necessitate the reinforcement of the entire arch beginning at the foundation as laid in 1913, thereby requiring a large expenditure for a comparatively small quantity of storage.

The last addition consisted in raising and "backing up" the main dam, together with the smaller dams. This work was carried on and completed during 1919.

The work on the main dam naturally attracts the greatest interest. The final plan called for an addition 15 ft. in height by continuing the upstream and downstream batters. These batters are 3 ft. and 16 ft. in 100 ft. respectively. The crest is now at El. 4,875 and is 11 ft. in width. In addition to this, the arch section of the dam was reinforced for a vertical height of 107 ft. above El. 4,738, by an added section on the downstream face. This concrete section has a maximum thickness of 15 ft. at El. 4,802 and tapers down to 3 ft. at the bottom and to an apparent feather edge at the top of the section. A horizontal notch 4 in. deep and 24 in. high was cut in the old concrete along the top of the reinforcing rib to protect the new concrete from local destruction due to freezing. This arch reinforcement has a tangent gravity section abutment at either end of the dam, it being impractical to carry the arch through to the natural rock, because of the topography of the site.

MAIN SPAULDING DAM IN 1917 BEFORE FINAL RAISE WAS STARTED

Several interesting problems arose in designing the addition of the main dam, the most important being the necessity to make the reinforcing section in back of the old section take a proper share of the stress.

The new concrete would naturally contract quite rapidly for two or three months and more slowly for a considerable time thereafter. Obviously any appreciable contraction cracks unless grouted would cause a reduction in the load carried by the arch reinforcement and an increased load on the old section.

In addition to this difficulty, another feature had to be taken care of. The water level in the reservoir was being constantly lowered from the beginning of the construction work, which was started early in June, 1919, when the lake was full. It was necessary to complete the job in about six months' time, as the first snows generally fall in November and excessive runoffs have occurred in January and February. It would be impossible to delay concreting until the lake was drawn down to allow the dam, which deflects about $\frac{3}{4}$ in. at the top under full load, to spring back sufficiently to assure even a comparatively uniform distribution of stress over the old and new section regardless of the shortening of the new reinforcing rib due to contraction. Consequently the purpose for which the reinforcing rib was designed would be defeated.

To solve these problems, open spaces or keyways 20 in. wide were left opposite each contraction joint of the old dam, these being about 80 ft. apart. These keyways were to be closed after practically all the shrinkage in the concrete due to setting had occurred and the temperature fallen to normal. The concrete in these keyways was held to one 80-ft. section by means of short $\frac{3}{4}$-in. square corrugated bar dowels at about 4-ft. centers in order to throw all further contraction into the joint between the key and the other 80-ft. section. Grout holes were provided in the latter, to be pressure grouted during the low-water period of the following year.

Devices were placed in the keyways at El. 4,800 whereby the actual contraction in the various sections could be measured to a thousandth of an inch with inside micrometer calipers. These devices consisted of a $\frac{3}{4}$-in. rod protruding from each concrete section with milled ends placed about $2\frac{1}{2}$ in. apart. These rods were surrounded by 6-in. screw pipes with a 6-in. Tee and a 6-in. nipple, which extended flush with the back of the dam. The ends of the pipe were unthreaded and set a couple of inches into the 80-ft. sections. Seven readings were taken at each observation and averaged. The curves shown herewith give the result of the readings taken. In some cases the first or zero reading was not taken immediately after the apparatus was set.

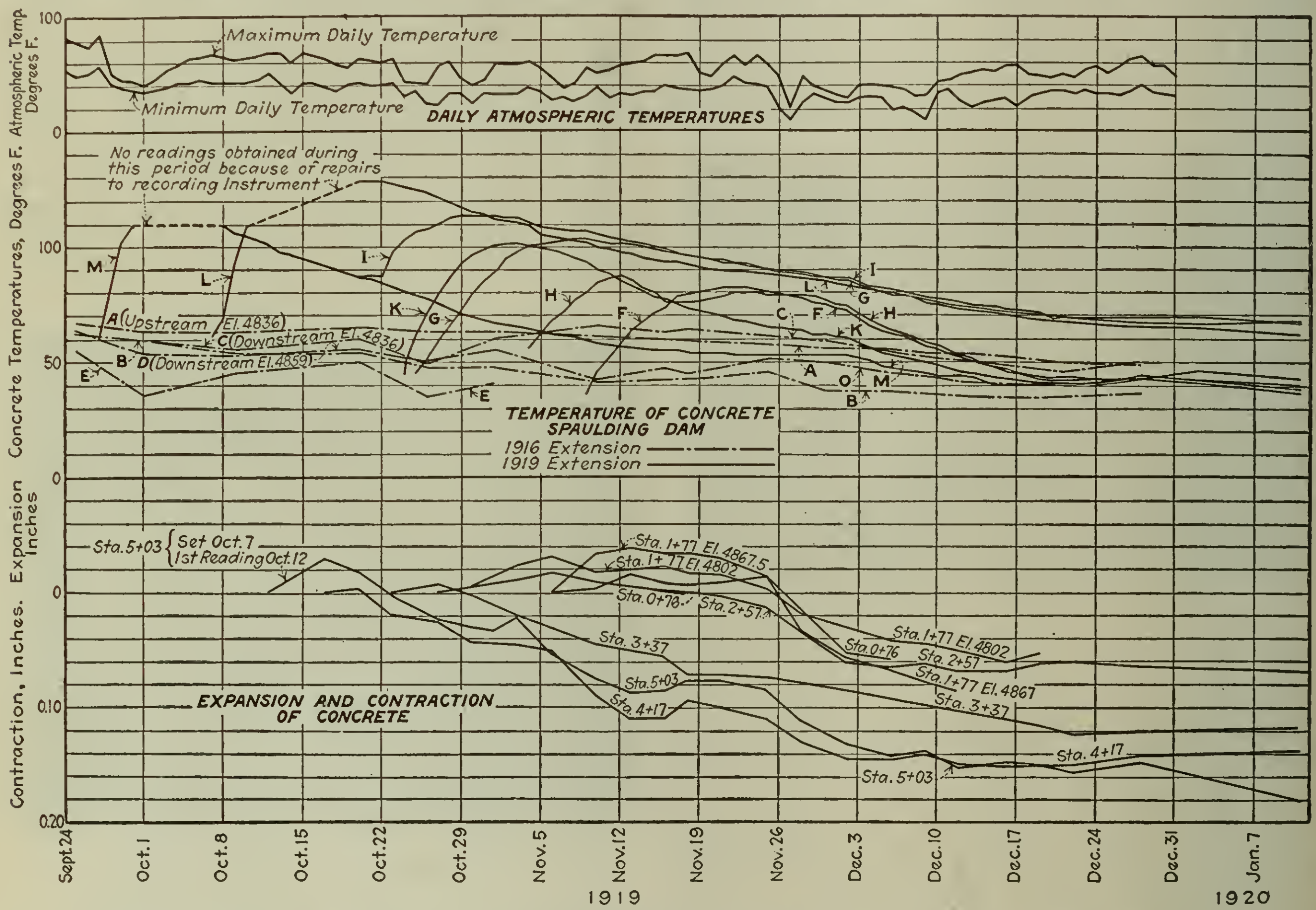
RAISED MAIN DAM SHOWING ADDED SECTION ON DOWNSTREAM FACE

These contraction readings indicate the contraction taking place at the outer edge of the section only and do not give any indication of what it might be close to the back of the old dam. Examination of the contact between the new and old concrete at the keys just previous to pouring the keys disclosed very slight cracks or lines of separation. These might indicate failure in bond between the new and old work due to contraction, though this is doubtful. The back face of the dam has been constructed in steps with steel rails protruding 4 or 5 ft. at 8-ft. centers vertically and 6-ft. centers horizontally. These were broken off where they were within 3 ft. of the edge of the keys in the new work and $1\frac{1}{4}$-in. square twisted bars 10 ft. long were placed hori-

zontally, parallel to and 1 ft. from the back face of the old concrete at 2-ft. centers vertically to prevent a tension failure in the vicinity of the keys due to the bond between the new and old concrete. Otherwise any possible failure in bond along the plane of contact between new and old work was not considered to be serious.

In addition to the provision for measuring the construction, it was desired to determine when the temperature of the concrete in the new work was approximately the same as that of the old concrete, for has been disregarded. The wheatstone bridge originally read from 15 ° to 100° (F.) but was changed to read up to 125° as soon as it was found that the temperatures were rising above the limit of the bridge.

The curves shown herewith give the results of all thermometer readings and contraction measurements. It must be borne in mind that the concrete in one section was in nearly all cases poured some time in advance of the adjoining section and that the measuring apparatus could not be completely installed until the last section had been brought up to the required level.



CURVES SHOWING EXPANSION AND CONTRACTION OF CONCRETE AND TEMPERATURE VARIATIONS IN LAKE SPAULDING DAM

when this condition was reached it would be quite probable that most of the shrinkage had been attained and the proper time for pouring the keys determined.

Thermocouples were placed in the new concrete, at the center of each 80-ft. section transversely and at El. 4,867.5 for the top section and El. 4,802 for the reinforcing rib. These were placed in pairs. Similar coils were already set at Sta. 2+97 in the 35-ft. raise of 1916 at various elevations and depths from the faces of the dam. Lead covered copper wires were carried from the coils to the crest of the dam where readings were taken with a wheatstone bridge, which had been calibrated to give the temperature of the coils. All temperature coils were tested to within 1° with the atmospheric temperature before being installed and all tabulated readings are the average of each pair set. In all cases except one there was very little variation between each two coils, the maximum being about 3 deg., most of them checking within one degree. One thermocoil placed in 1916 read 10° high continually and this

Hence, in most cases, the first section of concrete poured had time to fully expand by the time the initial reading was taken.

The accompanying table indicates the dates of setting and positions of the thermo-couples together with the initial reading.

Thermo-Couple	Elev.	Date of Setting	Initial Reading Date	Initial Reading Degrees (F)
M	4867.5	Sept. 27, 1919	Sept. 27, 1919	59½
I	4802	Oct. 15, 1919	Oct. 20, 1919	86½
L	4802	Oct. 7, 1919	Oct. 7, 1919	60½
H	4867.5	Nov. 4, 1919	Nov. 4, 1919	56
K	4867.5	Oct. 24, 1919	Oct. 24, 1919	44½
G	4802	Oct. 25, 1919	Oct. 25, 1919	45½
F	4867.5	Nov. 8, 1919	Nov. 8, 1919	36½

An appreciable increase in temperature was noticed in the 1916 concrete about two weeks after the new concrete was poured against this section. First thermometer "C," El. 4,836 and 3 ft. in from the back face, rose and then "B", located in the middle at El. 4,836, rose slightly.

In the early half of December, 1919, a big storm broke, continuing for several days, and it was feared

that an excessive runoff might occur before the keys were poured and set sufficiently; also, though of lesser importance, that the heavy snows and freezing weather would prevent the proper placing of the concrete. Some of the sections were about 60 days old and the contraction curves indicated that these had practically ceased to contract. The other sections were expected to contract further, but this could be grouted early in 1920, in case of a dangerous run-off, much more rapidly than the keys could be poured, and in case the joints should open up more by the fall of 1920 they could be grouted again by drilling holes every 6 to 10 ft. vertically in the back face of the dam and calking the joint between pipes. It was therefore decided to pour the keys as rapidly as possible and the work was carried through without hindrance, the last of the concrete being placed in the keys on Dec. 23, 1919.

Contraction joints had been provided at about 80 ft. centers in the original concrete. These are at right angles to the tangent of the arch and are offset occasionally to form keys. All but two of these had been grouted in 1916 and were practically watertight. The joints at Stas. 4+17 and 5+03 however could not be grouted, due to the lateness in the season, and these leaked considerably.

Grouting pipes were carried through the concrete keys to these two stations, and during the early part of January, 1920, the joint at Sta. 5+03 was calked and grouted from the upstream face of the dam. The joint had previously been calked up along the back face and the key poured against it. The joint at Sta. 4+17 was treated in the same manner and grouted about the middle of February. In both cases the grout was put in under about 70 lb. pressure and penetrated through the old and new concrete to the back of the reinforcing ring. To do this it had to find its way for 15 in. along the surface of contacts between the old and new concrete and out through the new contraction crack in which vertical holes had been provided for grouting in the winter of 1920. Consequently the entire joints were thoroughly grouted. 153½ sacks of cement and 4 sacks of sand were used at Sta. 5+03 and 200 sacks of cement at Sta. 4+17.

The grout used consisted of neat cement and water mixed in the proportion of about one part cement to two parts water. Some sand was used but proved to be less satisfactory than straight cement.

Drillings to Test Joint Tightness

All the other contraction joints in the main dam are apparently tight. An endeavor was made to drill into the old concrete with a diamond drill in such a manner as to cross the contraction joints at a slight angle. It was thought that the core would indicate whether or not these joints had been thoroughly filled with grout in 1916. This scheme did not work at all satisfactorily, as the drill shattered the concrete and only very short sections of core could be obtained even in the solid concrete. Considering the actual watertightness of the joints and the number of sacks of cement used in grouting them in 1916, it was evident that these joints were quite tight in full bearing. Therefore, no further effort was made to explore them.

Dam 2 is a spillway dam having a spill crest 5 ft. deep and 270 ft. long with 6-in. I-beam posts at 6-ft. centers to support wooden flashboards and a walkway. This dam is arched in plan with a radius of 300 ft. The raise was made by backing up the old section sufficiently to make the entire section a gravity section.

RAISED DAMS 3 4 AND 5 FORMING A CONTINUOUS DAM

Dams 3, 4 and 5 are now continuous and really make one dam, as shown in one of the views.

Dam 3 was previously very low and arched in plan with a radius of 200 ft. This dam spanned a rather deep pot hole. Consequently a buttress 4 ft. wide was placed on either side of the pot hole and sufficient reinforcing placed between to carry the stresses of the intervening section to the buttresses or rock abutments. The top 15 ft. was made a gravity section to conform to Dams 4 and 5, and also because the north end of Dam 3 joined the southerly end of Dam 4 and did not extend to a natural rock abutment.

Dams 4 and 5 were originally gravity sections but arched in plan with a radius of 800 ft. to conform to the topography of the site. These dams were originally poured under very severe weather and working conditions and Dam 5 in particular was very porous and leaked badly. It was decided to construct a buttress type backing instead of a solid section with drains carried out from in back of the buttresses to prevent any possible water pressure on them, and to treat the front face of the dam with gunite to prevent leakage. Consequently, the existing sections were backed up with buttresses 6 ft. thick at 30 ft. centers and a 15-ft. high gravity section placed on top. A reinforced slab 2 ft. thick was placed on the downstream face between the bottom of this latter section and a line 16 ft. lower where the batter of the rear face changed. As this section also formed a part of the upper gravity section the inclined face of the old concrete was stepped to give a proper bearing surface and the section reinforced to take care of the bending between buttresses under the full water pressure which could be exerted at that level.

An interesting question arose in taking care of the shearing stresses at the juncture of the buttresses and the old dam. The T section was figured to act as a gravity section and in order to do so there must be no danger of a shearing failure along this plane. The shear stresses ran from a maximum of 76 lb. per square inch at a point 60 ft. below the top of the finished structure to 8 lb. per square inch 29 ft. higher. Con-

BUTTRESS CONSTRUCTION—DOWNSTREAM FACE OF COMPLETED DAM 4

sequently it was deemed necessary to cut hitches or notches in the old concrete, 6 in. deep and 20 in. high sufficient in number to transmit the shearing stresses from the buttress to the old dam. These were 6 ft. long (the width of the buttresses) and from 4 ft. to 5 ft. centers with the closer spacing at the bottom.

The construction work was principally a problem of organization and transportation. Speed was the controlling factor in the work. Considerable equipment, sheds, buildings, railroad, locomotives, etc., remained on the ground from previous years and were readily put in shape to start work. The smaller dams were constructed first, the water level being kept high enough to float all materials from the delivery chutes at the south end of the main dam. Seven barges and two launches were used for this purpose. Three small mixers of from $\frac{1}{3}$ to $\frac{1}{2}$ yd. capacity were used. These were mounted on barges with donkey engines and elevator and the materials fed directly into the mixers from adjoining barges.

The work on the main dam was carried on with two 1-yd. mixers, located in the old mixer house constructed in 1912, and one $\frac{1}{3}$-yd. mixer on the top of the dam, the material for this being transported in ore cars along the top of the dam. The small mixer was used to pour the north end of the top 15-ft. section and a portion of the north and backing section. The concrete from the two larger mixers was carried down in chutes across the back face of the dam. Later, in order to reach the higher section, an elevated tower was built and the concrete hoisted and distributed through a second chute.

Twenty-two thousand four hundred and sixty cubic yards of concrete were placed in the main dam, and 7,886 cu.yd. in the smaller dams. All concrete placed in the last raise was a $1:2\frac{1}{2}:5$ mix, that in the previous work being $1:3:6$.

The work was handled under the direction of P. M. Downing as chief engineer of the company. F. G. Baum was consulting engineer. The construction work was done by Duncanson-Harrelson Co. of San Francisco. G. D. Ray was field engineer.

Advice to Freshman Engineers

No man can amount to much as an engineer who cannot write and speak his ideas fluently and clearly in strong, grammatical English. Engineering success is absolutely dependent on ability to convince men in authority that your plans are right.—Dean Anson Marston in the *Iowa Engineer*.

Art in Structures

By George Sydney Binckley
Consulting Engineer, New York City

A brief editorial comment entitled "What Is Art?" in "Engineering News-Record," *Sept. 16, 1920, p. 521, has called forth a variety of comment from readers, some of which has already been published in these columns. The following article was written without knowledge of the current discussion, but it is a clarifying addition to a somewhat confused subject.*—Editor.

An understanding of the relation of art to structures is important to the engineer even as it is vital to the architect. Far from this relation being one of uncertain quality capable of interpretation only by an artist, the elements of structural design, of the balancing of visible proportions, and of ornamentation are each perfectly separate and distinct, and constitute separate problems which must be treated as such.

By far the greater part of the wretched so-called architecture with which the modern world—and especially the United States—is encumbered, is the natural result of failure to recognize the simple fundamentals which fix and define the relations of art to structures. The purpose of this brief article is merely to show how simple these principles are and to indicate the method of their application.

Fundamentals of Structural Design

In a broad sense, all structures are engineering works. The underlying purpose of all structures is utilitarian—to furnish shelter for men or goods, to provide protection against enemies, or even to placate a god. This implies the very important corollary that each element in a structure must have a function. This is smiply engineering, but it is fundamental to proper structural design, whether it be a crude wall of rough stone, or a huge cantilever bridge.

It is most unfortunate that this simple fact is so little understood by the modern architect, for it is as fundamental to good architecture as to engineering. This principle is necessarily recognized by the engineer, for he deals with forces and the kind and amount of materials required to resist these forces. But architecture is a very old art, and its finest examples are based upon stone, not steel, as the material of construction. The great structural works of the early civilizations were almost exclusively of stone, and the architect of those days realized fully and applied perfectly the fundamental principles given above, with the result that there is perfection of proportion in classic architecture, improvement is impossible.

But the ancient architect dealt with a material which was employed under a factor of safety enormously greater than that generally permissible today. The actual unit stresses to which this material was generally subjected were very low, and the masses correspondingly large. So, although no structural element of ancient architecture is without functional significance, it is actually based upon an assumption of very low unit stress.

The modern engineer, dealing with stresses and materials unknown to the ancients, has run far ahead of any possible artistic development at all comparable to the technical progress made. Our greatest modern engineering structures are bare mathematical skeletons of

an idea. They are merely sketched in with scanty steel along their lines of stress. The beauty of a steel structure is the purely mathematical beauty of science. To a bridge engineer a great steel bridge is probably beautiful, but to the ordinary man of culture and taste it is merely large and very ugly.

Brooklyn Bridge Beautiful

Although we may not see yet how it will ever be possible to put beauty into structural steel, one of the most beautiful structures in the world is the old Brooklyn Bridge. Why is this so?

The answer lies in conscious or unconscious recognition by its designer of the first principle of architectural excellence. For the great catenary is a curve of beauty. From the head of each magnificent stone pier—stone because it resists compression stresses alone—spread fan-like the delicate threads that reach out along the lightly arched roadway. The slender cables are subject to tension only, yet theirs is the greater load, and they are visibly thicker than the subsidiary tension elements. Massive, solid, obviously proportioned to carry to their foundations a great vertical load, the majestic towers are a perfect foil to the airy lightness of the web of steel between and beyond them. This lightness is accentuated by the grace of the cambered roadway, springing as it does from pier to pier and sloping on each side to earth. And, last, the roadway itself even now with the later additions made, suggests in its proportions a perfect relation to its functions and the manner of its support.

Here we see a most perfect blending of engineering and art. It is the more instructive that in this classic structure, beauty of proportion is wholly unsupported by any attempt at ornamentation. And this was the crown of wisdom, for in such a case embellishment would be impertinence.

Simplicity of Design

But the beauty of the Brooklyn Bridge is made possible by the simple mathematical elements of its design. Plain to the eye is the function of tower and steel, and the primitive savage who has seen a vine hanging between two trees would know why this bridge stands. Not so the other great bridges. Vast, impressive, to be accepted, like the crashing and incomprehensible harmonies of Wagner as undeniably great, they cannot be accused of beauty, and to attempt to make them beautiful is on a plane with putting a bearded Cossack in the gauze skirt of a ballet-girl. For some generations to come at least, structural steel would seem hopeless as a basis for beauty.

But with the exceptions of steel, the case is far otherwise, and there is little or no excuse for ugliness. The engineer prescribes the bones and sinews of a structure, and he may or may not have the talent and the training to harmonize its visible proportions in a manner to satisfy the esthetic sense. But it is a worthy subject for his study.

Here we may consider in order the three elements of a structure in which artistic values as well as structural integrity are given weight. These elements are:

First—The general plan of the structure with reference to its purpose, the best use of the space available, the relation of masses, and the influence of the location selected.

Second—The adjustment of the proportions of the visible elements of the structure, in such a manner as to harmonize with and emphasize their functional importance. This involves the relations of openings to solid spaces, of columns and pilasters to lintels and pediments, and of masses, one to another.

Third—The element of decoration or ornamentation.

Of these elements, the first two are in good architecture absolutely essential. But the value of the third is not to be underestimated, for even with the best of general plans, perfect correlation of masses, and skillful adjustment of the relations of all the visible elements of the structure, the total absence of the decorative element will probably result in a cold and forbidding style. The structure might be massive, well balanced in its proportions, majestic and impressive in fact, yet without the lightening touch of a properly subordinated decorative element it would at best be grim and austere.

The Decorative Element

The function of the decorative element is quite as legitimate as that of adjusted proportion, although subordinate to this. Right here is where the average architect fails miserably. To him, a structure is often merely a support and excuse for ornament. The later renaissance period is an extreme development of bad taste in architectural adornment, and the baleful influence of that epoch is with us still.

Yet the decorative element has an important function. The prime requisite to its proper employment, however, is thorough and definite understanding of its relative position. *This position is subordinate.* It must never be allowed to be anything else. Ornamentation must never be employed in a structure merely for its own sake. A structural element should never be subordinated to or be dominated by an ornamental or decorative feature.

The decorative element can only have legitimate use where it is desired by this means to emphasize the proportions or functions of a structural element. In its simplest form, such as a simple capital, it still has a structural significance in emphasizing the distribution of load. The use of ornamental capitals for columns is very ancient, and is capable of relieving the severity of a plain column as nothing else can. Even the grim and tremendous architecture of Egypt did not disdain the plant-motive in their great monolithic columns, and the hieroglyphic inscriptions so freely used, although not originally intended as such, became decorative elements of recognized importance. In Egypt, the relations of masses, of form, and of surfaces were very thoroughly understood, but these vast structures were the works of engineers rather than of artists, and, majestic as they are, theirs is the grim beauty of perfectly proportioned strength and mass.

As far as the Egyptians went in architecture so far it should not alone be the right but the aim of the engineer of today to go. There is every reason why he should cultivate a knowledge and appreciation of the esthetic value of perfect proportions and in his plans give due weight to this factor. There is generally more than one way to design a structure correctly, and that way which is most harmonious to its purpose and location is most likely also to provide a basis for the most beautiful structure. Broad vision that contemplates a great project in all its true relations, will suggest an arrangement of its elements that is not alone the best,

but almost as a consequence the most stately and beautiful. Knowing the purpose and relative significance of each of the elements of his structure the engineer should be even better able than the architect to so adjust their visible relationships as to emphasize and define their functions. This is the legitimate aim of architecture, and may well be compassed by the engineer.

But of attempts at ornamentation, let him beware. It may be irreverent to say so, but of ornamentation also let the architect beware. For the use of the decorative element is the function of an artist who knows architecture—and few engineers, and quite as few architects are artists. The proportions of an opening, the emphasis of a line, the breaking of a surface, or the choice of materials are all legitimately within the field of the architect or the engineer whose taste and training fit him for such work. But to say where, and to what extent, and what kind of embellishment is permissible is purely the function of an artist. A beautifully proportioned structure of absolute simplicity, while perhaps cold and austere, is a thousand times better thus than bedizened with meaningless and absurd ornaments. Decorated with good taste, with true reference to the inherently subordinate rôle of the decorative element, it would gain in beauty and possess a lightness and life lacking in the cold purity of line and mass. Yet just here is where the greatest crimes are committed in the name of architecture.

It is also well for the engineer to remember that he should not strive for picturesque effect, for engineering is a science, while true picturesqueness is not even art—it is essentially casual. Hence when he designs a bridge or a dam, a wall or a powerhouse, he should seek to fit his structure as consistently as possible to its natural setting, always keeping in view its purpose. For the more completely and perfectly this purpose is realized, the more harmonious is the possible result. A great arched dam is a stately and beautiful structure, and it and its appurtenances should not seem to intrude but should grow out of their surroundings, as a part of them. The graceful arch of a bridge should seem to spring from the rock on which it is based, a growth in harmony with its environment, not an excresence.

These things can be done by the engineer who grasps the simple fundamentals of architectural excellence, and if he chooses to follow the pleasant paths of study to this end, he will have no need of the assistance of an architect. And this is desirable, for too often the architect is allowed to obscure noble structural features, and riot in a perverted taste that leads him to bedeck and bedizen a dignified engineering work with masses of meaningless and impertinent ornamentation.

Pressure of Concrete on Forms Measured

In recent measurements of the hydrostatic pressure of concrete by the Bureau of Standards it was found that maximum pressure was caused by the head of concrete existing at the end of about 40 min. from the time of beginning pouring. After that time the pressure decreased, although the head of concrete on the gage increased. The maximum pressure was found to be equivalent to that of a liquid weighing 124 lb. per cubic foot. The tests were made by W. A. Slater and A. T. Goldbeck. A bulletin on the subject will soon be issued by the Bureau.

Outline of Accounting Scheme for Water-Works Utilities

In a preliminary report the Committee on Uniform Accounting of the New England Water-Works Association submitted to the convention of the association held at Springfield last September an outline of the uniform water-works accounting system. The scheme was prepared after careful consideration of the uniform classifications of accounts for water-works formulated by the Public Service commissions of Maine, New Hampshire, Connecticut, Pennsylvania, New Jersey, Wisconsin, Indiana, California and Washington, and also after having reviewed various reports on this subject. The committee was also guided by the accounting system and classification used since 1913 by the municipal water-works plant of Springfield, Mass., recommended by William J. Hagenah, Chicago, a public utility engineer, statistician and accountant formerly connected with the Public Utility Commission of Wisconsin. The members of the committee already named are Albert L. Sawyer, Haverhill, Mass., Walter B. Schwabe, Thompsonville, Conn., Samuel H. McKenzie, Southington, Conn., Edwin L. Pride, Boston, and Alfred R. Hathaway, water register, Springfield, Mass. The latter compiled the report.

The report states that "it is assumed that the water utility should be a self-supporting enterprise of the municipality, and that "no provision has been made in the accounting scheme" for contribution of municipal funds toward its operation, but this provision can easily be taken care of by the utility's accountant if needed."

The committee's own outline of its accounting scheme is as follows:

A Condensed List and Statement Form for Income and Profit and Loss Accounts — (for monthly and annual use; all accounts on accrual—not cash—basis), including Operating Revenues, Operating Expenses, Non-Operating Revenues, Deductions from Gross Income, Net Income, and Disposition of Net Income.

A Classified List of Income and Profit and Loss Accounts (as shown on above Condensed List), including indicated and given explanation of these accounts, with suggested arrangement and subdivisions, all supporting the condensed list.

A Condensed List of Balance Sheet Accounts (in balance form) showing Assets and Liabilities in condensed balance grouping.

A Classified List of Balance Sheet Accounts, showing Supporting Detail Accounts, with indicated or given explanations of same. *Also under Plant Accounts* is shown a possible and logical analysis of same into various physical and other units, for appraisal purposes when wanted. This analysis conforms to the different steps or processes in sequence of operation of the water utility, and corresponds to the grouping of accounts, which lends itself to the obtaining of proper data for rate and consumption questions, as well as the financial data always needed.

A Condensed Summary Form for Showing Cash Receipts and Expenditures in Annual Reports, under various funds. —This is followed by a supplementary and more detailed form for use in showing funded divisions of such *cash expenditures* where it may be wanted. Where any water utility may find it to be inexpedient to at once adopt and put into practice the suggested scheme of accounting it may, by the use of these forms, obtain at least some uniformity for the comparison of *cash transactions* by its utility operations with the same transactions by another utility, which uniformity is also now sadly lacking. Then, whenever such utility may be in better condition to adopt the accounting system here outlined and suggested (or some other system which may be recommended by the Association), even to the

extent at first of using the grouping accounts, and adding the supporting sub-accounts later, the changes will adapt themselves easily and gradually, and the cash statements can be kept as supplementary statements.

The scheme as given in outline just above is elaborated in some detail in the report of the committee. The report will come up for discussion at one of the 1920-21 meeting of the New England Water Works Association.

Pile Driving Results with Steam and Drop Hammers Compared

OPPORTUNITY for comparison of the results obtained in driving piles with drop and with steam hammers has been afforded on the construction, now in progress, of the Claremont piers of the Lehigh Valley R.R. at Greenville, N. J., and on jetty work for the new Albert locks on the Thames River in England. Data on these projects have been collected by the McKiernan-Terry Drill Co., the source of the following notes:

The Claremont pier terminal in New York Harbor, when completed, will embrace approximately 7 mi. of new work. There is a large amount of dredging involved and the character of the soil makes pile driving difficult. The average run of material is silt, sand, coarse gravel and hardpan, in the order given. Pile driving is being done with three floating rigs, two of which are outfitted with 6,500-lb. drop hammers and a third with a McKiernan-Terry steam hammer of the following description: Net weight, 13,535 lb.; strokes per minute, 120; energy exerted per blow, 17,500 ft.-lb.; over-all height, 10 ft.

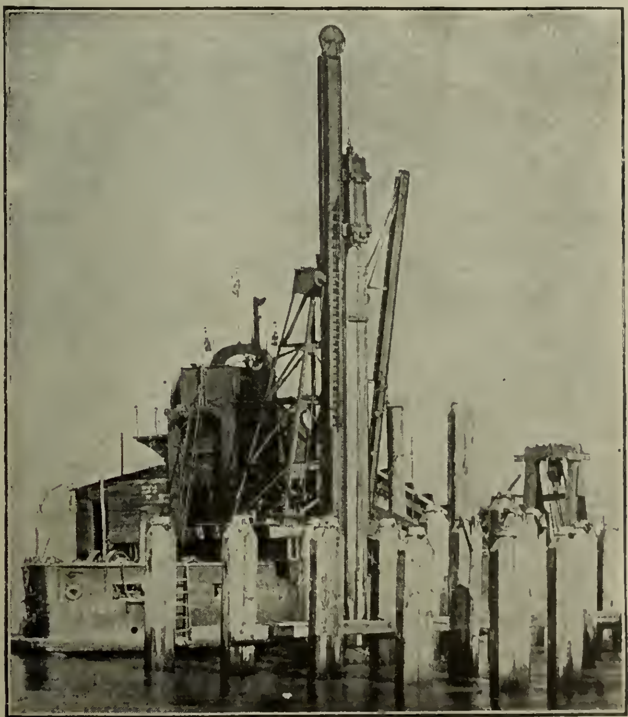


FIG. 1. TIMBER PILES USED ON THAMES RIVER PROJECT

It has been found that piles driven with the drop hammers, first jetted practically to their full length, have, at times, a bring-up of from 6 to 10 ft. above grade after driving. Many of them are badly broomed and others are split from 5 to 8 ft. below the butt.

When the heavy steam hammers were first used the piles were all driven to grade without jetting, but, owing to the difficult character of the soil, it was found that the alignment was not as good as in the case of jetted piles. Thereafter, a hole about 15 ft. deep was jetted, the pile set in it and driven in accurate alignment to grade with the heavy hammer.

FIG. 2. SHEET PILES DRIVEN 15 FT. BELOW WATER WITH FOLLOWER

Comparing the work of the heavy steam hammer and the ordinary drop hammer on this job, record of weekly performance gives the drop hammer an average of 35.7 piles per 8-hr. day, and the steam hammer, working under the same conditions, 48 piles per day. During the driving with a 13,000-lb. steam hammer, without jetting, eleven piles were put down consecutively to a total penetration of 426 ft. in 42 min. 8 sec., or an average of 10 ft. per minute. The piles used on this job are from 60 to 70 ft. in length and 16 to 18 in. butt measure.

Another comparison between the drop hammer and the steam hammer is given by the work now being done for the entrance jetty to the new Albert locks, Thames River, England. Timber piles, averaging in length from 64 ft. to 70 ft., each pile being made up of two timbers 15½ in. square, securely bolted together and having a cast-iron shoe weighing 175 lb. embracing the two piles at their ends, are being used on this job. An iron ring surrounds a reduced section at the top of the pile for driving.

When the work was started a 5-ton drop hammer was used. According to the British engineer in charge, piles were driven through material consisting of river mud, clayey sand, gravel—locally known as "Thames ballast"—to the chalk level. Probably the hardest driving for the piles was through 25 ft. of this "Thames ballast." Coupled with the hard driving encountered was the fact that only three or four hours were available in which to drive, owing to tidal conditions. The drop hammers took an average of 3½ days to each pile, while the steam hammer drove two piles per day.

On nine of the twelve piers being built at Stapleton, Staten Island, New York City, steam hammers are being

FIG. 3. STEAM HAMMER IN THREE-POINT SUSPENSION DRIVES BATTER PILES

used. Here the particular type has a net weight of 6,800 lb., 140 strokes per minute, exerts an energy per blow of 7,800 ft.-lb., has an over-all height of 92 in., and a cylinder stroke of 16 in. Two of these hammers have been rigged to drive batter piles, as shown in Fig. 3, the hammer being rigged on a three-point suspension by means of a bridle which is attached to the hub of the derrick line. By the method of rigging shown the hammer hangs at a fixed angle and by means of a turnbuckle the angle can be changed as desired. The pipe sleeve makes a guide for the hammer and holds it in place while driving. The three-point suspension relieves the leverage on the bottom of the pile so that it is readily driven to the predetermined angle merely by lowering the hammer. The piles are all approximately 50 ft. in length and are driven to an average penetration of 25 ft. The city inspector in charge of the pile driving work states that the steam hammer with the attachment herein described drives two piles to one driven with a drop hammer.

Less Forest Fire Loss During 1920

No loss of timber or equipment has occurred in the territory comprising several million acres protected by 66 wardens maintained by the Western Forestry and Conservation Association, and in general the forest-fire loss in the Northwest has been less this year than last. Washington has had 754 fires in 1920 against 847 in 1919 and lost less than 42,000,000 ft. of timber, compared to 60,000,000 ft. last year. Of the 754 fires, 120 were due to campers, 74 to lightning, 60 to cigarettes. There has been an unusual proportion of lightning fires in Oregon this year but less loss than last year. The same is true of Montana and of other western states.

New York Contractors Disapprove Proposed Contract Provisions

At a recent meeting of the executive committee of the New York General Contractors Association the proposed contract provisions submitted by the committee on contracts of the Associated General Contractors, and noted in *Engineering News-Record* June 3, p. 1119, were presented for discussion and those proposed provisions referring to freight rate, wage scale and material price changes were disapproved. Failure to approve these particular provisions lay in the fact that they could only be made applicable to public works by legislation; and on private work would tend toward the adoption of a cost-plus contract, to which the majority of the members of the committee are opposed as a general proposition.

Regarding the cost-plus contract, the committee seems to agree that while such a contract is advantageous under certain conditions, when handled by a contractor of approved reliability and experience, the general adoption of such a form of contract would lead to gross extravagance and carelessness in the conduct of the work, says a recent issue of the *Bulletin* of the Associated General Contractors. It is contended that a general adoption of the cost-plus form of contract would react against those firms who have built up their businesses on such a basis.

The proposed provisions disapproved by the executive committee of the New York contractors follow:

1. *Freight rate changes.*—Bids should be submitted on the basis of existing freight rates, with the provision that in case a change in rate should occur between the time bids are received and the date fixed for the completion of the contract the contract price should be increased or decreased accordingly.

2. *Wage scale changes.*—Bids should be stated and be submitted on existing wage rates, with the provision that the contract price be increased or decreased in accordance with any change in such rate before the date fixed for the completion of the contract.

3. *Material price changes.*—Bids should be submitted on the basis of existing prices for materials f.o.b. the producer's plant or distributor's yard, with the provision that the contract price shall be increased or decreased in accordance with any change in such price that takes place within the time allowed the contractor to purchase and fabricate his material.

The proposed revisions relating to changes in quantities was not approved. The committee felt that, particularly on large contracts, where the contractor would be reimbursed were the unit quantities smaller by a stated amount than the estimate, and the unit prices would be decreased were the unit amounts found to be larger beyond a certain limit than estimates, the incentive would be lacking to build efficient organizations or to devise methods of handling work more economically than one's competitor. This particular provision would mean, the committee believed, contracts would be placed on a basis of absolute assured profit.

In the matter of changed quantities the executive committee proposed that items for plant expense and overhead expense be incorporated in bids. These are the two items that are most affected by any reduction in the quantities, particularly when those quantities happen to be the ones on which the contractor distributed most of his plant and overhead expense. The contractor would bid a lump sum for these two items and payment would be made monthly as the work progressed. In this

way any decrease in quantity would not deprive him of any portion of his overhead. Such a plan would not need any legislative enactment but would be entirely in the discretion of the engineer drawing the contract. The committee agreed that there was obvious disadvantages of such a proposal, such as the attempt to overload the item and render the bids subject to criticism as being unbalanced.

Another point on which the New York executive committee failed to become enthusiastic was that one concerning arbitration. The constitutional inability of avoiding court action through the insertion of an arbitration clause providing that the arbitration award be final and binding the committee believed would have as a net result a condition wherein the winner in the arbitration award would pay for two actions—the arbitration and the lawsuit.

Object and Powers of International Hydrographic Bureau

AT A meeting of the Board of Surveys and Maps held in Washington Oct. 12 the Committee on Hydrographic Charts, in submitting its report, pointed to the importance of the International Hydrographic Bureau, now being established. This bureau is to be maintained jointly by all nations having an "interest and concern in hydrographic charts and other navigational data." Its object and powers are stated in the report to be, essentially:

The establishment of a close and permanent association between the hydrographic services of the associated states, to co-ordinate their efforts with a view to rendering navigation easier and safer in all of the seas of the world, to cause the national offices to adopt the resolutions taken by the various international hydrographic conferences, to try to obtain uniformity as far as is possible in hydrographic documents, and finally, to advance the theory and practice of the science of hydrography.

The International Hydrographic Bureau shall keep itself in direct and close communication with the national services of the associated States.

The principal subjects which should be studied by the International Hydrographic Bureau are the following:

(a) The production of documents published by hydrographic offices.

(b) The drawing up and publication of various lists, such as of geographical positions, primary and secondary meridians, time signals, etc.

(c) The construction and use of hydrographic instruments and methods of hydrographic surveying, the principles of which have been approved by a national office.

(d) Researches on the subject of the constitution of the earth, in so far as it affects hydrography.

In reference to co-ordination of work the report states that it is the object of the International Hydrographic Bureau to obtain as much uniformity as possible in the documents published by the various national offices and to propagate the methods of making hydrographic surveys, and to encourage all proposals tending to this end, and also itself to propose efficient solutions and endeavor to have these solutions adopted.

In order that the Board of Surveys and Maps may have it on its official files there is appended to this report part of the report of the organizing committee which sets out the "objects and powers" of the International Hydrographic Bureau. Prominence has been given to this feature of the report for the reason that the navigation charts of each country are of concern and importance to the navigators of every maritime nation.

Trend of Highway Development —a Survey

Practice in Nebraska and Iowa

THIS IS THE THIRD *of a series of staff articles on the highway situation. It discusses the general substitution of tractors for teams in earth road grading in Nebraska and the satisfactory results obtained from the truck patrol system.*

The chief points of interest in Iowa's practice are the successful use of pit-run gravel for concrete paving, a survey of which disclosed gravel supplies and the inauguration of the patrol system.

The fourth article in the series will appear in next week's issue.—EDITOR.

Nebraska's Practice

NEBRASKA expects to grade 2,000 mi. of earth road in 1920. This is perhaps a greater mileage than any other major earth road building state will complete. To the road builder, however, the year's highway operations are less interesting because of the mileages involved than for (1) the intensive use of machines for both grading and maintenance; (2) the successful employment of dragline excavators for making long, low fills particularly in wet locations, and (3) the general substitution of tractors for horses to operate equipment. It would not be greatly in error to name Nebraska the tractor road building state.

Practically all the highway activity of 1920 is the outcome of enabling laws scarcely three years old. In 1918 major acts were passed: (1) to create a state highway system, (2) to increase automobile license fees to provide a maintenance fund, and (3) to levy a three-mill tax to meet Federal aid funds for road construction. Patrol maintenance was inaugurated in 1920 and 1920 witnesses the beginning of construction on a large scale. This year, therefore, records Nebraska among the large road building states and also gives it exceptional rank in the technics of road construction.

Grading methods and equipment as an engineering study are reviewed by State Engineer G. E. Johnson in an article prepared for a future issue of *Engineering News-Record*. The conclusions of this article will not be anticipated here, but readers are urged to observe two of the features which it will emphasize (1) tractor operation of elevating and wheel graders and 5 cu.yd. fresno scrapers, and (2) dragline construction of long fills. Field observation of both operations tempts one into unstinted praise of their effectiveness.

A study of the records of patrol maintenance of earth roads has developed interesting comparisons of team, tractor and truck patrol maintenance costs. Briefly, experience indicates that the costs of team and tractor patrol for equal sections are about equal and that truck patrol is perhaps most economical. Patrol maintenance began April 1, 1920, and the records for April, May and June, three months, are the basis for comparison.

Team patrol requires one man who furnishes his own team and equipment and who is paid an average of \$175 a month. The equipment employed consists of one 6-ft. wheel grader, one farm wagon, one planer, one scraper or fresno, one plow and small tools. The average team patrol section is six miles. Ten team patrols for a three months' period cost \$6,493.26, or the

cost of one patrol for one day was $8.32 and per mile per day was $1.38.

Tractor patrol requires two men. It is employed only in counties which had the equipment on hand or which preferred it to other methods. The equipment consists of two maintainers, two small tractors, one plow, one Wisconsin planer, one buck scraper and small tools. Plus depreciation on equipment, the cost of five tractor patrols working 14-mi. sections for three months was $7,532.15, or the cost of one patrol per day was $19.31 and per mile per day was $1.38.

Truck patrol requires two men who are paid $120 a month. Gas and oil are supplied by the county boards. The trucks are part of the surplus war material donated to the State and their price to the counties has been the freight and overhauling charges, which have averaged about $1,000, but which haved varied according to the type of body. New trucks would have cost from $3,500 to $5,000, which would increase the maintenance costs cited here. For truck patrol the equipment consists of one truck, one scraper, one maintainer, two planers, one plow and small tools. Plus depreciation on equipment the cost of eleven truck patrols working 17-mi. sections for three months was $13,692.64 or $15.96 for one patrol per day and $0.94 for one patrol per mile per day.

On an equal mileage basis of 14 mi., 2⅓ team patrols equal one tractor patrol and the daily cost ($8.32) of one team patrol multiplied by 2⅓ equals $19.41, while the daily cost of the tractor patrol is $19.31. Truck patrol is altogether more economical than either team or tractor patrol. It is assumed in this comparison that equal amounts of work are accomplished. Also no differences of soil or weather are taken into account. In all cases, however, the costs per mile per day do not mean that one mile was patrolled but once, but as many times as was necessary, and the counties selected for comparison represent average conditions and kinds of work. Incidentally, experience has shown (1) that cost of maintenance decreases if the road is kept constantly in good condition, and (2) that with truck patrol a jointed wheel maintainer will perform 90 per cent of the work.

Concrete Construction

Concrete road construction has been purposely kept to a small mileage because of high costs and shortage of materials. A development of significance, however, has been the use of Platte River gravel as aggregate for a section of about ten miles on the Lincoln Highway. Previously this gravel has been held of doubtful quality for concrete, but tests made by the U. S. Bureau of Roads were sufficiently favorable to encourage its trial on the project mentioned. If the trial proves a success it will establish the only available gravel deposits, which are in the stream beds, as suitable supplies for concrete road materials, and will have a great influence on the state's hard surface road program.

The river deposits are suitable for gravel surfacing, but except for narrow zones along the streams, railway transportation is necessary. On some of the gravel road work performed this year a variation from the usual surfacing practice has been inaugurated: (1) a 2-in. layer is first spread on the earth grade and allowed to rut in and become thoroughly compacted with the subgrade soil and then (2) a second 2-in. layer is applied and consolidated by travel while it is kept smooth by persistent dragging. Since the gravel used has an oxide of iron and clay content, the surfacing is more of the nature of constructing a cemented earth and gravel surface shell to an earth road than it is of the nature of ordinary gravel surfacing.

This gravel surface construction; the probability that local river gravels may be used for concrete; the excellent economic results of truck patrol maintenance; the wide adoption of tractors to operate grading equipment, and the demonstration of dragline excavators as successful earth grading tools, are the outstanding impressions of 1920 highway practice in Nebraska.

Iowa's Practice

Iowa in 1920 inaugurated hard surfac[illegible]tion on its primary road system. Despite i[illegible]earth road grading and gravel surfacing pr[illegible]n-tinuation of several year's practice, i[illegible]rd surfacing which commands notice prin[illegible] because about one-third of the counties i[illegible]ave voted to hard-surface their mileages [illegible]ary system (in Iowa the counties initiate [illegible]tion) and (2) because scientific investigatio[illegible] possible, in a state presumably deficient i[illegible]ggregates, the construction of concret[illegible] local gravels. No development in highwa[illegible] 1920 surpasses in importance the experi[illegible]ractice in using pit-run gravel for concrete [illegible]

Without developing the argumen[illegible], practice in Iowa in respect to material[illegible]e roads may be said to be based on the follo[illegible]ts: (1) Equal quality concrete and not fix[illegible] cement, sand and gravel is fundamental; [illegible] as practicable roads should be construc[illegible] materials which are locally available; (3) [illegible]alysis of aggregates affords a means of c[illegible] concrete-making qualities of different ma[illegible] an aggregate need not conform to a sing[illegible] instead aggregates of many different g[illegible] make concrete of equal strength; (5) n[illegible]ng variability of deposit there is no in[illegible]tacle to the use of pit run gravel. As to[illegible] is only necessary that the inspection be[illegible]ough so that the proportions can be chang[illegible]he variations in the material and that the[illegible]nform to accepted standards in other res[illegible]

Aggregate[illegible]

Upon the reasoning indica[illegible]ravel is being used this year, so far as o[illegible]oes, with success. In the way of determ[illegible]s, besides the usual inspection and observa[illegible]e being undertaken (1) to determine the [illegible]ing of aggregates in the mixed concrete, [illegible]mine resistance to wear and (3) to determi[illegible] strength. At intervals, as the paving pr[illegible]ples are taken from the mixer discharge, [illegible]ediate washing, drying and screening and t[illegible]ch the abrasion cylinders and crushing te[illegible] molded to be tested in the laboratory t[illegible] The results of these tests will be given in[illegible]ticle in a future issue of *Engineering Ne*[illegible] So far as the grading analyses indicate, [illegible]ter proportions could have been secured [illegible] and remixing the gravel. Should it hap[illegible]pected, that the

wearing and crushing tests prove satisfactory, the concrete specifications for future road work are quite likely to be made very broad in respect to the use of pit-run gravel.

Material Surveys

Materials surveys conducted persistently have disclosed a greater supply of gravels usable for concrete than, generally speaking, it had been assumed were available. This year the surveys have been conducted primarily in those counties where it was known that hard surfacing projects were to be undertaken, but ultimately they will have covered the state. A chief of party using the records of the state geological survey of 1913 and local information spots the possible deposits in reconnoisance. His assistants then carry out the investigation. The areas located are divided into 200-ft. squares; pits are dug at the corners and the material is tested by sieving for mineralogical character, silt content, etc. Where investgiation is to be carried to greater depths than pits can readily be dug with shovels, or in wet ground, very successful use has been made of a small orange-peel bucket, working inside a 10-in. casing which is carried down with the hole. A small folding derrick is used with this outfit, but the bucket is operated by hand. A light truck moves the gang and its outfit from place to place.

From the materials surveys made the indications are that local supplies of gravel ample for the highway construction of several years to come will be disclosed. Generally the counties have purchased these deposits which it was decided to develop, although a few have been leased. Purchase prices have run from $160 to $2,000 an acre but the average price is from $300 to $500 an acre. Lease prices average between 20c. and 30c. a cubic yard. Some tendency of landowners to profiteer has been experienced, but the state's power to condemn gravel deposits for highway work has discouraged excessive asking prices. Probably 75 county-owned gravel pits are now being operated and this number will be increased greatly as the hard surfacing program develops.

A survey of the concrete paving in progress presents examples of about all the usual methods, but generally they are (1) central proportioning and dry batch hauling (a) by industrial railway and (b) by motor trucks, or (2) central mixing plant and wet batch haulage by motor trucks. This season, as it was desired to encourage contractors to take up paving work, stock piling on the grade, while it was not encouraged, was not prohibited. Only two or three contractors chose this method and it is quite probable that in future work the specifications may prohibit it. Haulage practice presents little that is unusual; one contractor is using two Lee dump bodies instead of one on large trucks and one has hauled wet batches 5½ mi. for concrete base for brick pavement. Generally speaking, the central mixing plant and wet batch haulage method is gaining favor both with contractors and with highway officials.

Progress

Altogether about 150 mi. of paving has been placed under contract for completion in 1920. Of this mileage perhaps one-third will be completed. The major reason for the slow progress has been shortage of transportation. It has not been possible to secure deliveries either of materials or of equipment. On some contracts it has been impossible to start construction. With the purpose of giving contractors all the time practicable to prepare for operation contracts for 1921 construction are now being awarded and will continue to be put up for bids. As a rule, bidders have not been lacking for all the contracts offered. Lack of transportation has not affected grading and this year, as have many years past, will see completed a substantial mileage of earth grade. Only one variation from former practice calls for attention. In one county the state, as an experiment to determine costs, undertook, in 1919 and 1920, force account work with leased equipment. The results indicated no material saving from contract prices.

Prices for highway work, using mileages and quantities as of about September, have averaged for: 357 mi., or 2,998,700 cu.yd. of earth excavation, 57c. a cubic yard; 57.06 mi., or 339,657 cu.yd. of earth excavation incidental to paving, $1.22 a cubic yard; 115.81 mi., or 1,241,015 sq.yd. of concrete paving, $3,938 a square yard; 17.24 mi. brick on concrete paving, or 180,950 sq.yd., $5,665 a square yard; 144 mi., or 206,447 cu.yd. of gravel surfacing, 89.1c. for one-mile haul and 24.75c. for each additional one-half mile haul.

Beginning July 1, Iowa placed its entire primary road system of 6,400 mi. under patrol maintenance. This action, with the experiments previously described in using pit-run gravel for concrete paving, are the outstanding developments in 1920 in highway practice.

Sanitary District Proposed To Regulate Mahoning River

An elaborate storage project for increasing the low-water flow of the Mahoning River above Warren and Youngstown, Ohio, is proposed in a report just rendered to the authorities of Warren by Alexander Potter, consulting engineer. The plan is intended to utilize all the water resources of the valley. At present the low-water flow is far below that required to meet the needs of the numerous industrial plants in the valley without excessive pollution and increase of temperature tending to make the water unfit for the city supply of Youngstown. The latter city built a storage dam at Milton some years ago, by which the low-water flow is considerably increased, but the present project contemplates a large increase of storage.

Three reservoirs are now proposed, one above the Milton dam at Berlin, of five billion gallons capacity, and two others of seven billion and fifty billion gallons on Eagle Creek and Mosquito Creek, below Milton. The two latter would be connected by a canal with the drainage area tributary to the Milton dam. Together the reservoirs would store the flow of the entire Mahoning watershed of about 700 sq.mi., and would make it possible to obtain a summer minimum flow six times as great as the present minimum.

The city council of Warren approved the plan and instructed the officials to petition the Common Pleas Court for the formation of a sanitary district under the Davis law passed by the State Legislature last year. The district would comprise Trumbull and Mahoning Counties. After the formation of the district commissioners representing the counties would decide on and carry out the construction plans. The project as now proposed is estimated to cost $13,000,000 to $14,000,000.

Impressions Here and There

Butte—and a Welded-Steel Water Line

BUTTE looks like a country God forgot. From the time that the big electric locomotives back the Milwaukee's yellow cars down the Y into the station until their twins slide you gently through the pass toward Anaconda there is no sign of natural beauty except the snowcaps of the continental divide that rise bowl-like some three or four thousand feet above the city. They, at least, have been undisturbed, but everywhere else on what the Butte people like to call "the richest hill in the world" are the evidences of what lies underground. For if God did forget the surface here He provided magnificently below. No place or man can have everything.

Not so many years ago Butte was only one of the many passes—perhaps the lowest—through the Rockies. Then a stray prospector found gold and it became a mining camp. Today it is nothing more. But the gold has long since been taken out and soon the silver, which was found not long after, became unprofitable, but the later and richer discovery of copper and zinc made it what it is today. For a time it was even more desolate than now because of the smelters that ruined vegetation and dropped a perpetual haze over the town, but all but one of them have now moved to Anaconda, some twenty-five miles away, and the air is reasonably clear and a plot of grass or a flower are no longer expensive curiosities. The tailings from the old smelters spread everywhere, however, and the ore dumps and trestles and head frames hang out over the city—a constant reminder of the reason for its existence. Butte is utility personified. Probably it will never be anything else.

Just now the city is in a mild slump. It is probably the only place of its size where there are "To Let" signs. Its most boastful citizens do not claim over 75,000 population for a city which once housed 50,000 more. Copper production is on about half-time and copper is Butte's life. Some day copper is coming back and then if the "Wobblies"—what we in the East know as the I. W. W.'s —can be kept down Butte will come back. Meanwhile, production being low, labor is quiet and the labor element was decisively beaten at the polls this year.

There are no civil engineers to speak of at Butte. Outside of the water company and the Montana Power Company there is no civil engineering to be done. What civil engineers there are are masquerading as mining or metallurgical men and from the looks of the main footbridge leading to the big smelter at Anaconda—a nice wood truss with no sign of post or diagonal, a perfect tribute to the efficiency of the arch—there are few of the metallurgical men with structural training.

A trip through one of the deep mines, though, leaves a civil engineer with a great admiration for his mining brethren. The problems of tunneling and shaft sinking the construction man meets are trivial compared to those encountered in dropping a hole 2,500 ft. into solid granite and feeding up through that hole the precious content of narrow veins that slope and twist through all the intervening space over an area of many acres.

One good engineering job is under way. This is the construction of a 30-mile pipe line from the Big Hole River over the divide into Butte. One such line delivering 8,000,000 gal. a day has been built for a number of years, but the tremendous demand of the mining companies requires a duplicate, making 16,000,000 gal. per day, which would be a very high per capita for the population except for the mining use. The old line is of wood-stave and iron pipe and is standing up very well after over 20 years' use. The new line, which is being built under the direction of Eugene Carroll, who has been with this company for nearly 30 years and is now vice-president, as well as chief engineer, will be of wood-stave where the head is under 300 ft. and of welded-steel pipe in the other sections, where the head runs up to 860 ft.

This welded pipe is a new idea of Mr. Carroll's, for it will have no expansion points except at the occasional valve where a sleeve with lead joints is used. About 10 miles of this line is in the steel pipe, half of it 24-in. and half 26-in. Of the 20 miles of wood-stave about 13 miles is 24-in. and 7 miles 26-in.

The steel pipe comes in 19-ft. lengths and is welded alongside of the 4-ft. deep trench—which goes up and down hill with transit-like directness—into a length of seven sections. Gas-flame welding is used and the pipe turned over on blocking so that the welder is always working on top. When the 133-ft. length is complete the whole section is rolled over on a runway to beams straddling the trench and this near end welded to a similar length already in place. Meanwhile back up the line rope slings have been thrown under the pipe at intervals and the whole snake-like structure is eased down into its bed in the trench at such a progressive rate as always to keep the line on an easy slope from the completed pipe in the trench bottom to the newly placed section on the straddling timbers. Thus the strain on the joints due to bending is kept at a minimum.

Work on the 60-mile line is practically completed and the dirt fill placed over all but a short stretch inside the city. It is Mr. Carroll's idea that the temperature in the pipe will be kept nearly uniform—certainly with no more than 50-deg. variation—by the equable temperature of the water and the 4-ft. topping of earth, and that the expansion stresses will be negligible. It is original engineering in a country where the civil engineer is in the decided minority.

One comes away from Butte with an intense admiration for the men who are doing things there. It is such a bare, hopeless sort of country. But the enthusiasm for the job is much smaller in many a more prepossessing place. The engineering spirit, which delights in surmounting natural odds, is strong there and it prevails.

Butte, Nov. 8.

Decrease in Detroit Labor Employed

According to a labor barometer maintained by the Detroit Employers' Association, a net decrease of 4,440 men was noted for the week ending Oct. 26. The aggregate working force of the seventy-nine firms reported upon was, at that time, 151,141 men. Thirty-five shops were working short hours, employing 32,915 men averaging 39.44 hours per week per man.

Single Track Cut-Off for Double Tracking Main Line

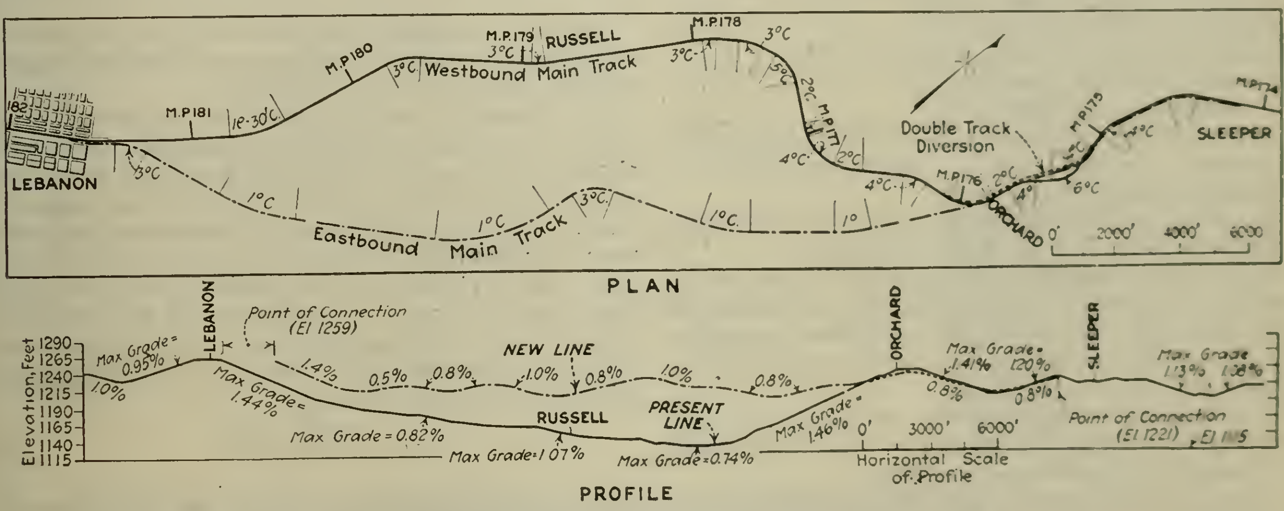
Old and New Lines Equally Favorable for Traffic in Opposite Directions—Heavy Rock Work in Hilly Country

IN DOUBLE-TRACKING its main line between Sleeper and Lebanon, Mo., the St. Louis-San Francisco Ry., is building a single track cut-off about eight miles in length for eastbound traffic, as the present single-track line is favorable to the lighter westbound traffic. The maximum distance between the old and new lines is about 5,000 ft., as shown in the accompanying plan and profile. This single track diversion may be compared with the double-track diversion of the Cleveland, Cincinnati, Chicago & St. Louis Ry. at Zionville, Ind., where a five-mile double-track cut-off has been built to eliminate an unfavorable section of the old single track line, as described in *Engineering News-Record* of Sept. 23, 1920, p. 606.

Lighter curves and less total curvature, with a slight saving in distance and also a saving in rise and fall are accomplished by the new location. A comparison of grade of 1.41 per cent to 0.8 per cent in both directions.

Higher elevation for the new line is obtained by a location through the higher rough country, the old line following down the valley of a creek for a distance of four miles north of Lebanon and then climbing up on the ridge at Sleeper by a grade of 1.46 per cent. The general topography of the country is hilly, with about 50 per cent under cultivation and the remainder wooded. A limestone formation underlies a cover of 4 to 10 ft. of loose rock and earth.

Grading for the new line will average 30,000 cu.yd. per mile, in alternating cuts and fills, the heavier cuts being about 35 ft. deep and the largest fills 25 ft. high. Two steam shovels at opposite ends of the line are at work in the heavier cuts, and the lighter cuts are being handled by teams and scrapers. Steam-shovel fills are made by dumping from pole trestles built of local timber, about 9,000 lin.ft. of this trestle work being required. Material is handled in 4-yd. dump cars on narrow gage track, trains of 12 to 15 cars being handled by 13½-ton locomotives. All openings are of permanent construction, including eight concrete arch culverts of 8 to 20 ft. span and 19 culverts of reinforced concrete pipe from 18 to 36 in. in diameter.



CUT-OFF FIVE THOUSAND FEET LONG BEING CONSTRUCTED IN CONNECTION WITH DOUBLE-TRACKING ON ST. LOUIS-SAN FRANCISCO RAILWAY

the two lines is shown in the accompanying table. Grades are compensated at the rate of 0.04 per cent per degree of curve. All curves have transition spirals laid out on the Talbot system.

COMPARISON OF OLD AND NEW LINES

	Old Line	New Line	Saving
Distance, miles	7.53	7.08	0.45
Maximum curve	6 deg.	4 deg.	2 deg.
Total curvature	496° 59′	316° 40′	180° 19′
Maximum opposing grade	1.46%	0.8%	....
Rise and fall, feet	134	62	72

This improvement is part of a general program of double-tracking the main line from St. Louis to Monett, Mo., 283 miles. It has been put under construction in advance of other work partly on account of the grade limitation noted above, but mainly for the reason that present operation requires the passing of many trains at or between the stations of Sleeper and Lebanon. For this reason, a 7-mile stretch of double-tracking has also been undertaken between Eureka and Pacific, Mo. In the first part of the new work from Sleeper there is a short double-track diversion which will replace a 6-deg. curve with a 4-deg. curve and will reduce the present

The work will cost about $460,000 and is to be completed in the spring of 1921. The contract has been let to Scott & White, St. Louis, Mo. The construction is in charge of R. Owen, resident engineer, under the direction of F. G. Jonah, chief engineer, St. Louis-San Francisco Ry.

Temperature Effects on White Metals

In experiments on various white metals for bearings, made at the Bureau of Standards recently, it was found that tin-base alloys maintain their strength properties better at elevated temperatures than do those containing lead. However, the yield point or ultimate strength of a high grade babbit at either 25° or 75° C. is not affected by lead admixtures up to 3 per cent. Prolonged heating lowers the strength of lead-base alloys much more seriously than it does that of tin-base alloys. The yield point of a tin-base alloy was not affected by heating for six weeks at about 100° C., but the yield point of a lead-base alloy was lowered by only two weeks' heating at the same temperature.

The Hydraulic Jump and Critical Depth in the Design of Hydraulic Structures

How Established Principles May Be Applied to the Design of Canals and Other Works—A Study Based on the Laws of Conservation of Energy and of Linear Momentum

By Julian Hinds
Engineer, U. S. Reclamation Service, Denver, Col.

The hydraulic jump and the critical depth have recently come to be recognized as factors of considerable importance in the design of open channels and related hydraulic structures. An excellent technical discussion of this subject will be found in the *Transactions* of the American Society of Civil Engineers, Vol. LXXX, p. 338, in a paper on "The Hydraulic Jump in Open Channel Flow," by Karl R. Kennison, with discussions by a number of prominent engineers. Also, Messrs. Ward, Riegel and Beebe in "Technical Reports, Part III," issued by the Miami Conservancy District, in 1917, present an interesting discussion of the problem, and submit valuable experimental data on the action of the jump below reservoir outlet works. E. W. Lane, in *Proceedings* of the American Society of Civil Engineers, December, 1919, discusses the occurrence of the hydraulic jump in connection with experimental work on flow through contractions.

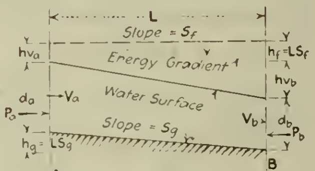


FIG. 1. STEADY FLOW WITH CHANGING VELOCITY, UNIFORM CHANNEL

It is not the intention of this paper to add to the fundamental theories already advanced, but an attempt will be made to show how the established principles may be applied to the design of canals and canal structures.

It is assumed throughout this discussion that the kinetic head is truly represented by the velocity head as computed from the mean velocity.

Practically all formulas previously proposed for the solution of hydraulic jump problems are limited to rectangular sections. While such a limitation simplifies the computations it in no way simplifies the fundamental conceptions, and an attempt will be made to keep the discussion general.

The notation used herein is as follows:

A = Area of water prism = $f(d)$.
b = Width of rectangular channel.
d = Depth of water in any channel.
d_1, d_2, d_a, etc. = Depth of water at Stations 1, 2, A, etc.
d_c = Critical depth.
F = Force producing change in momentum.
$f(d)$ = A = Area of water prism.
$f'(d)$ = T = First derivative of A with respect to d.
g = Acceleration of gravity.
H = Energy of flow = $d + hv$.
h_f = Fall in energy gradient = friction (or other) loss.
h_g = Fall in bottom of channel.
hv = Velocity head.
hv_1, hv_a, hv_b, etc. = Velocity heads at Stations 1, A, B, etc.
hv_c = Velocity head for critical velocity.
L = Distance between consecutive stations.
M = Mass.
P = Hydrostatic pressure on vertical plane across the water prism, the unit force being the weight of a cubic unit of water.
P_1, P_2, P_a, etc. = Values of P at Stations 1, 2, A, etc.
Q = Discharge in cubic units per second.
S_f = Slope of energy gradient.
S_g = Slope of canal bottom.
T = Width of channel at water surface.
t = Time interval.
V = Velocity.
V_1, V_2, V_a, V_b, etc. = Velocities at Stations 1, 2, A, B, etc.
V_c = Critical velocity.
W = Weight of a cubic unit of water.
X = Ratio of T to d for a triangular channel.

As a fundamental basis for discussion it will be necessary to accept the law of the conservation of energy and the law of the conservation of linear momentum. The former law will appear as Bernoulli's theorem, i.e., the elevation of the water surface at any point in a channel plus the velocity head at that point is equal to the same functions at any other point, plus (or minus) intervening losses. Using the notation already given and as shown in Fig. 1 and taking the bottom of the canal at B as datum, this relation may be expressed thus:

$$h_g + d_a + hv_a = d_b + hv_b + h_f \qquad (1)$$

There is no exception to this rule and it is independent of the form or slope of channel, or of channel changes occurring between the two points.

The second law requires that the momentum of a system of particles, considered collectively, cannot be altered by the particles impinging upon each other, but can only be changed by the influence of an external force. The change produced in momentum depends upon the magnitude of the external force and its duration. Stated simply, the law requires that force must equal rate of change of momentum or that force is equal to mass times acceleration. If the acceleration between two stations as A and B, Fig. 1, be uniform, the relation may be written

$$F = \frac{MV_b - MV_a}{t} \qquad (2)$$

where F equals force, MV_a and MV_b are the momentum at A and B respectively and t is the time through which F is applied. If F' is the force acting on a unit volume of water, of weight W, then from equation (2)

$$F' = \frac{W}{gt}(V_b - V_a) \qquad (3)$$

The total force acting on Q units per second for time t will be

$$F = F'Qt = \frac{QW}{g}(V_b - V_a) \qquad (4)$$

Fig. 2 shows graphically the relation existing between the energy of flow (depth plus velocity head), the momentum and the depth for a given discharge in a given channel. This diagram is not affected by the slope or roughness of the channel, and is independent of the method of producing or maintaining flow. The diagram is constructed to scale for 150 sec.-ft. flowing in the irregular channel shown in Fig. 3. The lower of the two curves is obtained by platting values of $d + hv$ over corresponding values of d, and may be called the energy curve, since it represents the energy of flow corresponding to various depths, the bottom of the canal being taken as datum. Values of V and hv may be found for any depth by computing or planimeter-

ing the area. It will be observed that there is one point, C, on the curve for which the value of $d + hv$ is a minimum. The depth, d_c, corresponding to this point is called the critical depth. If flow is taking place at any depth, d_o, other than d_c, there will be a corresponding depth, d_g, having the same value of $d + hv$. The depths d_o and d_g will be called alternative energy depths or alternative energy stages.

Let Fig. 4 represent the profile of a portion of a channel of uniform cross-section having functions as represented in Fig. 2. Then from the energy curve, Fig. 2, it appears that the depth at S may be either d_o or d_g and that it may be made to change from one of these depths to the other at will, provided some means for making the change without depressing the energy line through the point C be supplied.

Such a change in depth with no loss of energy, however, involves a change in momentum and can only be

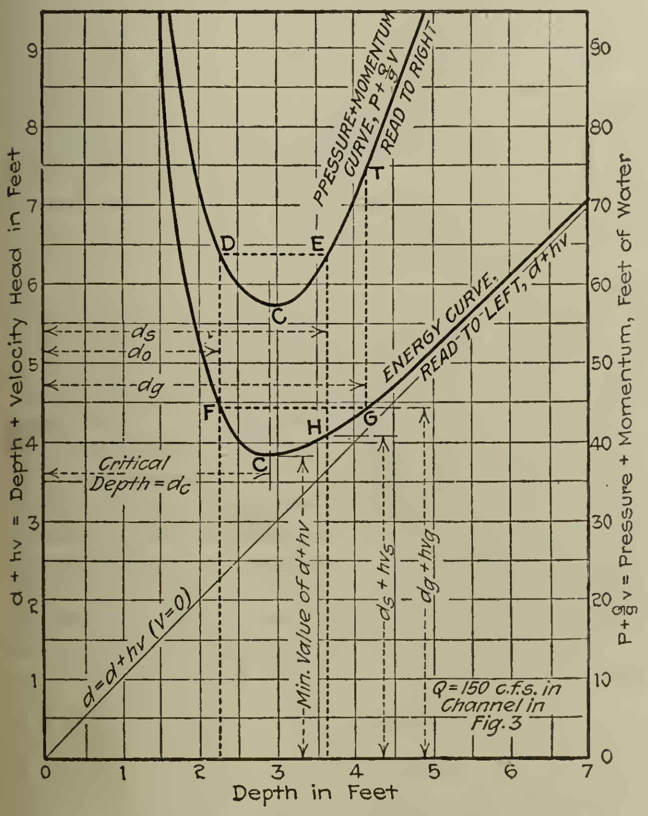


FIG. 2. RELATION BETWEEN ENERGY OF FLOW, MOMENTUM AND DISCHARGE

effected by the intervention of some external force. The required force may be supplied by gravity, friction, unbalanced pressures or by a combination of these factors.

In Fig. 1, let P_a be the hydrostatic pressure on the plane of the cross-section at A, P_b being the corresponding pressure at B, and let F'' equal friction, or any other external force applied between A and B. From (4), taking $W = 1$

$$\frac{Q}{g}(V_b - V_a) = P_a - P_b + F'' \qquad (5)$$

If the change in depth occur without the intervention of the force F'', then equation (5) placing $F'' = o$ and transposing gives the relation

$$\frac{Q}{g}V_a + P_a = \frac{Q}{g}V_b + P_b \qquad (6)$$

which must hold if a change in depth occurs under the influence of the external forces P_a and P_b only.

The momentum curve in Fig. 2 gives values $\frac{Q}{g}V + P$ for various values of d. The abscissæ are the same as used for the energy curve and values $\frac{Q}{g}V + P$ are shown on the right. For a given depth there is always one other depth having an equal value of $\frac{Q}{g}V + P$, this point falling in all cases beyond the critical depth. Therefore, for any depth of flow there is always another depth which we will call the alternative momentum stage, to which the flow may change without the intervention of an external force. Such a change, however, requires a change in the energy of flow.

Since for a given change in depth the change in $d + hv$ is not proportional to the change in $\frac{Q}{g}V + P$ it follows that a change in depth cannot occur without the introduction of some factor to preserve a balance. A change between alternative energy stages without loss may be effected by the application of an external force only, and a change between alternative momentum stages may be accomplished by a change in energy only. All other changes in depth, involving a change in velocity, require both an external force and a change in energy.

There are numerous causes which may produce a change in stage in a canal, but if the channel is straight, of uniform cross-section and roughness, and free from obstructions, changes in stage are generally caused by changes in grade. An analysis of a simple case will be made to show where changes may be expected. Let Fig. 5 be the profile of a canal of uniform cross-section. Let the slopes to the left of K and to the right of N be sufficient to maintain flow at normal depths, d_i and d_s, respectively, both greater than the critical depth, the slope between K and N being sufficient to maintain a normal depth, d_m, less than the critical. Let I be a sufficient distance upstream from K not to be affected by the "drawdown," and let M be sufficiently far below K for uniform flow to be established. Flow at I will be at high stage while at M it will be at low stage. Somewhere between it must pass through the critical depth.

Before proceeding to locate the point of passage it will be well to investigate the properties of the "energy gradient" shown on the profile. This gradient is determined by plotting the velocity head above the water surface at all points. At a given point the total energy, i.e., the sum of the static and kinetic energies, is represented by the elevation of this line. It follows from Bernoulli's theorem that the fall in this gradient between any two points represents the sum of all losses occurring between the two points. The slope of this line at any point represents the slope required to overcome friction and other losses at that point. The energy gradient can never rise in absolute elevation in the direction of flow, since there can be no increase in energy. The distance from any point on the energy gradient vertically downward to the bottom of the canal is $d + hv$. It will be clear from Fig. 2 that there will in all cases be two water depths corresponding to

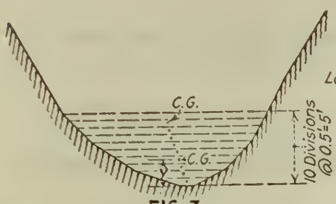


FIG.3

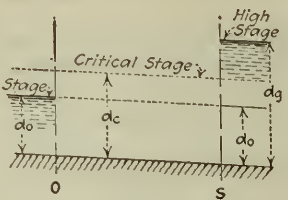


FIG.4

FIG. 3. SHOWING SUBDIVISIONS FOR COMPUTING AREAS AND PRESSURES. FIG. 4. ALTERNATE STAGES

any possible energy gradient. It is also evident that the energy gradient cannot be brought to within less than a certain minimum distance from the bottom of the canal, the two corresponding depths becoming equal at that point. The gradient will generally be a continuous line and can make an abrupt change in height or slope only where a sudden loss occurs. An example of sudden loss, caused by an abrupt change in stage, is shown at O, Fig. 5. So-called sudden changes in open channels are actually more or less extended, but for simplicity they are assumed in all computations to be instantaneous.

Returning to Fig. 5, the water surface must pass through the critical depth between I and K, at K or between K and M. Assume the passages to occur at some point J above K. The energy gradient must under this assumption drop down at J to a minimum height above the bottom of the channel. Therefore, the friction slope from J to K cannot be steeper than the slope of the base of the canal, and, since the slope of the canal is only sufficient to maintain flow at the normal depth, d_i, which is greater than the critical depth, the energy available is not sufficient to overcome friction losses from J to K and maintain flow at or below the critical depth. Hence the critical depth cannot exist at any point above K. If the passage occurs at some point, L, below K the water surface from K to L must be at or above the critical, the velocity will be less than normal, and therefore the friction slope will be flatter than the canal slope; that is, the value of $d + hv$ at L will be greater than at K, whereas if the critical depth occurred at L it should be less. Therefore, the passage cannot occur below K. If the point of passage is at K, $d + hv$ will increase from K to M and the fall in the gradient will be less than the fall in the canal grade. This is logical since the velocity is less than the normal velocity. The fall in the energy gradient from I to K will be greater than the fall in the canal grade, to balance the increase in friction due to velocities in excess of the normal velocities. The point of critical flow will, therefore, come at K.

No reference has been made to values of the slope from K to N except to state that it is sufficient to maintain flow at a depth less than the critical. As long as this slope is sufficient to support flow at a normal depth equal to or less than the critical depth, it may be varied at will without affecting flow conditions above K. For this reason K is called a control.

Flow to the right of M will be uniform at the depth d_m until the flatter slope at N is encountered. For simplicity the loss through shock due to the vertical angle at N is neglected. In actual construction this angle, if sharp, would be relieved by a vertical curve to reduce the shock. Flow to the right of N cannot continue at the depth d_m, since the slope of the canal is insufficient to overcome friction at that depth. The excess of the frictional resistance over the force due to the slope of the bottom of the channel produces a retarding force tending to reduce the velocity and momentum of flow and causing the depth to gradually increase, the velocity head and the depth plus velocity head being decreased to supply the energy necessary to overcome friction.

If this gradual rise in water surface be assumed to continue, along the dotted line YZ in the figure, until the normal depth is reached at Z, there will be some point, as at S, where the depth is equal to the critical depth. Since $d + hv$ is a minimum at S and is not a minimum at Z it follows that the available friction slope from S to Z must be less than the canal slope. But the velocity from S to Z is greater than the normal velocity, hence the required friction slope is greater

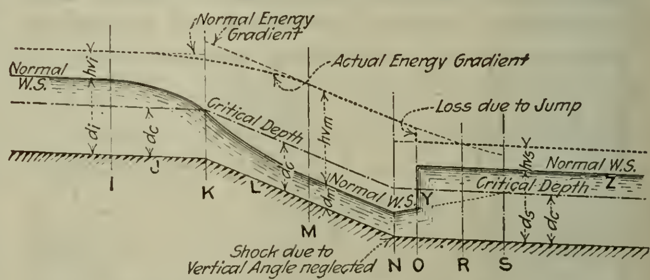


FIG. 5. CHANGES OF STAGE IN UNIFORM CHANNEL

than the canal slope, and the depth cannot change from d_c at S to d_s at Z. It is necessary that the water depth change, between N and Z, from d_m to d_s, but it must not at any point have the intermediate depth d_c nor in fact any depth for which $d + hv$ is less than at Z. The change occurs suddenly through what is known as the hydraulic jump, from some low-stage depth to the depth d_s. The depth d_s and the low-stage depth at R, where the energy gradient for the water surface YZ intersects the normal energy gradient, are alternate energy depths, similar to d_g and d_o in Fig. 2, and if the jump involved no loss of energy it would occur at that point. Referring to Fig. 2 it will be seen that in order for the change to occur at R there must be an increase in $P + \frac{Q}{g}V$, similar to the change from D to T. Such a change in momentum requires the application of an external force. The only external forces available aside from P_e and P_t are the forces of gravity acting through the canal slope and resistance due to friction. These tend to neutralize each other and are negligible in amount. Therefore, F'' in equation (5) may be assumed to be zero, equation (6) must hold, and the jump cannot occur at R, but must take place at some earlier stage where $P + \frac{Q}{g}V$ is equal to the final value of that function. This requirement apparently conflicts with Bernoulli's theorem, but there is automatically introduced a disturbance which produces an internal loss of proper magnitude to preserve the equilibrium of equation (1). The low-stage depth at the jump will be d_o, corresponding to the point D on the momentum curve in Fig. 2. The loss of energy in the jump is equal to $(d_g + hv_g) - (d_s + hv_s)$.

This loss is unavoidable for a change in stage in a channel of constant cross-section and falling grade.

By properly adjusting the shape or vertical alignment of the channel additional external forces may be introduced, and the jump, with the attendant loss of head, may be reduced or eliminated, as will be pointed out later.

The two curves in Fig. 2 approach each other indefinitely to the left of C, while to the right of C they diverge rapidly. A little study of these curves will show that for small heights of jump the loss approaches zero, but that the loss of head increases rapidly as the height of jump increases. For example, in Fig. 2, if the jump occurs from $d = 2.5$ to $d = 3.38$ the loss in depth will be from $d = 3.47$ to $d = 3.38$ or 0.09 ft. The corresponding energy loss is about 0.05 ft. If the jump occurs from $d = 2$ ft. to $d = 4$ ft., the loss in depth will be from 5 ft. to 4 ft. or 1 ft., the energy loss being $5.17 - 4.33 = 0.84$ ft. If the jump occurs from $d = 1.75$ ft. to $d = 4.55$ ft. the loss in depth will be $6.30 - 4.55 = 1.75$ ft. and the energy loss will be $6.40 - 4.80 = 1.60$. Taking the discharge as 150 sec.-ft. this last loss requires the continuous destruction of energy equivalent to about 27 horsepower.

After the depth, d_o, from which the jump will take place has been determined the location of the jump may be obtained by finding the point at which flow will be retarded to that depth. This point may be conveniently found from the following equation, derived from Fig. 1:

$$Ls_g + d_a + hv_a = d_b + hv_b + Ls_f \qquad (7)$$

By assuming values for d_a and d_b all functions at A and B can be computed, including the friction slopes. If the canal slope, s_g, be known and if the friction slope from A to B, be assumed equal to the average of the slopes at these points, all factors in equation (7), except L, become known and L is readily found.

Equation (7) is applicable to any variable flow. The only approximation involved is in the assumption that the average slope is equal to the average of slopes at the computed points. By assuming depths sufficiently close together the error from this source can be reduced as far as desired. However, ordinary friction formulæ are not known to apply accurately to variable flow and extreme refinement in computation is not justified. The friction slope may be determined by Kutter's formula, or by any other friction formula. This equation should not be applied through a control section or a hydraulic jump, but may be used to find the water surface at J, L or N, Fig. 5, or above a check or dam.

The changes in canal slope at points K and N, Fig. 5, are purposely assumed to be great, so that the changes in stage will be marked, but when the normal depth is near the critical, troublesome fluctuations are often produced by very slight unintentional irregularities in the channel. The fluctuations in such cases appear to be out of all proportion to the offending irregularities. This is due to the fact that in the vicinity of C, Fig. 2, the momentum and energy curves are approximately horizontal so that if the amount of energy $(d + hv)$ required at a given point is changed slightly, a comparatively great change in depth must occur to preserve a balance. The possibility of trouble from this source is discussed by J. S. Longwell in an article on "Flow Conditions, Congo Low Line Flume, North Platte Project," published in the *Reclamation Record*, August, 1917, and reprinted in *Engineering News-Record*, Jan. 3, 1918, p. 38. If in the design of a channel it is found that the depth is at or near the critical the shape or slope of the channel should, if practicable, be changed to secure greater stability. Usually the critical velocity can be changed by widening or narrowing the channel, or the normal velocity by altering the slope. If such changes are not practicable, liberal freeboard should be allowed, and extreme care should be used in construction to secure uniformity in grade and cross-section.

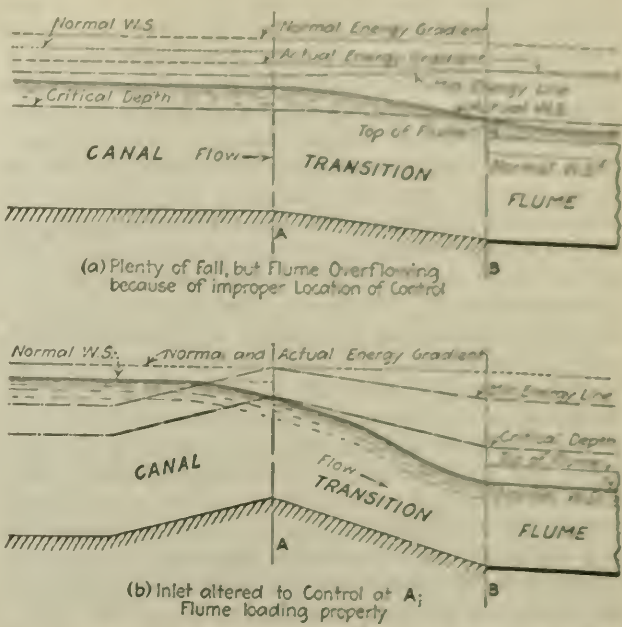


FIG. 6. VARIABLE CROSS-SECTIONS CANAL TO FLUME FOR TRANSITION FROM HIGH TO LOW STAGE

Changes in stage which occur at transitions between canals and flumes, tunnels or other high-velocity conduits, where the cross-section of the channel is variable, involve only the principles already discussed, but additional factors are introduced which affect the mathematical treatment. It will be convenient to consider these transitions under six headings, as determined by the stages between which changes occur, as follows:

(a) Changing from high stage to low stage, increasing velocity.

(b) Changing from one low stage to another, increasing velocity.

(c) Changing from one high stage to another, increasing velocity.

(d) Changing from low stage to high stage, reducing velocity.

(e) Changing from one low stage to another, reducing velocity.

(f) Changing from one high stage to another, reducing velocity.

Case (a) is similar to the example presented in the discussion of Fig. 5, and by arguments already used it can be shown that the control section cannot be above A or below B, in Fig. 6, AB being a variable transition between a canal and a flume. To locate the point of control plot a minimum energy line, as shown in (a) and (b), Fig. 6. This line is obtained by plotting the minimum values of $d + hv$ above the canal bottom, and it represents the minimum possible elevation of the energy gradient at any point. The actual energy gradient cannot fall below this line and if the two gradients intersect it must be at the highest point on

the minimum line. Hence, in Fig. 6 (a), although there is apparently sufficient drop from the normal water surface in the canal to that in the flume, the flume will overflow because of the incorrect location of the control. The drop which should produce velocity head is used up in friction through the lowering of the water surface in the canal. By humping the bottom, as in (b), to bring the minimum energy line at the upper end of the transition into coincidence with the normal energy gradient, the trouble is avoided. Racing in the canal is prevented by the throttling effect of the control at A. The same effect can be secured, if desired, by narrowing the section at A, rather than by raising the grade. The inlet structure may be made to act as an automatic check by shaping it so that the head required to pass any quantity of water at the critical depth is equal to the normal head in the canal above for that quantity. It is theoretically possible to construct such a control check so that it will exactly control all quantities of flow in a given channel, but it is sufficient, for all practical purposes, to design the structure to fit exactly for two discharges, usually full discharge and one-fourth discharge, as in the case of a notched drop.

In changing from one low stage to another, having a greater velocity (case b) it is possible, by contracting the channel or by raising the bottom, or both, to force the water surface up to the critical depth and under extreme conditions a jump may be produced within the transition or in the canal above. Such a contingency is, however, remote and ordinarily this type of transition will not be effected by the critical depth or the hydraulic jump.

The transition from one high stage to another, having a higher velocity (case c) is often accompanied by disturbances attributable to an incorrect control. Fig.

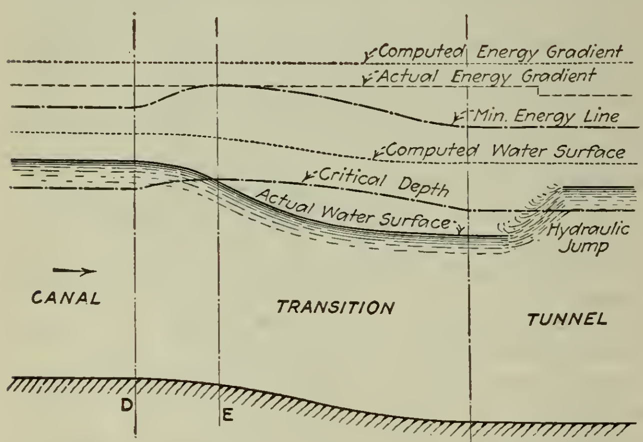


FIG. 7. FAULTY INTAKE—ONE HIGH STAGE TO ANOTHER

7 represents to an exaggerated scale a faulty design recently prepared by the writer for a transition from a segmental open channel to a circular tunnel. The hydraulics for this transition were computed at 2-ft. intervals and no discrepancies were found. However, liberal allowance was made for transitions and friction losses, and a "safe" coefficient of roughness was used to determine the depth in the tunnel. After construction it was found that transition losses were negligible and that the normal depth in the tunnel immediately below the entrance was considerably less than the assumed normal depth. As a result the energy gradient

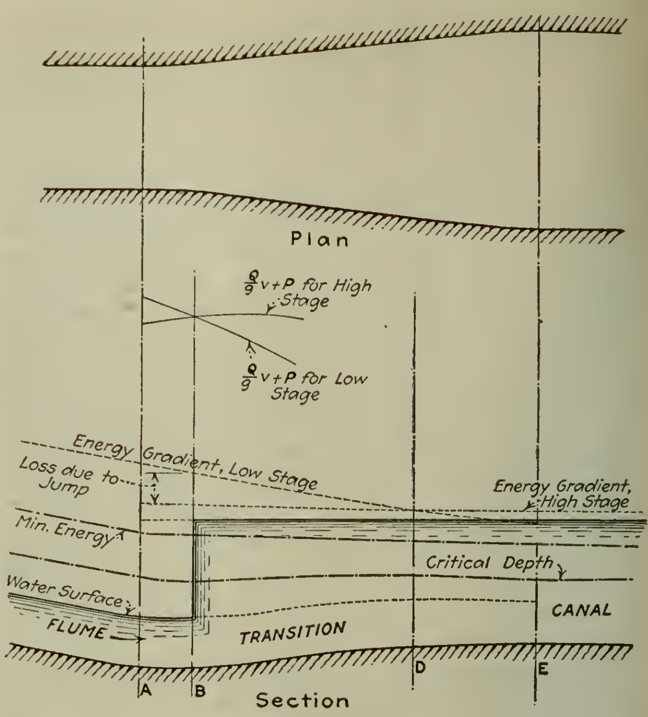


FIG. 8. JUMP, WITH VARYING CHANNEL SECTION AND BOTTOM SLOPE

for the tunnel dropped below the summit of the minimum energy line, and the flow passed to low stage at E, causing a jump to occur just below the end of the transition. The transition should have been proportioned to keep the summit of the minimum energy line below the lowest possible position of the energy gradient at F. The jump was particularly objectionable at this location, and was eliminated by bolting cross timbers to the bottom of the channel, thus increasing the friction and bringing the energy gradient up to its computed position.

Transition from low stage to high stage, (case d) may be accomplished either with or without the hydraulic jump. Unless the section of the channel is properly varied or the bottom "humped" the jump is inevitable. Fig. 8 represents a transition in which the variation in channel section is not sufficient to avoid the jump. The energy gradient for low stage is computed from A toward E, using equation (1), the gradient for high stage being computed backwards, from E toward A, in the same way. After these gradients and their corresponding depths are found values of $\frac{Q}{g}V + P$ for the two stages are computed, and plotted to any convenient scale and datum. The jump must occur where this function is equal for the two depths, or at B, the intersection of the plotted lines. By varying the cross-section or the elevations of the flume, transition or canal, the location of the intersection, B, may be varied at will. If this point falls to the left of A the jump will occur in the flume and may cause it to overflow. If it falls to the right of E the jump will occur in the canal section where the resulting disturbances may be objectionable.

If the transition in Fig. 8 be so altered that the minimum energy line at D becomes tangent to the two energy gradients at their point of intersection, the two gradients automatically changing to become tangent to

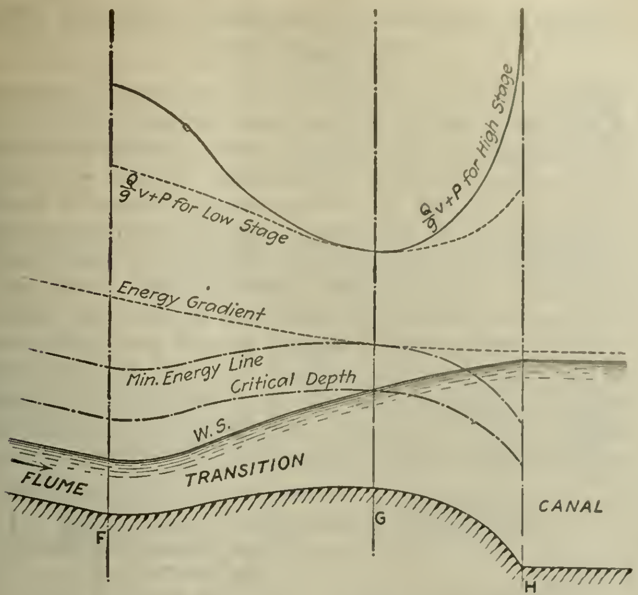


FIG. 9. TRANSITION WITHOUT JUMP

each other at that point, the transition may be accomplished without the jump. Such a transition is illustrated in Fig. 9. The $\frac{Q}{g}V + P$ lines intersect and become tangent at the point G. The excess of the pressure in an upstream direction over that in a downstream direction on the hump in the bottom or on contractions in the sides of the channel supplies the force F'' required in equation (5).

In changing from one low stage to another with a lower velocity (case e) the hydraulic jump and the control section are not often encountered. A contraction in the sides of the channel or a hump or obstruction in the bottom may cause the water surface to rise temporarily above the critical depth, but such contraction or obstruction is not likely to exist in an artificial channel, except by deliberate design. The low secondary dam sometimes placed below an overflow dam to break up the high velocity constitutes such an obstruction, but the normal depth below the secondary dam is usually above the critical so that the conditions of (case d) obtain.

The most usual form of canal transition for reducing velocity is from one high stage to another and such structures are often subject to unexpected irregularities. It is usual in designing transitions of this type to provide for only a partial recovery of head, to allow a factor of safety to take care of imperfections in the structure and of fouling in the canal below. This results in an excess of energy. If the minimum energy line is at all points well below the energy gradient the water surface in the high-velocity channel will be lowered and the excess head will be consumed in increased friction, but if the minimum energy line is high a control is likely to be formed, resulting in low-stage flow for a short distance, followed by a jump back to normal. An actual instance of such an outlet is shown in Fig. 10, where a very gradual change from a 6.1-ft. diameter tunnel to a 8.3-ft. segmental lined section is effected in a length of 100 ft. If the critical depth in the tunnel and in the transition had been lower the water surface would have been further drawn down at J to make the energy gradient from above coincide with that from below, but the high position of the minimum-energy line at J limits the draw down. As a result the flow passes to low stage at J, returning to high stage through the hydraulic jump at K. The location and height of the jump may be determined as in case (d) Fig. 10 is plotted from actual observations. If the required water surface elevation at L were to be increased to bring the energy gradient at that point above the elevation of the minimum-energy line at J, the control at J and the jump at K would be avoided. It will be noticed that the velocities increase from J toward K, reaching a maximum somewhere near K, the effective length of transition being reduced to KL. Under proper conditions the point K may fall to the right of L, and in any event the turbulence below L will be greater than if the transition were effected without the jump. If turbulence is objectionable the outlet should be proportioned to avoid the formation of a control.

The critical depth may be found by constructing either the energy or momentum curve, and finding its lowest point, as in Fig. 2, but it can be more readily determined by means of the equation

$$\frac{A^3}{T} = \frac{Q^2}{g} \qquad (8)$$

where A and T are respectively the area and top width of the water sections for the critical depth. Using

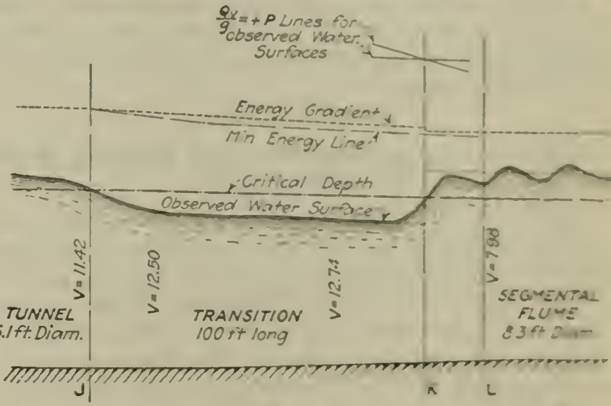


FIG. 10. TRANSITION FROM ONE HIGH STAGE TO ANOTHER: JUMP CAUSED BY EXCESS HEAD

the notation already established, and letting $H = d + hv$, and A = area of section = some function $f(d)$ of the depth, equation (8) is derived as follows:

$$H = d + hv = d + \frac{V^2}{2g}$$

$$= d + \frac{1}{A^2} \times \frac{Q^2}{2g}$$

$$= d + \frac{1}{f^2(d)} \times \frac{Q^2}{2g};$$

differentiating, $\frac{dH}{dd} = 1 - \frac{f'(d)}{f^3(d)} \times \frac{Q^2}{g}$,

where $f^3(d) = A^3$ and $f'(d)$ = the first derivative of A with respect to d, = T, the width at the water surface. H is a minimum when

$\frac{dH}{dd}$ is zero, or when $\frac{A^3}{T} = \frac{Q^2}{g}$ as given above.

By substituting AV for Q this equation may be written

$$\frac{A}{2T} = \frac{V^2}{2g} = hv \qquad (9)$$

In a rectangular section of width, b, A is equal to bd, T is equal to b, and (8) may be reduced to

$$\frac{Q^2}{g} = b^2d^3_c \text{(for rectangular sections)} \qquad (10)$$

from which d_c is readily determined. Equation (9) reduces to the well-known form

$$hv_c = \frac{1}{2}d_c \text{ (for rectangular sections)} \qquad (11)$$

In a triangular section, where the ratio of T to d is X, equation (8) reduces to

$$\frac{Q^2}{g} = \frac{d^5X^2}{8} \text{ (for triangular section)} \qquad (12)$$

and (11) becomes

$$hv_c = \frac{1}{4}d_c \text{ (for triangular section)} \qquad (13)$$

Similar formulæ may be deduced for any channel having a known mathematical relation between A, t and d, but generally the resulting equations are of the $\frac{5}{2}$ deg., and are complicated, and it is preferable to use equations (8) and (9) without further reduction. If d_c is known and Q required these equations may be solved directly, but if d_c is the unknown the solution can best be made by trial.

Valuable assistance in the preparation of this paper has been rendered by D. C. McConaughy and W. H. Nalder and other engineers in the Denver Office of the Reclamation Service.

To Discuss Labor Conditions and Hours of Work in Steel Industry

In order to learn the results of the three-shift system in steel plants Horace B. Drury, formerly of the economics department of Ohio State University and recently with the Industrial Relations Division of the Shipping Board, has been spending some months in visiting steel plants in the United States, collecting technical data covering the details of the operation of the system.

Mr. Drury has put the results of his observations into a paper which will be presented at a joint meeting held under the auspices of the Taylor Society in New York, Dec. 3 at 8 p.m., in the Engineering Societies' Building. The other organizations participating in the meeting will be the metropolitan and management sections of the American Society of Mechanical Engineers, and the New York section of the American Institute of Electrical Engineers.

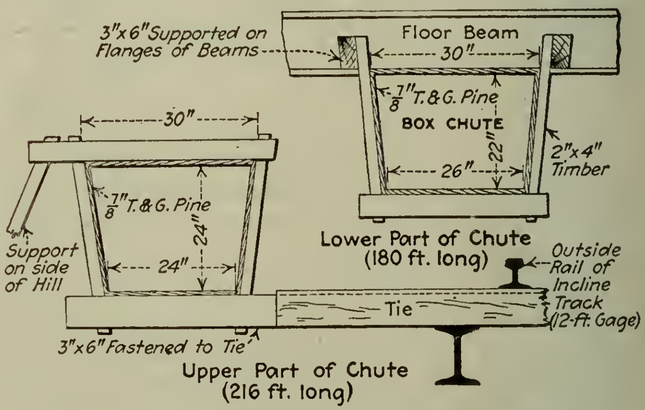
The purpose of presenting the paper is to assist the steel industry in America to prepare for the three-shift system which, judged by the general tendency toward the shortening of hours of labor and the fact that in other countries steel production has been put upon the three-shift basis will probably come here. It is therefore the part of wisdom for managements to prepare for it.

At the same meeting William B. Dickson, vice-president of the Midvale Steel & Ordnance Co., will discuss the subject from the point of view of the manufacturer, and the general discussion will be led by Robert B. Wolf, consulting engineer, New York.

Landslip Material Successfully Chuted Into Railroad Cars

REMOVAL of a hillside slide by passing the material down a steep chute into cars has been carried out successfully on the Pennsylvania System near the Birmingham station at Pittsburgh. At this point the rocky face of the hill rises abruptly from the track level for 150 ft. and then continues on a steep slope for about 200 ft. to the top. During the thaw early this year, springs in the hillside caused a slip near the top, the material blocking two of the four tracks.

Two steam shovels mounted on flat cars were sent to the work, laborers secured by ropes tied to trees being stationed at the top to shovel down the loose earth. After a few days a fire hose was led over from the top and an attempt was made to wash the dirt down.



INCLINED CHUTE USED IN CLEARING LANDSLIDE

This proved unsatisfactory, but the steam shovels had cleared the tracks and drying weather had set in, so that there was no immediate danger of further sliding. The engineers in charge of the work finally decided upon a system of removing the loose material by hand and passing it down an inclined chute, a ¾-in. jet of water being used simply as a lubricant. This method proved satisfactory and was carried on during the summer, when conditions were favorable.

The steel inclined structure of the Monongahela Inclined Plane Co. is near the slip and was utilized to support the chute, which was 396 ft. long and had a slope of 1 on 3. The construction is shown in the accompanying drawing. For the upper 216 ft. of the length, timbers 3 x 6-in. were placed in the track of the incline, projecting on one side about 5 ft. beyond the ends of the ties and carrying frames for the box chute. For the lower 180 ft. the chute was suspended beneath the deck of the incline, the frames being spiked to timbers resting on the flanges of the steel floor beams. The chute was a closed box of ⅞-in. tongued and grooved flooring, but as this was rough enough to cause clay to adhere to the sides it was afterward lined with sheet iron. With this lining and the lubricating effect of water operation was successful.

Traps or movable doors in the top provided for dumping the material into the chute, twelve men with wheelbarrows being engaged in this work, and loading on an average of two cars daily. These openings were useful also in removing occasional stoppages when the material consisted mainly of clay. At the lower end of the chute a bottom trap delivered the material into the

car. This method was adopted as it avoided any interference with traffic on the four-track main line, the cars being placed on an existing side track. The work was carried out under the direction of C. W. Richey, division engineer, and W. D. Wiggins, chief engineer of maintenance of way, Pennsylvania System, Pittsburgh, Pa.

Notes on the Design and Principles of Sewage Siphons

By Weston Gavett
With Clyde Potts, Civil Engineer, New York City

THE large number of automatic devices of the hydro-pneumatic type that have been produced for sewage disposal plants indicates that many engineers have enjoyed the diversion of working on this interesting subject. At present the manufacturers of patented apparatus seem to have the subject well covered and in most cases are permitted to do all the worrying about design. The article by G. H. Bayles in *Engineering News-Record*, May 13, p. 974, describes an exceptional case where the engineer avoided a delay in the delivery of the apparatus by designing and constructing a timed siphon with no other guide

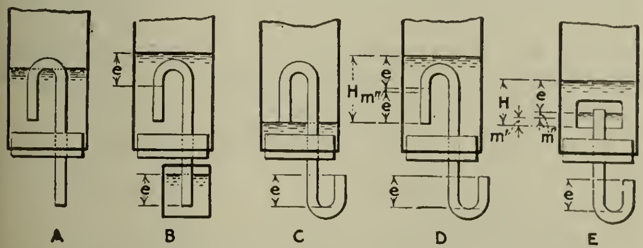


FIG. 1. DEVELOPMENT OF SEWAGE SIPHONS

than a picture of the device. As Mr. Bayles points out, little information is readily available on the design of these devices. An excellent article by E. G. Bradbury appeared in the *Proceedings* of the Ohio Engineering Societies for 1910. A short article in the *Cornell Civil Engineer* of June, 1912, summarized the thesis studies of the writer. The latter, now out of print, discussed the operation of simple siphons, methods of venting, etc. with the results of tests on the hydraulics of small siphons.

Some knowledge of the design and principles of operation of this type of apparatus should be of value to the engineer, first in choosing the type best suited to the work required and later in interpreting any failure in operation. The following notes on the first principles and hydraulics of siphons may be of interest:

Fig. 1 illustrates the elements of the simple siphon. A shows a plain siphon of the form the name suggests. This would function intermittently provided, (a) the inflow is great enough to carry the air from the siphon when the liquid overflows into the long leg and (b) the inflow is small enough to allow the liquid to be drawn to the bottom of the short leg so that venting is obtained. Practically this would not work. What is lacking is a sure and positive means of starting and stopping the flow through the siphon. The early flush tank siphons of the Vibbard, Field-Waring and Van Vranken class are examples of type A with auxiliary devices to give positive operation. If the long leg of the siphon dips in a sump as in type B, the water

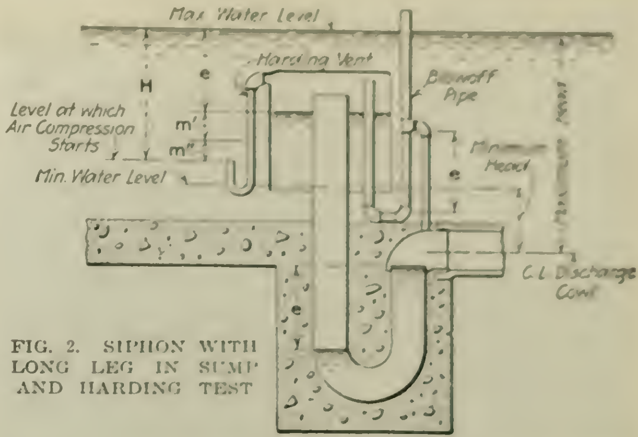


FIG. 2. SIPHON WITH LONG LEG IN SUMP AND HARDING TEST

level in the tank may rise above the top of the siphon before discharge commences. This has the advantage that when the confined air is released, either by blowing out at the bottom of the long leg or by auxiliary blow off, the siphon is under some head and will more surely fill with water and start operating. One form of siphon on the market is of this type, equipped with suitable blow off and vent pipes for starting and breaking the flow. Instead of terminating the long leg in a sump another bend may be used as in C. Substitute a bell for the upper bend and the siphon takes the form used by Mr. Bayles. (E, Fig. 1 and Fig. 2.) Siphon C should work well in starting, at least with small sizes, but difficulty might be expected at the end of discharge in obtaining a thorough venting and return to the original starting condition shown in C.

The discharge head, H, is determined by the length of the lower leg e and with a siphon of the same internal area throughout as D, Fig. 1, $H = 2e + m''$, where m is the rise of water in the upper leg caused by the compression of the trapped air. If the legs are of unequal diameter as with a bell, (E', Fig. 1,),

$$H = e + m' + m'' \text{ where}$$

$$m' = \frac{ea_1}{(A - a_2)} \quad \text{and}$$

m'' = the rise in bell caused by the compression of air,

$$= \frac{V' - V''}{(A - a_2)}$$

a_1 = area of inside of pipe

a_2 = area of outside of pipe

A = area inside of bell

V' = volume of enclosed air under atmospheric pressure

V'' = volume of enclosed air under water pressure of head e.

$$V'' = \frac{V'(P_{atmos})}{(P_{atmos} + 0.434\,e)}$$

H indicates the distance between the level where air compression starts and the level where discharge commences. It is important to note that with the Harding vent air compression starts at the top of the small pipe, a higher point than the level at end of discharge. (See Fig. 2.)

For dependable operation, auxiliary blow off pipes are needed for large siphons and vent pipes or sniff holes for all sizes. Various types of each are in use.

When an auxiliary blowoff is used, the discharge head is figured from the length, e, of the trap of the blowoff, which is smaller than the length of the main trap. (Fig. 2). This method of starting the siphon has the advantage that the water is suddenly and completely ejected from the small pipe, giving no opportunity for the water to surge and reseal the air outlet before the siphon has started. The same advantage holds for the Harding vent, Fig. 2. As the water in the tanks drops below the top of the small arm of the vent, during the discharge of the siphon, the liquid in the vent drops slightly lower due to the friction loss and velocity head in the siphon. When the lower bend of the vent is reached, the liquid in the vent is suddenly inspirated, giving a clear air passage protected from resealing by the short arm projecting above the liquid in the tank. A further advantage of auxiliary pipes subject to violent expulsion of liquid is in preventing clogging.

In figuring the discharge head of a siphon with auxiliary piping the principle is the same as for a simple siphon but care must be taken to allow for the change of air volume in small piping in computing the factors m' and m''. The article by Mr. Bayles gives an excellent example of the method of determining the discharge head of a siphon with complicated connected piping. The actual discharge head may vary from the computed head by 0.1 ft. or less. With the Harding vent the low water level in the tank is a short distance above the point where venting starts for the reason mentioned above.

Comparative Experiments

Experiments with a 3-in. Miller siphon and 4-in. Merritt siphon demonstrated that the variation in the actual discharge head during repeated tests was less than 0.01 feet.

For the average rate of flow of sewage siphons, Mr. Bradbury gives the formula

$Q = 0.4\ A\ \sqrt{2gh}$, where

Q = rate of flow in cubic feet per second.

A = area of discharge pipe

h = average head = ½ the distance from the center of the discharge pipe to the maximum head.

The 3-in. Miller siphon tested gave the approximate formula

$Q = 0.4\ A\ \sqrt{2gh}$, where

h = (max. h + minimum h) ÷ 2

A = area of siphon pipe.

For the 4-in. Merritt siphon (type B, Fig. 1) an approximate formula for average flow is

$Q = 0.4\ A\ \sqrt{2gh}$, where

h = the average head above the center line of the outlet pipe in sump

The greatest part of the friction loss is caused by the short radius bends. Smaller loss may be expected in types having bends of larger radius.

The equations for flow through the siphons tested gave a straight line relation on logarithmic cross section paper except where modified by suction of air through vent pipes.

3-in. Miller siphon:

$h = 32.0\ Q^{1.95}$

$h = 0.09\ v^{1.95}$

$v = 3.45\ h^{0.513}$

h = head in feet above center line of discharge bell, so includes the velocity head in the discharge cowl.

v = vel. in 3-in. siphon pipe

Q = discharge in sec.-ft.

4-in. Merritt Siphon:

$h = 6.3\ Q^{1.95}$

$h = 0.054\ v^{1.95}$

$v = 4.470\ h^{0.519}$

h = head measured to water level in sump represents total friction head.

Deducting the velocity head at outlet cowl from total head in formula for flow in the Miller siphon, the relation obtained is approximately

$Q = 0.174\ h^{0.5}$

$v = 3.52\ h^{0.5}$

$h = 0.0807\ v^2$

To get an expression for the friction loss in terms of a length of straight pipe to give the same loss, the formula for uncoated cast-iron pipe in Barnes' "Hydraulic Flow Reviewed" was used:

$h = 0.000343\ lv^{1.953} \div d^{1.173}$

for 3-in. pipe

$h = 0.00174\ lv^{1.953}$

The length of straight pipe required to give the same loss of head as the 3-in. Miller siphon

= 0.0807 ÷ 0.00174 = 46.4 ft.

or = 185.6 diameters (neglecting difference in exponent of v)

For 4-in. straight pipe

$h = 0.00124\ lv^{1.953}$

Equivalent length of straight pipe with same friction loss as 4-in. Merritt siphon

= 0.0054 ÷ 0.00124 = 43.6 ft. or 130.8 diameters.

A table in a catalog of a siphon patentee giving the rate of flow for 5 to 30 in. siphons at various heads up to 9 ft. was evidently computed from the formula

$v = 0.45\ \sqrt{2gh}$

This is no doubt satisfactory for approximate results but an exponential formula of the form $v = C\ d^x\ h^y$ should give greater accuracy. The writer knows of no experimental data on large-sized siphons to aid in finding an exponent, x, for the diameter, d, in the formula. The large siphons in service are usually connected with piping systems making tests of the siphon difficult.

Data on friction losses through siphons are of more than theoretical interest. In determining the hydraulics of a sprinkling filter, especially when the head is limited, accurate data are desirable. In such a case it is convenient to express the friction loss in terms of a length of straight pipe having the same loss. A fair guess should be 190 diameters until test data on large sizes give further data.

When a siphon is used in a dosing tank subject to continuous inflow, it is important that the rate of discharge of the siphon at the minimum head be greater than the rate of inflow into the tank. With several types of vents a slight suction of air occurs before complete venting takes place. This results in a considerable reduction of flow. With a vent of this type the minimum flow indicated with no air suction should be divided by two to give a safe value.

Placing Concrete Membrane Lining in Herron Hill Reservoir

Continuous Sheet Two Inches Thick Applied by Cement Gun to Stop Leakage—High Rates of Progress

BECAUSE of costly leakage of water from a high-service water-supply reservoir on Herron Hill, Pittsburgh, Pa., a concrete membrane lining is being placed in the reservoir by cement-gun deposition on a double layer of mesh reinforcement. A lining of the more common type, consisting of two layers of concrete molded in separate slabs, with bituminous waterproofing between the layers, was contemplated at first, but after careful study of the case the decision was reached that a thin reinforced cement-gun lining without waterproofing and without expansion joints would be entirely adequate for the service, and the work is being carried out accordingly.

Definite figures on the leakage from the reservoir were obtained on several occasions in recent years when it was possible to cut off both the pumping and the discharge lines and measure the lowering of water level. The reservoir is of 11.2 million gallons capacity, is about 172 x 305 ft. on the bottom by 24 ft. deep, has side slopes of about $1\frac{1}{2}$ to 1, and carries normally about 22 ft. depth of water. It was built in 1878. The bottom is partly on rock and partly on earth directly overlying rock, all undisturbed soil, while the larger part of the embankment is fill formed from the excavation of the reservoir site. The original

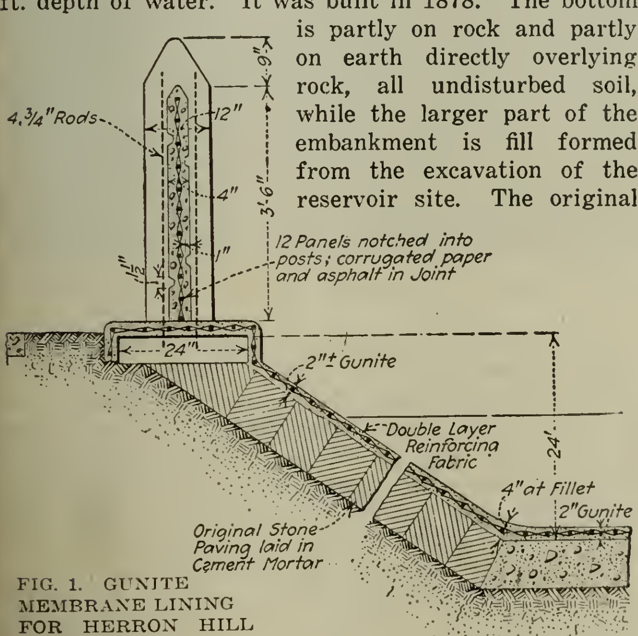


FIG. 1. GUNITE MEMBRANE LINING FOR HERRON HILL RESERVOIR

lining comprised a floor of unreinforced concrete and slope paving of stone blocks laid up in cement mortar. About fourteen years ago a second layer of concrete was placed on the bottom, largely to give the floor a drainage slope to an affluent pipe. Most of this layer has since spalled off.

Old coal-mine workings exist directly under the Herron Hill reservoir, at a depth of about 150 ft. These were worked out at least fifty years ago, and it is not believed that any disturbance of the ground has resulted from them in late years. Nevertheless there has for a long time been a considerable amount of leakage from the reservoir, water appearing both at the mouth of the coal workings and at other points near the base and on the side slopes of the hill. It has been demonstrated that several of these leaks have connection with the reservoir. No tendency of the leakage to decrease could be observed, but at the same time careful analysis of the situation indicated that there was no danger to the structure, and, as the issuing water in all cases was perfectly clear, no soil was being moved by the flow.

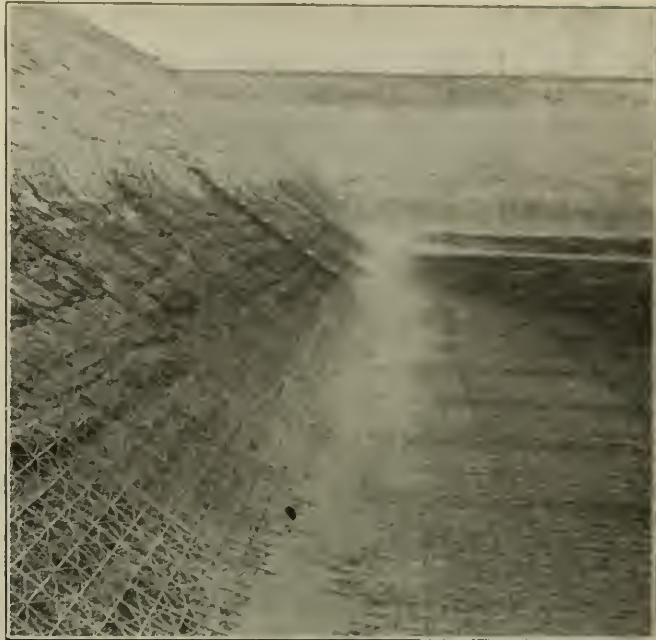


FIG. 2. REINFORCING MESH HELD IN PLACE BY CONCRETE RIDGE AT FOOT OF EMBANKMENT

Calculations of the cost of the water lost by leakage were made several years ago, after it was possible to determine that the amount of the loss was approximately a million gallons per day. As the Herron Hill storage is part of the high-service supply of the city (there are four supply zones, this one having a normal water level 564 ft. above Allegheny River pool level) and is pumped in two stages, the cost of the water is high. Under the conditions, the leakage water was computed as having a value of $7,500 per year, counting only the fluctuating load value to the plant. Therefore an expenditure of $60,000 to stop the leakage would yield a high percentage of return on the investment. The commercial value of the water for selling purposes at city water rates is, of course, many times the load value given above.

Three years ago it was decided that the leakage should be stopped by relining with a waterproofed two-layer concrete pavement. Following standard practice in reservoir lining, the concrete was to be laid in square blocks, breaking joint. But as no settlement was to be apprehended, because of the support furnished by the old lining, consideration was also given to a continuous lining, with either a single contraction joint at mid-length or without any joint. Inspection of a reservoir at Muscatine, Iowa, lined with a thin reinforced cement-gun lining, which after several years' service is free from cracks, finally turned the decision in favor of the continuous type of lining.

Estimates made on both types of lining in spring of this year indicated that the cost would be approximately $125,000 for the two-layer lining with waterproofing, and $55,000 for a continuous cement-gun lining, a difference in favor of the latter of about $70,000. In case the

thin lining should develop objectionable cracks, against all expectation, it would still serve as the lower layer of a waterproofing concrete lining laid in blocks, and proper credit for such use would make the net loss due to the construction of the gunite lining in the first place not more than $8,000. The prospect of a gain of $70,000 as against a rather remote chance of losing $8,000 was an important consideration in the final decision.

In Fig. 1 herewith is shown the design of the lining in its essential features. The old slope paving, of block stone laid in cement mortar, is in such excellent condition as to require no work except the occasional pointing off of a projection; the 2-in. lining of the bottom is therefore carried up the side slopes unchanged, and it is expected that a good bond will be secured by the grip of the gunite on the rough surface of the pavement. The lining sheet is continued on up over the old stone coping and down the outside of the coping so as to enclose all the old work. A solid-panel railing and a watchman's house inserted in the railing at one point are also to be built of cement-gun work. The reinforcement throughout consists of two layers of wire mesh in which the sheets run at right angles to each other, and amounts to 0.3 per cent.

In the methods of construction as well as in the design, the work has close similarity to that of relining Lake Elizabeth, a park lake on the North Side, Pittsburgh, described in our issue of Aug. 26, 1920, p. 410. While the two basins are of about equal area, the park lake is only 4½ ft. deep; the 24-ft. depth of the Herron Hill reservoir means a very much greater water load and tendency to crack formation and leakage, for which reason about twice as much reinforcement is used.

Construction is carried out by four cement guns, operated from separate machines set under a charging bin and screening plant on the reservoir embankment, at mid-length of one side. The view Fig. 2 indicates the layout. The dry cement-sand mixture, 1:3 by volume, is made at a mixing plant at the foot of the embankment slope, about 250 ft. from the charging bin. Allegheny River gravelly sand of ¼-in. maximum size is used. The plant consists of a ⅝-yd. mixer. With about one minute turning a very intimate mixture is obtained, but it is found that the sand must not carry over 5 per cent moisture to be satisfactory for the purpose. A small bucket car, hauled by cable up an inclined track, takes the cement-sand mixture to a small bin over the gun machines, passing it through a ¼-in. rotary screen before discharging it into the bin, to eliminate oversize particles that might clog the hose. Making a trip in two minutes, this car plant has been able to keep the four machines supplied for full-time operation of the four guns, placing 8,000 sq.ft. of the 2-in. layer in a single day of 8½ hr. A bag of cement lays about 14 to 15 sq.ft. of the 2-in. layer, corresponding to full utilization of the mortar, as none of the material is lost.

With a gage pressure of 80 to 85 lb. of air at the compressors, and about 30 lb. at the gun nozzles, there are only infrequent stoppages through plugging of the hose. In general, with maximum hose length of about 200 ft., the loss of time per gun does not exceed ½ hr. per day. There is no separation of the material and only a minute amount of rebound directly adjacent to the jets. To secure corresponding results in the work on the slopes this part of the placing is to be done from staging laid on the slope, so arranged that the jets can be directed at right angles to the surface.

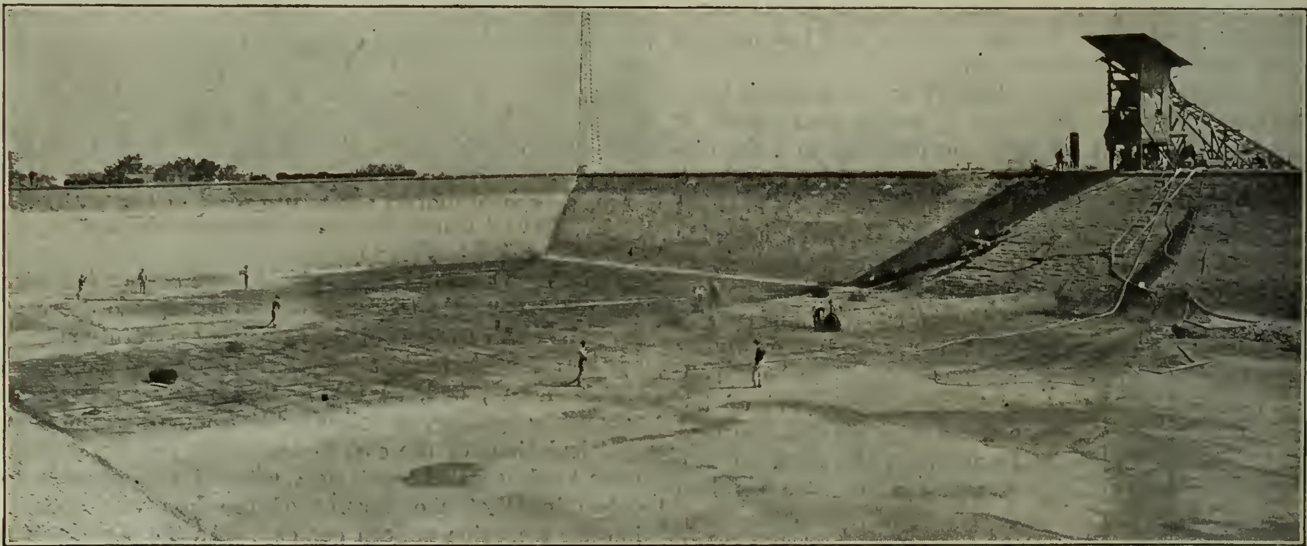


FIG. 2. FOUR GUNS PLACING CONCRETE MEMBRANE, WITH SUPPLY FROM FOUR-MACHINE PLANT ON EMBANKMENT

A total of 105,000 sq.ft. of gunite lining is included in the bottom and slope paving. This was contracted for at 49c. per square foot, to A. V. Purnell, of Pittsburgh. The design and supervision of the work is under the Bureau of Water of the City of Pittsburgh, Charles A. Finley, managing engineer, and E. E. Lanphere, division superintendent of distribution.

Since the preceding was written the new lining has been completed, and on Oct. 26 a test of its tightness was carried out. Inlet and outlet gates were closed, and with water at depth of 21 ft. 8 in. the change in surface elevation was determined by hook-gage readings at the beginning and end of a 24-hour period. The lowering of water level was 0.0208 ft., which for the area of water surface of 86,530 sq.ft., corresponds to 13,500 gals. No allowance was made for evaporation (average temperature 68° F., average humidity 58 per cent, average wind velocity 4 mi. per hr., sky cloudy).

FIG. 4. CLOSE-UP OF GUN OPERATOR

Thus the relining work has reduced the loss of water from nearly a million gallons per day to one-seventieth of that amount, or as much as would flow from a ¾-in. pipe under 5 lb. pressure.

Rails Made from Hot-Top Ingots Show Uniform Structure

To determine the value for rail-making purposes of the Hadfield sink-head ingot process the Pennsylvania R.R. some years ago had comparison rails rolled from a number of imported Hadfield ingots and ordinary ingots made by the Maryland Steel Co. These rails are now in test service, and ultimately should show whether the one kind of rail gives better wear or greater safety against fracture than the other. In the meantime, very thorough studies of the uniformity structure or other quality features of both ingots and rails were made by Dr. George K. Burgess, of the Bureau of Standards. A report of his work as published in *Chemical and Metallurgical Engineering* of Nov. 3 to 17, 1920, shows that the Hadfield ingots were decidedly superior to the others in uniformity and freedom from piping or segregation, that they required only 13 per cent as against 26 per cent top discard to eliminate piping and segregation above 12 per cent, and that the rails compared about the same as the ingots. It is not known whether the service results will similarly favor the Hadfield ingots, but Dr. Burgess concludes concerning the Hadfield type, "it is maintained, that its adoption would be a step in the right direction in view of the present heavy casualties and property losses on American railroads."

Self-Cleansing Underground Water Collecting System

THE filter material above and around a wooden gallery under the bed of the North Platte River for 600 ft., to furnish water for a Western city, 100 miles below the Pathfinder dam, becomes clogged periodically with an almost impervious curtain of cementitious material. It is said to be caused by the character of the hard water and the material surrounding the gallery. Temporary relief only has been obtained by excavating since the incrusted material forms again within a few weeks. George T. Prince, consulting engineer, Omaha, Neb., who presented the above data recently before the Iowa section of the American Water Works Association, considered it essential to construct another collecting system with self-cleansing features.

The system proposed by Mr. Prince will consist of 900 ft. of 14-in. cast-iron pipe with tight joints laid 50 ft. from the low water shore line of the river. At intervals of 100 ft. cast-iron special wye castings will be inserted, the branch openings of which will be fitted with a flange to which an 8-in. valve will be bolted. Three 12-ft. lengths of 8-in. flange pipe will be laid from the valves. Perforations in these branch lines will consist of three lines of 1-in. holes, 50 holes in each pipe length, equally spaced and staggered. The outer ends of the pipe will be closed with a blank flange.

Each branch line will be laid for its length of 36 ft. at the same elevation as its connecting wye special in a trench not less than 46 in. in width at the bottom. The trench will be excavated to a depth of at least 12 in. below the pipe and refilled with washed gravel, no particle of which will be less than 2 in. in size, the larger particles being placed next to the pipe. On either side of the flange pipe for a width of 18 in. and on top to a depth of 4 ft., washed gravel of like character to that below the pipe will be placed and above this the trench is to be filled with excavated material.

About once a week it is proposed to close all of the 8-in. valves on the branches of the collecting system and then open each one successively for back-flushing from the reservoir to remove the clogging material.

Mr. Prince makes the following calculation on the hydraulics of the back-flushing procedure:

Assuming the pipe conditions to be such that 3,000 gal. of reverse flow per minute can be delivered to each branch pipe line under a dynamic head of 70 ft., it is evident that each of the 150 holes in the branch pipe line would have to pass 20 gal. of water per minute, requiring a velocity through the holes of 8.16 ft. per second. If we assume the value of the co-efficient of discharge C to be 0.5 in the formula $V = C\sqrt{2\,GH}$ and assume H to have a value of 70 ft., the formula would indicate a velocity per second of 32.4 ft. Just how much the velocity would be retarded by the gravel filling around the branch pipe lines is indeterminate, but the above figures would indicate a reduction in pressure of 75 per cent due to the surrounding gravel mass.

Reconstruction of Thirty-third St. Bridge

In the reconstruction of the Allegheny River bridge of the Baltimore & Ohio R. R. Co. at 33rd. St., Pittsburgh, described in *Engineering News-Record*, Nov. 4, p. 904, the company retained J. E. Greiner, of Baltimore, as consulting engineer. Through an oversight Mr. Greiner's connection with the work was not stated in our description.

Enlarging the Facilities of the Harbor of Marseilles

Work Started Before the War Comprises Harbor Breakwater with Large Concrete Blocks, a Huge Tunnel for Ship Canal and Development of Shipping Quays

By Thorndike Saville
Associate Professor of Hydraulic and Sanitary Engineering,
University of North Carolina, Chapel Hill, N. C.

SOME of the most important engineering work in France is now being undertaken in the development of the Port of Marseilles and the construction of the Rove Ship Tunnel. Much of this work had been planned shortly before the outbreak of war in 1914, and its accomplishment has been interrupted until the present. The engineering works comprise the following construction.

I. The Grand Jetty. This is a concrete sea wall and dike forming an outer barrier, which runs parellel with the shore and serves to protect the docking basins, of which it forms one side. The sea wall itself acts in part as a dock, and is extended by a dike of masonry blocks to form a fore-port to the basins.

II. The Interior Basins. These are large areas protected by the Grand Jetty, and flanked by quays with freight handling machinery. They are large enough to accommodate and allow to maneuver the largest transatlantic liners entering the Mediterranean.

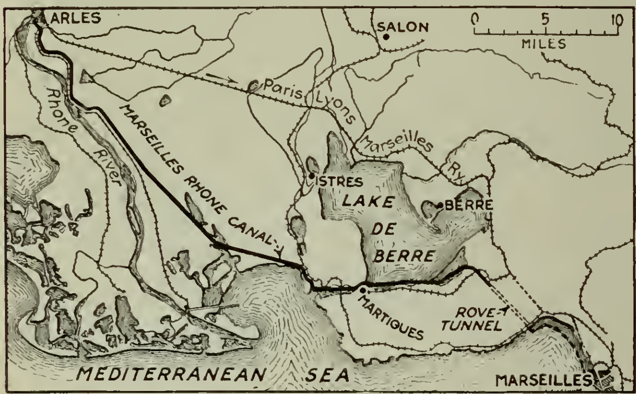


FIG. 1. MAP OF MARSEILLES AND VICINITY, SHOWING CANAL CONNECTION TO THE NORTH

III. A coast-wise canal from the interior basins and port to the Rove Tunnel. This is to allow river barges to come alongside the quays and proceed directly to the Rhone River.

IV. The Rove Tunnel. One of the largest single span tunnels in the world, devised to permit river barges to proceed direct from Marseilles to the Rhone, and thence to the interior of France.

V. The Development of the Etang de Berre. A great inland sea, adjacent to Marseilles, but separated from it by the Rove Hills. It will be connected with Marseilles by the Rove Tunnel, and with the sea by the Straits of Martigues. It is planned to develop here a supplementary port for Marseilles, a barge terminus for river traffic, and a protected naval base.

VI. Canal from Marseilles to the Rhone. This passes along the coast to the Rove Tunnel, through the Etang de Berre and thence to the Rhone at Arles. It forms a direct water highway from Marseilles to Lyons and interior points, and is destined eventually to make possible water communication from Marseilles to Switzerland through Lake Geneva.

Marseilles is the chief port of France, and notwithstanding the severe losses inflicted upon its shipping during the war, its imports in 1916 (the last year for which statistics are available) were 5,704,903 tons and its exports 1,493,535 tons. The chief traffic is naturally import traffic with the Mediterranean ports, comprising 36 per cent of the total, of which 64 per cent is with Africa. Import traffic with the United States, England and India comprised 11, 20 and 11 per cent respectively of the total.

Situated at the head of an excellent harbor near the mouth of the Rhone river, and at the terminus of the great Paris-Lyon-Marseilles Ry. Marseilles is naturally placed to serve all interior France as the principal port for the large Mediterranean trade. Moreover, Marseilles has to a large extent served heretofore as a port for Switzerland also. Within the past decade, however, the equipment of the port has been wholly inadequate to serve the increase of shipping. Thus from 1900 to 1913 the area of the quays and docks was increased some 19 per cent while the total traffic of the port increased 90 per cent. This resulted not only in great congestion of shipping, but in the diversion of a good deal of shipping to other ports. This was notably the case with Genoa, which has greatly improved its port facilities and now handles the greater part of the Swiss trade.

Before the war the Chamber of Commerce of Marseilles had outlined certain comprehensive plans for the enlargement of the port, and itself agreed to bear a large part of the expense. The first and most pressing need was for additional docking space. This was greatly accentuated after the outbreak of war by the allocation of certain docking space to the French and British army bases, and in consequence those parts of the plan of port development most susceptible of rapid accomplishment were pushed energetically.

The Great Jetty

All of the newer basins of the Port of Marseilles are formed behind a great sea wall running parallel with the shore. This arrangement of sea wall and basins is shown in Fig. 2. This is to be continued toward the north as new basins are constructed. The wall is kept always a little in advance of the northernmost basins to form a protection for the entrance. As the basins are added, the wall is widened on the basin side to form a quay. The method of construction is shown in Fig. 3, and the additions necessary to form the Terminal Quay are noted.

The masonry blocks indicated in Fig. 3, and shown in the photographs, form a novel feature of construction in the port. They not only serve for protection to the Grand Jetty, but are used to form the quay walls and to protect the dikes forming the canal to the Rhone described hereafter. They are of masonry construction measuring 4 x 2 x 1.75 meters (13 ft. 2 in. x 6 ft. 7 in. x 5 ft. 9 in.) and weigh about 30 tons. They are manufactured in a construction yard near the entrance to the Rove tunnel, and the limestone rocks excavated from the tunnel are embodied in them. The

cement is of lime, and a very coarse limestone sand is used. As shown in the views mechanical handling is extensively used in the yard and in getting the blocks to the wall.

Work on the quays forming the Madrague (now renamed the President Wilson) Basin was pushed during the war, and at the end of hostilities some 2,500 lin. ft. of quays were available for shipping. This comprised space along Mole G and the Terminal Quay. The basin is now being completed by finishing the Terminal Quay immediately behind the Grand Jetty and by the construction of the "Traverse du Cap Janet" forming the north end of the basin. A depth of water of 39.5 ft. is provided.

The quays are formed by sinking concrete caissons onto prepared foundations and building up the quay on the caissons. The caissons are built in a construction yard and consist of a reinforced-concrete shell containing multiple hollow sections. Steel forms are used and the caissons are made of sufficient sections to form the desired length. The caissons are floated to their desired position, sunk, and the sections filled with concrete. Fig. 8 shows a caisson sunk in place at the end of the west side of the "Traverse du Cap Janet."

The President Wilson Basin, with its approaches and foreport will probably be entirely completed early in 1920. This will increase the water area of the port by some 100 acres and the length of quays by about 3,600 lin. ft. which will augment the total capacity of the port by about 15 per cent. The development project then calls for the construction of the Mirabeau basin to the north of and adjoining the President Wilson basin. This is shown by dotted lines in Fig. 2 and will add some 20,000 lin. ft. of quays. The cost is estimated (1918) at about $22,500,000 and will be borne by the Chamber of Commerce of Marseilles. It will not be completed before 1924 or 1925.

There is also, in the general project of enlargement, a plan for a great new basin extending south of the National Basin to the present Joliette basin and called Jolliette basin No. 2. This would add 63 hectares (156 acres) of water to the port and 12,210 lin. ft. of quays with a minimum depth of 43 ft. It would serve particularly the passenger and mail traffic of the great transatlantic and Mediterranean steamship lines. It will be, however, some years before this work is started.

To connect the docking basins of Marseilles with the Rove Tunnel, a protected waterway has been built following in general the outline of the shore. This is constructed by means of a dike, built at 300 to 350 ft. from shore. The minimum depth will be 3 m. (9 ft. 10 in.) to accommodate the standard 600 ton barges, consisting simply of standard masonry blocks.

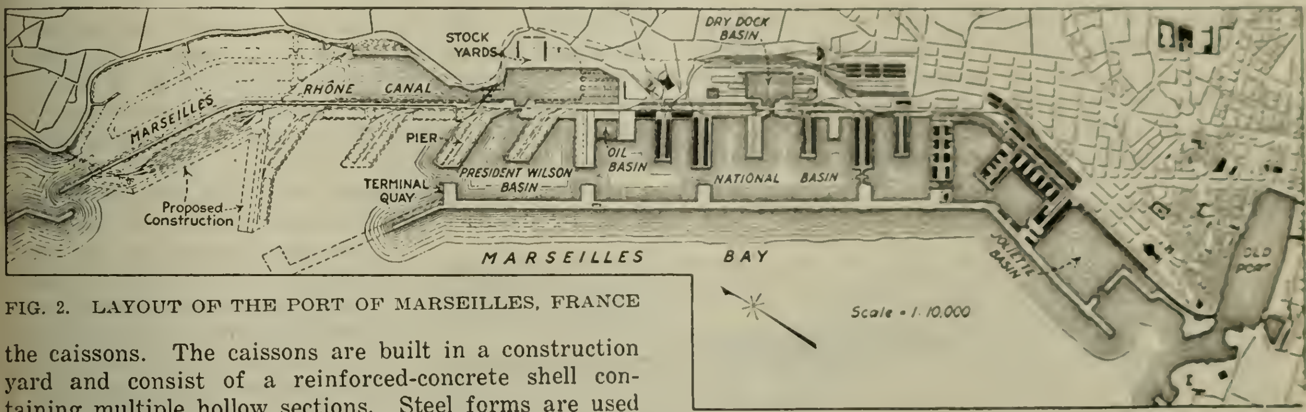


FIG. 2. LAYOUT OF THE PORT OF MARSEILLES, FRANCE

With the completion of the President Wilson basin the greatest need for the immediate future will be for adequate storage space for merchandise. Indeed, this is a pressing necessity which is constantly becoming more acute. Marseilles is very densely built over the seaward slopes of hills bordering the sea. The railways enter through tunnels in the hills, and there is available very little flat ground for the storage of freight pending its interchange between railroad, canal barge, or ship. In consequence there is ever-increasing congestion at the docks and often loss of time and efficiency through inability of small boats to discharge their cargoes quickly.

In Fig. 2 there is shown in dotted lines the proposed location of certain "Terre Pleins" or filled land where storage depots will be created. In connection with these there will be certain small basins created in the existing bays as termini for the canal boats. This development, however, carried to its fullest extent, will not be sufficient to serve the needs of the increasing traffic of the port and additional space will have to be found on the lands adjoining the Etang du Berre.

Probably the most gigantic and spectacular engineering construction now being prosecuted in France is the Rove Ship Tunnel. It is of particular interest not only because it is the largest tunnel in the world, but also because of the very carefully considered methods devised for its construction, all of which have thus far proved eminently successful. The tunnel will connect the coastal canal and port of Marseilles with the Etang du Berre on the northern side of the hills which border the coast from Marseilles to the mouth of the Rhone. From the northern end of the tunnel there will be direct communication by canal with the Rhone at Arles. Earlier progress on this tunnel was described in *Engineering News*, Aug. 26, 1915, p. 386, Oct. 21, 1915, p. 803 and Nov. 30, 1916, p. 1013.

The general dimensions of the tunnel are shown in Fig. 9. The dimensions were decided upon only after much discussion in which it was finally decided that a width was desirable sufficient for boats to pass going in each direction. Before the tunnel was commenced, two shafts were sunk, one in the middle of the Rove Hills, 2,500 meters (8,250 ft.) from the south end, the other near the Etang de terre. The first had a depth of about 460 ft., the second about 230 ft. Both shafts were 11.5 ft. in diameter and were located 39 ft. off the centre line of the tunnel. They both penetrated a marly limestone of which the hills are composed. Indeed the geological characteristics of these hills along the line of the tunnel are singularly simple. There

FIG. 4. CONSTRUCTION YARD FOR MASONRY BLOCKS USED IN GRAND JETTY

FIG. 5. MASONS MAKING BLOCKS FOR CONSTRUCTION OF GRAND JETTY

are no faults, nor subterranean streams of any magnitude. The drainage from the entire tunnel is carried by a 12 in. pipe serving several small centrifugal pumps. The rock is a fine grained limestone which decomposes on exposure to the air and moisture, but remains firm enough when protected by the lining of the tunnel.

The tunnel is lined with masonry, composed of limestone blocks set in lime cement. The blocks are taken partly from the rock excavated from the tunnel after being shaped up, and partly from near-by quarries. The mortar is formed of equal parts of coarse limestone sand and "maritime chalk." The latter is in the nature of a very calcareous natural cement manufactured at Teil. The resulting mortar is coarse, and it is not believed that the bonding strength is very great. The finished lining is not smooth or workmanlike in appearance. The thickness of the lining depends upon the nature of the ground traversed. The strongest was designed to withstand a pressure of 31 kgm. per sq.cm. (44 lb. per square inch).

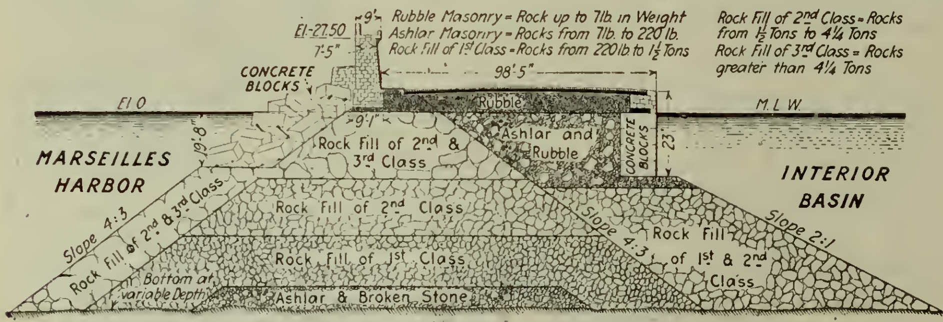


FIG. 3. CROSS-SECTION OF THE EXTERIOR JETTY AT MARSEILLES

The method of penetration of the tunnel is of interest, and is shown graphically in Fig. 9. The right hand pilot cutting is kept slightly in advance of that on the left. Each is between 75 and 100 sq.ft. in area of cross-section. Between the two there are established galleries at intervals of 330 ft. which serve for ventilation, location of machinery, storage of equipment, explosives, etc. When the two lateral galleries have been driven some distance, a third cutting is started in the middle, near the top. This cutting is connected by chutes to the lateral galleries on either side, and the material excavated is dumped through them into cars in the lateral galleries. The excavation then continues in all three galleries until the arch is completed. The lining is then placed, being built from each springing line and carried by wooden forms held by metal frames of H-section. The frames are supported on wooden struts and are spaced about 5 ft. apart. The arch is built in alternate sections of about 20 ft. in length as a precaution against accidents. Excavation is carried to the springing line at El-1.50 m. throughout, after which the bottom is carried to El-3.00 m.

The materials are brought in and the excavation removed by means of narrow-gage railways in each of the lateral galleries. In the larger parts of the tunnel small train locomotives are used and in the galleries the locomotives are driven by compressed air. The material excavated is used partly in making the masonry blocks for the jetties and partly for the blocks used in lining the tunnel. Excavation is accomplished by drilling with Ingersoll-Rand compressed air drills, blasting, and removal of the excavated material by hand to the dump cars. Progress is necessarily very slow, the maximum rate of excavation being about 450 cu.yd. per day with a total in the tunnel of some 450 men. Progress would be greatly expedited by steam shovels, which could readily be used under the prevailing conditions. At the present rate of progress the tunnel will not be completed before 1924. Work is carried on by 3 shifts of 8 hours each. Laborers are paid (1919) 24c. per hour. The 4½ miles of tunnel was contracted for at 47,949,520 francs ($9,250,000) before the war. The ultimate cost will doubtless be 75 per cent in excess of this sum.

The Etang de Berre is a large inland body of water connected with the ocean by a narrow strait between Port de Bouc and Martigues. On the southern border of this the Rove Tunnel has its northern end, some 5½ miles from the Port of Marseilles. The Etang de Berre furnishes a great natural interior harbor capable of serving equally as a terminus for the barge traffic from Marseilles and the Rhone, and as a supplementary Marseilles port for shipping which will enter through the straits at Martigues. For this purpose it is planned eventually to dredge a passage from the sea to Martigues 270 ft. wide and 46 ft. deep. At present there is entrance only by canal, the depth of which is 20 ft.

The lack of storage space in the vicinity of Marseilles has been noted above. The borders of the Etang de Berre present an area singularly well situated for

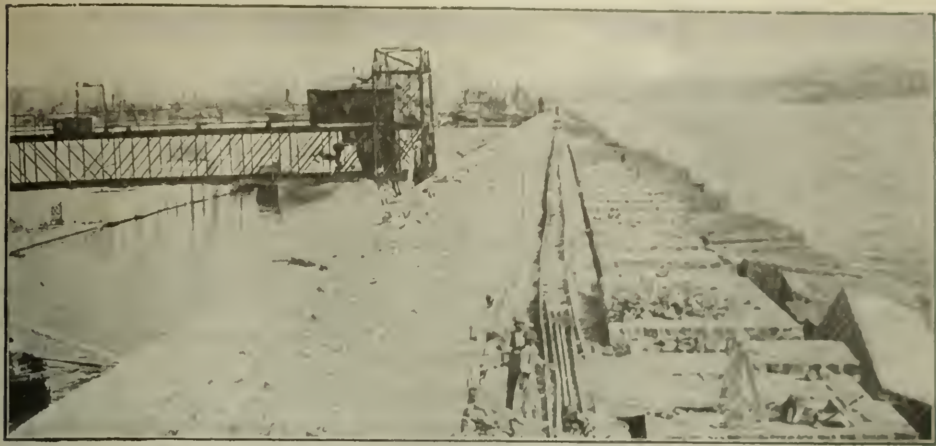


FIG. 6. TERMINAL QUAY. CONCRETE DISTRIBUTOR FOR FILLING SUNKEN CAISSONS

FIG. 7. CRANE TO HANDLE 30-TON BLOCKS

handling the great interior traffic of Marseilles—especially the enormous increase which will come with the canalization of the Rhone between Marseilles and Lyon. Already enterprising organizations are buying up ground on the shores of the Etang and constructing wharves there. The Etang de Berre is destined without doubt to become a great interior port and harbor of refuge as well as serving as a protected naval base.

FIG. 8. CAISSONS SUNK BUT NOT FILLED FOR PRESIDENT WILSON BASIN

There exists already a canal from Arles on the Rhone to the Etang de Berre, which was begun by the first Napoleon. This is being deepened and the locks at Arles increased in size. Eventually the canal will be 82 ft. wide, and will have a minimum depth of 8 ft. except between Marseilles and the Etang de Berre where it will be 10 ft. The dimensions of the canal are chosen to accommodate the standard canal boat of 600 tons. These boats are 60 m. (197 ft.) long by 8 m. (26 ft. 3 in.) wide and draw 1.75 m. (5 ft. 9 in.) of water. The steam tugs which will go from Marseilles to the Etang de Berre draw 8 ft. 3 in. and consequently that portion of the canal has a depth of 10 ft. The canal between Martigues and the entrance to the Rove Tunnel is formed merely by constructing a breakwater off shore along the Etang de Berre similar to that described above for the canal between Marseilles and the Rove Tunnel.

There will be only one set of locks at Arles, which will have a width of 52.5 ft. and a length of 525 ft. This will equalize the difference in level between the Rhone at Arles and the Etang de Berre, a difference varying from 23.6 ft. (highwater) to 0.5 ft. (low water). The present lock at Port de Bouc will be eliminated.

The writer desires to acknowledge the courtesy of Monsieur M. Bezault, ingenieur en chef des Ponts et Chaussees at Marseilles who arranged for a visit to the works at the Rove tunnel and provided several maps and much information descriptive of this work.

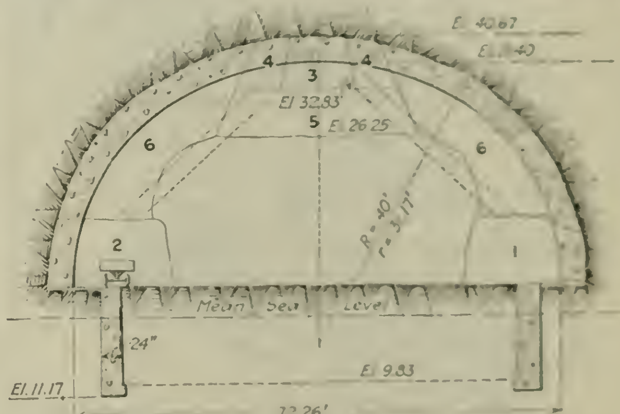


FIG. 9. SECTION OF THE ROVE SHIP TUNNEL

M. Fabre, ingenieur ordinaire des Ports et Chaussees at Marseilles arranged for the writer to visit the port works and provided maps and diagrams illustrative of construction now under way.

Traffic on New York-New Haven Highway

As an indication of the extent to which traffic passes over improved highways at night the following traffic figures, taken by the Connecticut Highway Department,

	Passenger Traffic			Trucks		
Oct. 27	Midnight, 8 a.m.	338		Midnight, 8 a.m.	103	
	8 a.m.—4 p.m.	1,168		8 a.m.—4 p.m.	358	
	4 p.m.—12 m.	910		4 p.m.—12 m.	192	
	Total		2,416	Total		653
Oct. 30	Midnight, 8 a.m.	363		Midnight, 8 a.m.	112	
	8 a.m.—4 p.m.	1,779		8 a.m.—4 p.m.	352	
	4 p.m.—12 m.	842		4 p.m.—12 m.	192	
	Total		2,984	Total		656
Oct. 31	Midnight, 8 a.m.	169		Midnight, 8 a.m.	80	
	8 a.m.—4 p.m.	1,770		8 a.m.—4 p.m.	73	
	4 p.m.—12 m.	2,515		4 p.m.—12 m.	90	
	Total		4,454	Total		243

are cited. This count was made at the Washington Bridge, Stratford, Conn., on the main New York-New Haven highway.

Transportation in New York's Metropolitan District

Extracts from Address Before New York Section, American Society of Civil Engineers, Nov. 17, 1920

By Henry M. Brinckerhoff
of Parsons, Klapp, Brinckerhoff & Douglas, Consulting Engineers, New York City

LET us first free our minds of our habitual ideas of New York as Manhattan Island and think rather of the great surrounding district extending even outside of the five boroughs of Greater New York. The population of Manhattan New York by the 1920 United States census is 2,784,103. Close scrutiny discloses the fact that in 50 years two important changes have occurred: The population of Manhattan Island has reached its maximum and started to recede, having lost nearly 50,000 in the past decade; and the old Manhattan New York as an independent, self-contained city no longer exists. The New York of our fathers has overflowed into or been merged with the life of its surrounding neighbor communities.

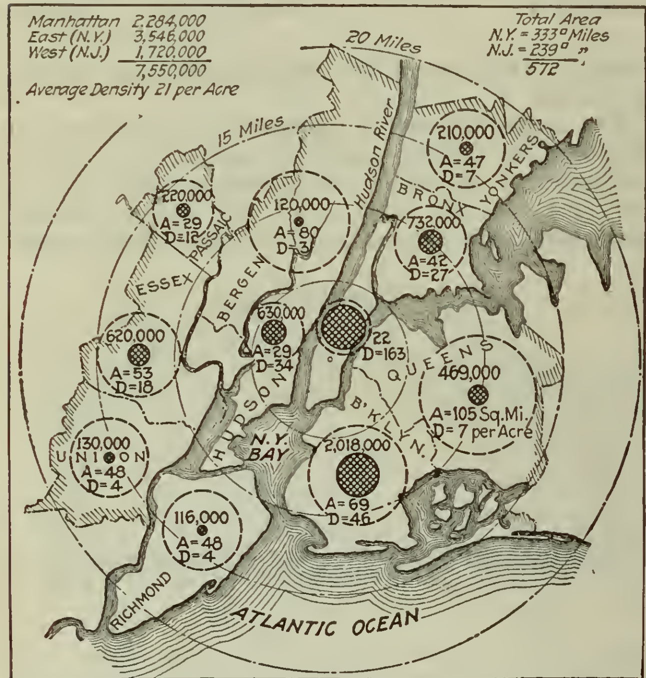


FIG. 1. A CIRCLE OF 15-MILE RADIUS INCLUDES MOST OF NEW YORK'S METROPOLITAN DISTRICT

For our purpose we may take the New York Metropolitan District substantially as defined by the United States Census Department and as shown in Fig. 1. Taking the intersection of Thirty-fourth St. and Fifth Ave. of Manhattan as the urban center of activity and describing circles with 5-, 10-, 15- and 20-mile radii we find that this Metropolitan District lies mostly within the 15-mile circle and all within 20 miles of the center. The cities grouped around Manhattan New York and included in our metropolitan area lie as far east as Flushing and Far Rockaway, Yonkers on the north and Paterson, Newark and Elizabeth to the west. Fifty years ago these latter were remote and totally unrelated communities but today the whole group, with New York as a center, has by a process of growth and development merged into a single metropolitan community in spite of geographical obstacles and political boundaries.

The conception of this whole district as a metropolitan unit, a single city, involves an urban and suburban traffic view in which Manhattan Island figures as the central delivery district for this larger area, with subcenters of activity in Brooklyn, Newark, Yonkers, etc., but all related to one another by the common necessity of easy, frequent passenger intercommunication.

The axis of Manhattan Island north and south almost exactly divides this metropolitan district in two equal parts. The division of areas between New York and New Jersey shows New York 333 sq.mi. against New Jersey with 239 sq.mi. Transferring Richmond Borough to the New Jersey side as being geographically and from a transportation standpoint west of the Hudson River, and considering Manhattan Island as a passenger delivery district with the remaining territory of the metropolitan areas as tributary, we find 263 sq.mi. east and 261 sq.mi. west of this central district.

Distribution and Growth of Population.—Transportation requirements have a direct relation to the number of people in the area to be served and also to their distribution residentially as well as the location of their places of occupation. At least 50 per cent of the passenger traffic handled by city transportation lines consists of workers going daily from homes to places of employment and return. The tendency of population growth is important, then, in an analysis of the transportation needs we are considering.

Table I shows the population for 100 years by 50-year periods of this metropolitan district, and the densities per acre at present.

TABLE I. POPULATION DISTRIBUTION IN METROPOLITAN DISTRICT

	1820	1870	1920	Per Acre 1920
Manhattan	123,000	942,000	2,284,000	163
Brooklyn	11,000	420,000	2,018,000	46
Bronx	....	....	732,000	27
Queens	22,000	74,000	469,000	7
Richmond	6,000	33,000	117,000	4
Yonkers	1,600	18,000	210,000	7
Total N. Y. State	163,000	1,487,000	5,830,000	Ave. 27
Bergen County	9,000	30,000	120,000	3
Hudson County	9,000	129,000	630,000	34
Passaic County	....	39,000	220,000	12
Essex County	12,000	133,000	620,000	18
Union County	....	31,000	130,000	4
Total in N. J.	30,000	362,000	1,720,000	Ave. 11
Total, for Metopolitan Area	193,600	1,849,000	7,550,000	Ave. 21

Two important points are to be noted from Table I: The ratio between the population east and west of the river has remained pretty constant for the past 100 years and the denser and larger population groups were located close to the harbor shipping development. This ratio of about 5 to 1 was true up to about 1900, but then the rapid transit lines began to stimulate the eastern or New York territory into a growth producing a ratio of 6 in New York to 1 in New Jersey in 1920.

We have now come to a point when further rapid transit plans are placed before us by our Public Service Commissioner, which are the result of a long period of study of the subject by the chief engineer, Mr. Turner. (See *Engineering News-Record*, Oct. 14.) Hampered by the limitations of state boundaries he has followed to a logical conclusion, Fig. 2, the result of distributing further large population increases by lines built exclusively in New York State and leaving the New Jersey side to take care of its own problem. We have been asked to disregard such limitations and to consider this subject from the broad metropolitan standpoint.

Mr. Turner predicts that corporate New York (the five boroughs) will grow to 9,000,000 population by 1945. He finds by a further development of the idea of north and south rapid transit lines on Manhattan Island that at least two eight-track subway lines will be required.

From a general economic standpoint the fact is apparent that the vital necessities for the maintenance of a great city

FIG. 2. TRANSIT CONSTRUCTION COMMISSION'S PLAN

population—food, fuel and water—come to this metropolitan district from the west and that the cost of transporting the two former from the west side of the district to Brooklyn and Queens is almost as great as the cost of hauling from Pittsburgh to Newark. This line of thought naturally leads to a suggestion that from the metropolitan standpoint at least a portion of the new population should be located west of the Hudson and that east and west rapid transit lines crossing Manhattan Island from Queens and Brooklyn to Bergen and Hudson Counties in Jersey are warranted and would bring about a better distribution of population relatively to Manhattan.

A rectangular system with transfers at the intersections would tend to distribute the development more evenly across Manhattan Island instead of the great congestion from four- and eight-track subways on north and south avenues (proposed in the Turner report). A shorter average haul would also be obtained and more balanced two-way traffic developed than by forcing the population growth entirely to the east. In Fig. 3 a general suggestion for such lines is shown to convey the idea of a gridiron system in relation to the whole metropolitan area. These east and west rapid transit tracks could be fed by the transfer from the present or new surface lines.

Present Transportation Needs.—More interesting to the average man than the future is the question of how he is to get to and from his work now. Having analyzed the general conditions and pointed out broad lines for thought upon the general scheme we can turn to our own troubles of today. Upon what transit facilities are we now dependent in metropolitan New York? In the reverse order of their importance by volume of passengers handled daily, they are as follows:

TABLE II. CLASSES OF TRANSPORTATION AND DAILY TRAFFIC, NEW YORK METROPOLITAN DISTRICT

	Per Cent of Total
Buses:	
Fifth Avenue Company and city buses	2
Ferries	5
Steam railways entering New York	4
Surface lines	35
Rapid Transit:	
Elevated and subways	54

This subdivision of traffic is peculiar to New York. In London the ratios are as follows: Bus, 33 per cent of total; surface cars, 27 per cent; rapid transit, 40 per cent.

In Chicago the situation is again different, the rapid transit lines being less developed: Surface cars, 75 per cent of total; rapid transit, 21 per cent; steam suburban, 6 per cent.

The passengers delivered to Manhattan by steam railway lines on an average weekday are: From the west, 167,000; from the north, 57,000; from the east (including those delivered by the Long Island Railroad to Brooklyn and Queens), 71,000; total, 288,000.

Similarly the traffic carried to Manhattan by ferries, excluding that of steam railway origin, is: From the west, 142,000; from the east, 92,000; from the south, 30,000; total, 264,000.

Into lower Manhattan, i.e., below Fifty-ninth St., or an area of 10 sq.mi., there is daily poured over 2,000,000 people.

This daily inflow to lower Manhattan is equal to one-fourth of the population of the metropolitan district, but of course a portion come from upper Manhattan and a small number from suburban territory beyond the limits selected. With double or certainly with triple the present population this concentrated central traffic movement would mean the displacing of a large part, if not all, of the resident population of Manhattan.

A study of the rate at which this centralized traffic has increased and the fact that it has developed largely coincident with the great rapid transit development of the past twenty years is cause for careful consideration before we adopt either the rate of increase shown or the growth of the traffic itself. Like the tendency indicated all over the United States by the 1920 census of a concentration of population in cities the thought occurs at once that this character of central travel must have some limit. If you bring all the people of the country into cities they will starve, and if you move more than a certain number into Manhattan daily they cannot walk about on the sidewalks.

We know that the old law, thought to be fundamental during the period of development of electric traction, that the riding per annum per capita of population increased as

FIG. 3. PLAN SUGGESTED FOR METROPOLITAN DISTRICT RAPID TRANSIT

the square of the population, cannot be applied to an increase from 1,000,000 to 5,000,000, for instance. In dealing with this matter quantitatively we must, therefore, be on our guard. Subcenters, as the retail districts of Brooklyn and Newark, will grow in importance and a reaction must set in against such continued increased concentrations.

Such a subcenter development will mean more local traffic of a type quite different from that carried by our long rapid transit lines.

Comparative Costs.—The most expensive type of transportation used by urban and suburban travelers in the New York metropolitan district is the steam railway penetrating to the heart of Manhattan and using a large terminal

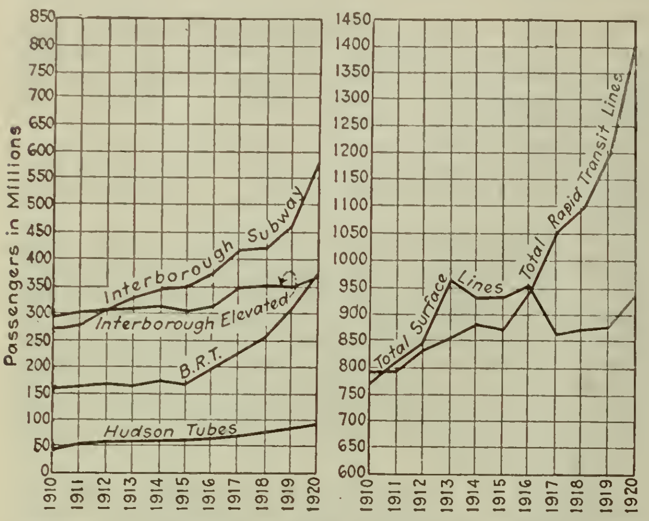


FIG. 6. PASSENGER TRAFFIC IN GREATER NEW YORK

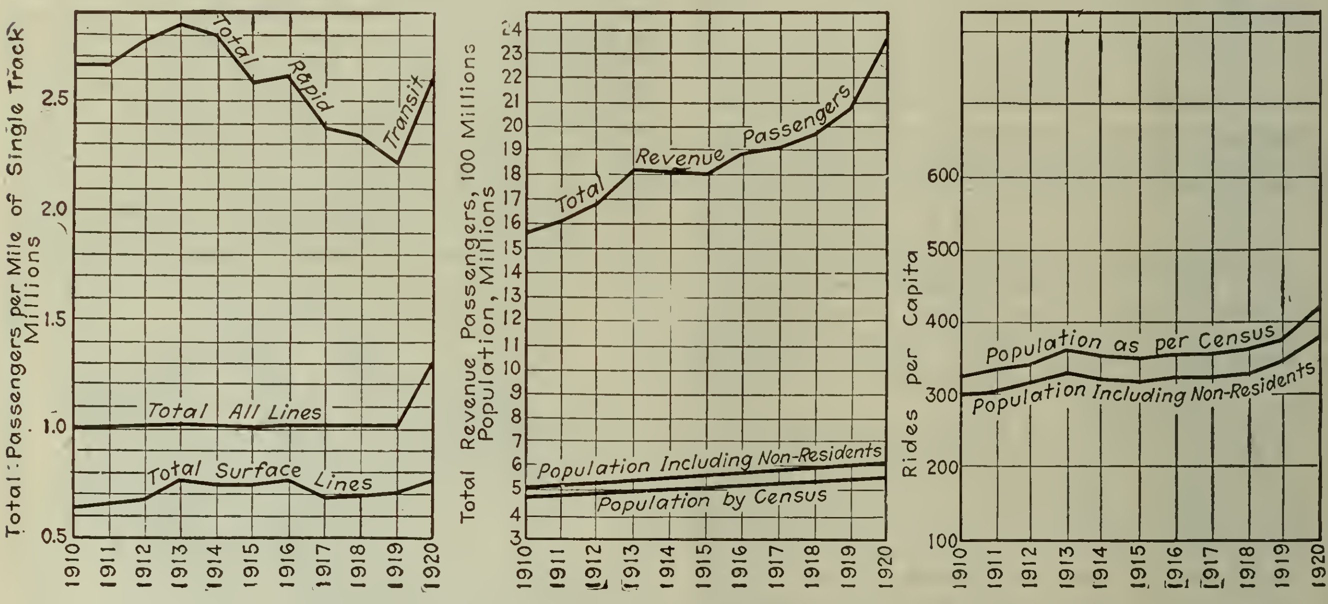


FIG. 4. PASSENGER TRAFFIC IN GREATER NEW YORK FOR PAST ELEVEN YEARS

Left-hand chart shows total passengers per mile of single track. Middle chart shows total revenue passengers and population of New York City. Chart at right shows revenue rides per capita in New York City.

station. Fortunately for the later solution of the problem the volume of this travel is relatively small compared to the rapid transit and surface lines.

It is a fact which is not generally realized, however, that as a city grows not only does its own local and suburban traffic into these great "steam" railway terminals increase but the long distance travelers grow in number also at an equal or even greater rate. With limited track capacity for carrying these two classes of traffic both cannot increase indefinitely. One or the other must ultimately give way. From this type of transportation we cannot hope for present relief, and, on the contrary, part of their load may soon have to be taken over by city rapid transit lines.

Subways cost per mile of single track thirty-five times as much as a bus line and can haul only seven times as many passengers per hour. This would seem a strong argument for buses. To try to haul a full subway load, however, on a bus system requires seven lines of buses in each direction, or a street twice as wide as Fifth Avenue at Forty-second Street. The cost of widening such a street would be fabulous and far more than the subway. This simply illustrates by a comparison of extremes that each type of transit has a peculiar field of its own and if we attempt to handle bus travel on a subway we will be just as wrong as to attempt to carry subway crowds on buses.

Growth.—During the past ten years the miles of single track have doubled on the rapid transit system of Greater New York. The surface lines have increased their trackage only 5 per cent. This is explained by the great rapid transit program which has been put through in this time.

The fact is that the best service to the public can be obtained by a unified co-ordinated system in which each type will function to the best advantage and as part of a unified whole. This is a pretty big order, but as compared to the process of disintegration and dismemberment which is now taking place it is plainly the right direction in which to work. The nearer we can approach to a single system distributing its load among its constitutent parts in the most effective way for both service and economy the nearer we will attain to 100 per cent economy and 100 per cent service.

More subways are of course inevitable but let us build them as long haul trunks and feed them with surface lines and buses. Thirty-five per cent of the passengers in the metropolitan district use surface electric cars today because they are the most convenient. A study of the needs of the metropolitan district as a whole suggests a necessity for a combined system cheap enough in its outlying sections to permit of wide distribution of travel. If the engineers can put out such a plan then it will be up to the lawyers, city officials and bankers to solve their part of the metropolitan transportation problem.

The Political Question.—I have purposely omitted mentioning the one great stumbling block in the way of a logical, sane solution of this metropolitan problem — *the political question.* Right down the center of the Hudson River we have an artificial political Chinese wall, the boundary between the State of New York and the State of New Jersey. Almost one hundred years ago an engineer designed a steamboat that could plow right across this Chinese wall on the surface of the Hudson; more recently engineers have built railway tunnels under this wall and river; today engineers stand ready to build bridges over this wall and across the Hudson River. As an engineer, let me point out to our political friends how this Chinese wall can be finally and forever removed:

Let us add a forty-ninth state to the Union and name it the State of Manhattan. Let is include the New York metropolitan district as a single self-governing state. Let us leave New York City, Jersey City, Newark, each with its own mayor, its own local government, but let us place matters of common interest to the whole metropolitan area, such as transportation, water, sewerage and port development, in the hands of a governmental body representing the people of all metropolitan New York.

The Engineer's Relation to Our Industrial Problems

By HERBERT C. HOOVER
President, American Engineering Council

(Address Delivered at First Meeting of Governing Body of the Federated American Engineering Societies, Washington, D. C., Nov. 19.)

THE federation of engineering societies, embracing the membership of between 100,000 and 200,000 professional engineers, has been created for the sole purpose of public service. This initial meeting surely warrants some discussion of a few of the problems to which this organization, for expression of the engineering mind, can quite well give consideration.

Some of the greatest of the problems before the country and, in fact, before the world are those growing out of our industrial development. The enormous industrial expansion of the last fifty years has lifted the standard of living and comfort beyond any dream of our forefathers. Our economic system under which it has been accomplished has given stimulation to invention, to enterprise, to individual improvement of the highest order, yet it presents a series of human and social difficulties to the solution of which we are groping. The congestion of population is producing subnormal conditions of life. The vast repetitive operations are dulling the human mind. The intermittency of employment due to the bad co-ordination of industry, the great waves of unemployment in the ebb and flow of economic tides, produce infinite wastes and great suffering. Our business enterprises have become so large and complex that the old personal relationship between employer and worker has to a great extent disappeared. The aggregation of great wealth, with its power of economic domination, presents social economic ills which we are constantly struggling to remedy.

I propose to traverse only a small fraction of these matters. I do not conceive that any man or body of men is capable of drafting in advance a plan that will solve these multiple difficulties and preserve the system which makes individual initiative possible. We have presented to us economic social patent medicines of one kind or another and, in fact, the great panacea of socialism is today in actual trial in its various forms. In Russia the attempt has been made to apply the most extreme form of complete communism. The Russian experiment is bankrupt in production. The populations of our modern states have been built up to numbers dependent upon an intensity of production that can only be maintained by stimulation of individual effort through the impulse of self-interest, and a departure from this primary incentive to production has now been demonstrated to lead only to famine and flame and anarchy. We have even had a gigantic experiment imposed upon the United States by the war in the necessity to operate a vast merchant marine at the hands of the government, with a result that should offer little consolation to those who advocate even the mildest application of socialism.

PROBLEMS OF REGULATION

We have built up our present civilization, polictical, social and economic, on the foundation of individualism. We have found in the course of development of large industry upon this system that individual initiative can be destroyed by allowing the concentration of industry and service, and thus an economic domination of groups over the whole. We have therefore built up public agencies intended to preserve an equality of opportunity through control of possible economic domination. Our mass of regulation of public utilities and of many other types of industry, aiming chiefly to prevent combinations in restraint of free enterprise, is a monument to our attempts to limit this economic domination—to give a square deal. This regulation is itself also proof of the abandonment of the unrestricted capitalism of Adam Smith. While our present system of individualism under controlled capitalism may not be perfect the alternative offers nothing that warrants its abandonment. Our thought, therefore, needs to be directed to the improvement of this structure and not to its destruction.

A profound development of our economic system apart from control of capital and service during the last score of years has been the great growth and consolidation of voluntary local and national associations. These associations represent great economic groups of common purpose, and are quite apart from the great voluntary groups created solely for public service. We have the growth of great employers' associations, great farmers' associations, great merchants' associations, great bankers' associations, great labor associations—all economic groups striving by political agitation, propaganda and other measures to advance group interest. At times they come in sharp conflict with each other and often enough charge each other with crimes against public interest. And to me one question of the successful development of our economic system rests upon whether we can turn the aspects of these great national associations toward co-ordination with each other in the solution of national economic problems, or whether they grow into groups for more violent conflict. The latter can spell breakdown to our entire national life.

THE ENGINEER'S POSITION

This engineers' association stands somewhat apart among these economic groups in that it has no special economic interest for its members. Its only interest in the creation of a great national association is public service, to give voice to the thought of the engineers in these questions. And if the engineers, with their training in quantitative thought, with their intimate experience in industral life, can be of service in bringing about co-operation between these great economic groups of special interests, they will have performed an extraordinary service. The engineers should be able to take an objective and detached point of view. They do not belong to the associations of either employers or labor, of farmers, or merchants or bankers. Their calling in life is to offer expert service in constructive solution of problems, to the individuals in any of these groups. There is a wider vision of this expert service in giving the group service of engineers to group problems.

We have just passed through a period of unparalled speculation, extravagance and waste. We shall now not only reap its inevitable harvest of unemployment and readjustment but we shall feel the real effect of four years of world destruction, and from it economic and social problems will stand out in vivid disputation. One of the greatest conflicts rumbling up in the distance is that between the employer on one side and organized labor on the other. We hear a great deal from extremists on one side about the domination of the employer and on the other about the domination of organized labor. Probably the tendency to domination exists among the extremists on both sides. One of the most perplexing difficulties in all discussion and action in these problems is to eliminate this same extremist. There are certain areas of conflict of interest, but there is between these groups a far greater area of common interest, and if we can find measures by which, through cooperation, the field of common interest could be organized then the area of conflict could be in the largest degree eliminated.

In this connection the employer sometimes overlooks a fundamental fact in connection with organized labor in the United States. This is that the vast majority of its membership and of its direction are individualists in their attitude of mind and in their social outlook; that the expansion of socialist doctrines finds its most fertile area in the ignorance of many workers and yet the labor organizations as they stand today are the greatest bulwark against socialism. On the other hand, some labor leaders overlook the fact that if we are to maintain our high standards of living, our productivity, it can only be in a society in which we maintain the utmost possible initiative on the part of the employer; and further, that in the long run we can only expand the standard of living by the steady increase of production and the creation of more goods for division over the same numbers.

The American Federation of Labor has publicly stated

that it desires the support of the engineering skill of the United States in the development of methods for increasing production, and I believe it is the duty of our body to undertake a constructive consideration of these problems and to give assistance not only to the Federation of Labor but also to the other great economic organizations interested in this problem, such as the Employers' Association and the Chambers of Commerce.

Three Causes of Industrial Waste

It is primary to mention the three-phase waste in production: First, from intermittent employment; second, from unemployment that arises in shifting of industrial currents, and third from strikes and lockouts. Beyond this elimination of waste there is another field of progress in the adoption of measures for positive increase in production.

In the elimination of the great waste and misery of intermittent employment and unemployment we need at once coordination in economic groups. For example, our engineers have pointed out time and again to the bituminous coal industry where the bad economic functioning of that industry results in an average of but 180 days' employment per annum, where a great measure of solution could be had if a basis of co-operation could be found between the coal operators, the coal miners, the railways and the great consumers. The combined result would be a higher standard of living to the employees, a reduced risk to the operator, a fundamental expansion of economic life by cheaper fuel. With our necessary legislation against combination and the lack of any organizing force to bring about this co-operation the industry is helpless unless we can develop some method of governmental interest, not in governmental ownership, but in stimulation of co-operation in better organization.

In help against the misery in the great field of seasonal and other unemployment we indeed need an expansion and better organization of our local and federal labor exchanges. We have a vast amount of industry, seasonal in character, which must shift its labor complement to other industries. The individual worker is helpless to find the contacts necessary to make this shift unless the machinery for this purpose is provided for him.

In the questions of industrial conflict resulting in lockouts and strikes one mitigating measure has been agreed upon in principle by all sections of the community. This is collective bargaining, by which, whenever possible, the parties should settle their difficulties before they start a fight.

It is founded not only on the sense of prevention but on the human right to consolidate the worker in a proper balanced position to uphold his rights against the consolidation of capital. This measure, advocated for years by organized labor, was agreed to by the employers' group of the First Industrial Conference. It has been supported in the platform of both political parties. The point where the universal application of collective bargaining has broken down is in the method of its execution. The conflict arises almost wholly over the question of representation and questions of enforcement. The employer in some industries denies the right of men other than his own employees to conduct the negotiations. Labor organizations demand that, as such negotiations require skill, experience and bargaining freedom, they are of more than local application and that thus they can only protect the body of workers by presenting the case on their behalf by skilled negotiators.

The Second Industrial Conference, of which I was a member, proposed a solution to this point by the provision that where there was a conflict over representation the determination should be left to a third and independent party. It also proposed that each party should have the right to summon skill and experience to its assistance. It further proposed that where one of the parties at dispute refuses to enter upon collective bargaining the entire question should be referred to an independent tribunal for investigation as to the right and wrong of the whole dispute—but only for investigation and report. That conference, embracing both a great employer and a most distinguished representative of organized labor, was completely convinced that the illumination of the public mind as to the rights and wrongs of these contentions would in itself make for material progress in their solution, and that in public education and the condemnation of public opinion of wrongdoing lay the root to real progress. No group should be afraid of authoritative publicity in these matters, and I believe it would greatly advance an understanding of the cause of labor. The conference did not believe that industrial contention could be cured by compulsory arbitration or any other form of governmental repression which must in the end use the jails for enforcement. The principles formulated by that conference should have your consideration.

Employer and Employee

There are questions in connection with this entire problem of employer and employee relationship, both in its aspects of increased production and in its aspects of wasteful unemployment, that deserve most careful study by our engineers. There lies at the heart of all these questions the great human conception that this is a community working for the benefit of its human members, not for the benefit of its machines or to aggrandize individuals; that if we would build up character and abilities and standard of living in our people we must have regard to their leisure for citizenship, for recreation and for family life. These considerations, together with protection against strain, must be the fundamentals of determination of hours of labor. These factors being first protected the maximum production of the country should become the dominating purpose. The precise hours of labor should and will vary with the varying conditions of trades and establishments, but the proper determination of hours, based upon these factors, is an immediate field demanding attention of engineers.

There is a broad question bearing upon stimulation of self-interest and thus increase in production that revolves around the method of wage payment. I need not review to you the advantages, difficulties and weaknesses of bonus, piece work, profit-sharing and saving plans that are in use as a remedy for the deadening results of the same wage payment to good and bad skill alike. The suggestion I wish to put for your consideration is the possible use of another device in encouragement of individual interest and effort by creating two or three levels of wage in agreements for each trade, the position of each man in such scale to be based upon comparative skill and character. This plan should be developed upon the principle of graded extra compensation for added skill and performance above an agreed basic wage.

We must take account of the tendencies of our present repetitive industries to eliminate the creative instinct in its workers, to narrow their field of craftsmanship, to discard entirely the contribution to industry that could be had from their minds as well as from their hands. Indeed, if we are to secure the development of our people, we cannot permit the dulling of these sensibilities. Indeed, we cannot accomplish increased production without their stimulation. Here again we cannot make an advance unless we can secure co-operation between the employer and the employee. In large industries this mutuality of interest that existed in small units cannot be restored without definite organization.

Shop Committees

There has been a great increase in shop committees as a method of such organization. Where they have been elected by free and secret ballot among the workers, where they are dominated by a genuine desire on both sides for mutual co-operation in the shop, they have resulted in great good. One of the most important phases of that good has been the tendency to turn the aspect of some foremen from that of slave-driving to leadership. And a great good has been possible by the encouragement of men to creative effort in the stimulation of their minds as well as their hands to the solution of these problems. It makes for pride of craftsmanship and is a real effort to offer them an opportuity of self-expression. Organized labor

has opposed some forms of these committees because of the fear that they may break down trade organization covering the area of many different shops. There is economic reason for this fear in certain cases deeper than appears upon the surface. One of the greatest accomplishments of organized labor has been the protection of the workers from the unfair employer, and it is worth the employer's notice that this is at the same time the protection of the fair employer from the unfair competition of the sweat shop. Again I believe the engineers could assist in the erection of a bridge of co-operation if organized labor, which has already made a beginning, would extend more widely its adoption of the principles of a shop committee settling its problems of wage and conditions of labor in general agreement and applying its energies through shop committee organization to development of production as well as to the correction of incidental grievance. There would be little outcry against the closed shop if it were closed in order to secure unity of purpose in constructive increase of production by offering to the employer the full value of the worker's mind and effort as well as his hands.

There is an immediate problem in increased production that is too often overlooked by the theorist. While it is easy to state that increased production will decrease cost and by providing a greater demand for goods secure increased consumption and ultimate greater employment, yet the early stages of this process do result in unemployment and great misery. It takes a variable period of time to create the increased area of consumption of cheapened commodities, and in the meantime when this is translated to the individual worker he sees his particular mate thrown out of employment. We accomplish these results over long periods of time, but if we would secure co-operation to accomplish them rapidly we must take account of this unemployment and we must say to them, the community, that if it is to benefit by the cheapening costs and thus the increased standard of living, or alternatively if the employer is to take the benefits, the entire burden should not be thrust upon the individual who now alone suffers from industrial changes. Nor can this be accomplished except by co-operation between groups. In fact, the whole problem of unemployment needs earnest consideration.

Summary

In summary, the main point that I wish to make is this: That there is a great area of common interest between the employer and the employee through the reduction of the great waste of voluntary and involuntary unemployment and in the increase of production. If we are to secure increased production and an increased standard of living we must keep awake interest in creation, in craftsmanship and *the contribution of the worker's intelligence to management.* Battle and destruction are a poor solution to these problems. The growing strength of national organizations on both sides should not and must not be contemplated as an alignment for battle. Battle quickly loses its rules of sportsmanship and adopts the rules of barbarism. These organizations—if our society is to go forward instead of backward—should be considered as the fortunate development of influential groups through which skill and mutual consideration can be assembled for co-operation to the solution of these questions. If we could secure this co-operation throughout all our economic groups we should have provided a new economic system, based neither on the capitalism of Adam Smith nor upon the socialism of Karl Marx. We should have provided a third alternative that preserves individual initiative that stimulates it through protection from domination. We should have given a priceless gift to the Twentieth Century.

I am not one of those who anticipate the solution of these things in a day. Durable human progress has not been founded on long strides. But in your position as a party of the third part to many of these conflicting economic groups, with your life-long training in quantitative thought, with your sole mental aspect of construction, you, the engineers, should be able to make contribution of those safe steps that make for real progress.

Letters to the Editor

The Writing of Engineering Reports

Sir—We have read with interest Prof. Mead's article on engineering reports (see *Engineering News-Record*, Nov. 4, p. 891), and we can add little to his admirable advice and detailed suggestions as to what a good engineering report should be. It only occurs to us to emphasize some general thoughts on the subject.

The great difficulty with many engineering reports is that their authors do not, or perhaps cannot, put themselves in the mental attitude of the client for whom the report is prepared.

The scope and character of the report as well as the art of presentation and the extent of appended facts and data all depend on whom the report is for, what use will be made of it, and how fully the client needs to be enlightened. Engineering reports are written primarily either for the public or their representatives, or for private owners, investors or promoters, or for technically trained minds, or for a combination of these classes. In any case they should adapt themselves to their proposed audience.

In investigating new projects or finding solutions for difficult problems it is almost always highly desirable for the engineer to present and estimate impartially all the reasonable methods of accomplishing the result and to discuss disinterestedly all the relative merits and objections of each method, and finally make his selection and recommendation only as a logical conclusion. This method enables the client to review all the accumulated facts, to get the engineering perspective of their relative importance, and to be in good position to see that engineering reasons in relation to outside economic considerations are given their proper weight. Properly presented it is a persuasive and convincing method of making an engineering report. Some few engineers fall into the temptation of deciding what they think is the best solution of a problem before they have collected or arranged the facts. Then of unfortunate necessity they must devote most of the report and cited facts to upholding the original contention.

Ideal engineering reports are in effect small court decisions. The evidence is first arranged, the arguments are presented, and finally an engineering judgment is rendered. Therefore the report should be so arranged that these separate functions are clear and distinct and not scattered or confused with each other. In presentation it is often desirable to reverse this order, but this should never mean that the original procedure is so conducted. It is of the highest importance that the author of a report should keep an open mind up to the moment of his final conclusion, and the report should bear internal evidence that he has done so.

It is always well to remember that the client has fully as much right to hear the evidence and alternatives and the reasoning which leads to a conclusion as the author of the report himself. A report so prepared is of the most convincing character. Reports of great length and laborious detail are seldom of interest or value except to technical men, or in the case of projects of great magnitude or importance.

What the client usually desires first is the conclusion of the engineer, tersely expressed in a few concise paragraphs and sustained in the body of the report by just enough simple convincing facts and proper comparisons to warrant the conclusions. Detailed technical analysis, if presented at all, should only be presented as an appendix. It goes without saying that simplicity of expression, avoidance of unnecessary technical terms, and use of ample illustration in the way of sketch plans, photographs, and simple maps, are most desirable and necessary in any concise report that aims to clearly present engineering problems to busy minds trained only in other directions.

JOHN W. ALVORD,
ALVORD & BURDICK,
Consulting Engineers.

Chicago, Nov. 15.

The Corps of Engineers and Our Public Works

Sir—In May, 1908, the writer discussed in *Engineering News* the relation of the Corps of Engineers to our public works. The editorial comment of 1908 on this discussion seems so pertinent to the present situation that it is worthy of repetition, including the appreciative paragraph concerning the fairness of the writer. It is as follows:

"We have never seen a fairer, more intelligent and more hopeful and helpful discussion of these questions than the letter printed above. We commend it to the careful study alike of the officers of the Corps of Engineers and of the civilian engineers who are interested in having the engineering work in connection with the coming expansion of waterway improvements placed on a better basis.

"As many of our readers know, agitation to have civilian engineers placed in control of river and harbor work dates back fully thirty years; but it has always failed and will always fail so long as it is construed by the public and by Congress as a mere quarrel between two branches of the profession, the civil and the military engineers, as to which shall have the authority.

"To be successful, appeal must be made not on behalf of the engineers but on behalf of proper, efficient and economical conduct of our great public works. There is no reason why the army engineers and the civil engineers should not join hands and work together for reforms in the conduct of our public works which will be of mutual benefit and, what is of far more importance, will place the planning and carrying out of our Federal public works on a basis calculated to better protect the public interests."

At the time of the publication of this article of 1908 the writer was serving under the Corps of Engineers as principal civilian engineer of the United States Lake Survey. His manuscript before submission to *Enigneering News* was placed in the hands of half a dozen engineer friends for comment. Comment indicated that such frank criticism of the corps would result in the decapitation of the critic; but it was published just the same—and the views expressed were followed by no reprisals.

Since that time some of the weaknesses of the corps have been eliminated. "Caste," or the exclusion in the personnel of everyone not of West Point, has disappeared. Men of other technical schools, Michigan, Boston Tech, Columbia or California, are working shoulder to shoulder with the honor men of the Military Academy. This infusion of other blood strengthens the stock and will ultimately add to the already high prestige of the corps. The problem of the civilian assistants is a difficult one, partially due to the long enervating effect of habitual subordination on the characters of the men themselves. Many good men still serve as assistant engineers with inadequate but permanent salaries and pensions ahead for their twilight years. The business and social relations of the officers and the civilians are in many cases cordial.

Let it be understood that the writer favors either a department of public works or an interdepartmental executive board of engineers, but does not approve the Jones-Reavis bill. Let it be further understood that with Herbert Hoover as Secretary of the Interior he believes reorganization will receive great impetus—and the dream of engineers for higher efficiency in our public works will be nearer realization.

The demand is now urgent for engineers to work out a really professional magnanimous organization of our federal engineering activities—as of today and tomorrow, with no reprisals for yesterday. The time is ripe for clear thinking without any jaundiced yellow infiltrations of old grudges or of interdepartmental or interprofessional jealousies.

The engineers of the country entered upon this reform in our public works administration as a crusade, a holy enterprise demanding fine courtesy, high ideals and immaculate motives. It was not intended as a predatory excursion—like the German advance on France—to dispossess one body of engineers for the gain of others. When the sinister predatory motive stands out clearly the crusaders cannot maintain the temperature of enthusiasm.

Has enthusiasm cooled? The report to Engineering Council on the Department of Public Works situation, as printed in *Engineering News-Record* of Oct. 28, is depressing enough with a clear statement as to the cooling of enthusiasm—and even rising opposition.

And this report makes it very clear that the issue is not primarily co-ordination of our federal engineering activities and therefore higher economy and efficiency with better protection to the public interests, but is the forty-year-old "quarrel between two branches of the profession, the civil and the military engineers, as to which shall have the authority." The Corps of Engineers in the report is referred to as our "adversary." Did the Germans use a similar term in the advance through Belgium?

If any churlish attitude has been evident in this campaign it should be pleaded in extenuation that the civil engineer is so tremendously virile and vigorous that he is sometimes ruthless, lacking such feminine qualities as courtesy and kindliness. That is the only possible defense. Is it sufficient?

The writer would like to extend this article beyond permissible limits in discussing the pettiness of this campaign against the corps and give a little testimony as to the human qualities, the engaging personality and the outstanding executive and engineering ability of some of the men of the corps he knows. He might with authority speak of what is fundamental in engineering education and show that certain things that are basic in engineering and in the conduct of life may be better taught at West Point than at many other technical schools. He might speak of the great ship lock at the "Soo" called the "Sabin Lock," after a civilian engineer there, and a government steamer called the "Alfred Noble." And the writer happens to know, as the world knows and all congressmen know, of certain engineering achievements which are properly viewed as the work of the corps.

In his inaugural address at Baltimore in June, 1914, Hunter McDonald as president of the American Society of Civil Engineers, spoke as follows:

"It is a matter of pride and cause for congratulation that the *most stupendous work of civilization*, the Panama Canal, is about to be presented to our government by *men of our profession*, completed greatly in advance of the time when it was due, and absolutely free from any taint of scandal, graft or incompetency in any of the stages of its progress."

Is it probable that with the echo of these words still ringing the corps will be dismissed as one might discharge an office boy?

Is it not possible to bring about a new larger co-ordinated administration of our federal engineering activities in which all that is sound, experienced, honest and capable is retained in the organization? Is it not time to forget that any group of engineers wished to oust the pre-eminent body of specialists in rivers, harbors and canals from this larger organization, or to retain them largely as spectators watching the master engineers operate?

In any new committee of the new council formed to carry on the work of higher co-ordination of our federal engineering work—which has been very helpfully advanced by the expiring committee—it would appear desirable to include some such men of the corps as Beach, Bixby, Jadwin, Judson, Keller, Langfitt, Newcomer, Patrick, Pope, Riché, Taylor or Townsend.

And civil engineers must think of these engineers of the corps, not as "adversaries," but as allies; because we surely wish a place in the sun of the distinction which the builders of the Panama Canal have conferred on all American engineers.

FRANCIS C. SHENEHON,
Consulting Hydraulic Engineer.

Minneapolis, Nov. 9.

Accidents Due to Neglect of Safety Orders

Of 758 industrial accidents in Wisconsin that were investigated by inspectors of the State Industrial Commission during the three months from July to September, 1920, it was found that 27 per cent were chargeable to violations of safety orders. The department also reports an increase as compared with last year's figures.

NEWS OF THE WEEK

New York, November 25, 1920

Federation, Under Hoover's Leadership, Plans Nation-Wide Industrial Survey

First Meeting of American Engineering Council Discusses Organization of Federated Societies and Chooses Washington for Headquarters

UNDER the leadership of Herbert Hoover, former food administrator and president of the American Institute of Mining and Metallurgical Engineers, who was elected to the presidency of the American Engineering Council, the governing body of the Federated American Engineering Societies, at the first meeting of that organization held in the Willard Hotel, Washington, D. C., Nov. 18-20, the federation is planning as one of its first activities in the interest of public service a nation-wide quantitative survey of industrial wastes, to include, among other special lines of inquiry, the aggregate loss to industry and to the public caused by strikes and lockouts intermittent employment and unemployment due to the shifting of industrial currents. Maintaining that the country's greatest problems today are those growing out of our industrial development Mr. Hoover, in his first address as president of the federation's Council, asserted that the engineer is the man best qualified to bring about co-operation among the country's great economic groups of special interests.

HERBERT HOOVER

The growing strength of national organizations of both employers and employees, he said, should not and must not be contemplated as an alignment for battle. These organizations, Mr. Hoover believes, should be considered as the development of influential groups through which skill and mutual consideration can be assembled for co-operation to the solution of our industrial problems. In their position as a party of the third part to many of these conflicting economic groups, Mr. Hoover pointed out, engineers, with lifelong training in quantitative thought and their sole mental aspect one of construction, should be able to make a contribution of those safe steps that make for real progress. His speech, in full, appears elsewhere in this issue.

Twenty Societies Represented

The initial meeting of the American Engineering Council was attended by delegates from 20 of the 21 engineering organizations which have become charter members of the federation. The membership list includes 7 national organizations—the mechanical, electrical, mining and chemical societies, in addition to the Society of Industrial Engineers, the Taylor Society, and the American Society of Agricultural Engineers—and 14 state, city or regional bodies. In addition, representatives were present from other engineering organizations which are considering charter membership in the federation but which have not taken final action. The Kansas Engineering Society was the only member organization not represented by a delegate, but this organization was the first to make payment of its contribution as a charter member of the federation; its check was received by the treasurer on the morning of Nov. 19.

The Council sessions on Nov. 18 and 19 were devoted largely to organization, while on Nov. 20 the Executive Board of the Council held its first meeting. Committee reports formed the major part of the business transacted, there being only four addresses, the first, by Richard L. Humphrey, chairman of the Joint Conference Committee of Founder Societies, outlining the steps which had led to the creation of the Federated American Engineering Societies; the second, by J. Parke Channing, giving a résumé of Engineering Council's work; the third by L. W. Wallace, on factory management and labor, and the fourth by Herbert Hoover, discussing national industrial problems.

With about seventy-five delegates and guests in attendance, the first meeting of American Engineering Council was opened Nov. 18 by Mr. Humphrey, who reviewed the events leading up to the Organizing Conference in Washington June 4. By the assembling of delegates for the first meting of the American Engineering Council Mr. Humphrey believes that "the first step in realizing the dream of the engineering and allied technical professions for solidarity has been taken."

Committees Named

After the appointment of temporary officers—E. S. Carman, representing the American Society of Mechanical Engineers, as chairman, and W. E. Rolfe, of the Associated Engineering Societies of St. Louis, as secretary—the business meeting began. A resolution of regret that the American Society of Civil Engineers was not represented by delegates at the meeting was offered by Philip N. Moore and unanimously passed. The following chairmen of committees were selected: Program, J. V. W. Reynders, American Institute of Mining and Metallurgical Engineers. Credentials, J F. Oberlin, Cleveland Engineering Society. Constitution and By-laws, C. F. Scott, American Institute of Electrical Engineers. Nominations, W. C. Powell, Engineering Society of Buffalo, N. Y. Plan and Scope, L. C. Nordmeyer, American Society of Mechanical Engineers. Budget, Calvert Townley, American Institute of Electrical Engineers. Resolutions, L. W. Wallace, Society of Industrial Engineers.

As a basis for the selection of members of the Executive Board of the council L. P. Alford presented a report suggesting the division of the United States into six districts from each of which a representative of the local member societies was to be selected. The Executive Board for the present will consist of the officers of the Council, 14 representatives from national societies and 6 representatives from local organizations. It was considered desirable not to elect the full number (30) authorized by the constitution, thus providing for representation of

(*Continued on p. [illegible]*)

Sliding Pittsburgh Hillside Covers Eight Pennsylvania R.R. Tracks

Fill Dumped on Steep Slope Below Bigelow Boulevard Causes Failure of Retaining Wall—Soil Flows Like Glacier

(Special report for Engineering News-Record by Morris Knowles and Maurice R. Scharff, Consulting Engineers, Pittsburgh.)

Burying eight tracks of the Pennsylvania R.R. under forty feet of dirt and threatening to cut in two its trunk line connecting Pittsburgh with the Atlantic seaboard, a great slide of filled ground on a steep hillside below and adjacent to Bigelow Boulevard, just east of the Union Station, Pittsburgh, has been in progress for the entire month past. The slide was started by the dumping of earth on the slope from street excavation near by, and has taken on progressively more serious form, up to the early part of this week, when the railroad forces engaged in digging away the base of the slide endeavoring to clear the tracks and prevent further encroachment of the flowing material were able to notice a slight gain. For nearly two weeks there has been imminent danger of complete interruption of traffic. Arrangements for abandoning the Union Station and diverting all traffic on the Panhandle and Fort Wayne lines of the Pennsylvania to a connection with the main line east of the slide have been made, so as to permit of maintaining operation whatever the outcome of the fight against the slide might be. General George W Goethals was appealed to by the city authorities of Pittsburgh late last week and inspected the slide on Saturday, Nov. 20. At last report (Nov. 22) the motion of the flowing mass on the slope had decreased. With continuing fair weather it is believed that no additional interference with the railroad operation need be expected. Long continued rains, however, might lead to very serious conditions.

PITTSBURGH SLIDE, LOOKING DOWN FROM BIGELOW BOULEVARD TO PENNSYLVANIA R.R. TRACKS; UNION STATION TO LEFT OF VIEW

Improvement of Bigelow Boulevard, a main thoroughfare from downtown to the east end, part of Lincoln Highway from Pittsburgh east, was started some months ago, the main operation being the construction of a retaining wall on the uphill side for a length of about one-half mile to widen the road and prevent fall of hillside material onto the roadway. At the same time a curve in the boulevard farther east, where the original alignment was bent into the hillside at a natural hollow, was being straightened by dumping the excavation spoil on the slope below the boulevard. This filling process started the slide.

The portion of the boulevard near Kirkpatrick St., built in 1898, is located on a curve following the hill contour near the top of a deep gully known as Jones' Hollow, leading down to the Pennsylvania R.R. roadbed. At that time an ashlar masonry wall was constructed at the foot of the hollow and the hollow partly filled with material wasted from the cuts on the boulevard construction. During the progress of this filling the wall cracked and moved several inches; further deposition of material was then stopped, and the motion of the wall was checked by proper drainage. A rock-filled wooden crib at the foot of the slope was built up to take the pressure of the further filling necessary to support the boulevard roadway.

Since that time the city's highway maintenance department has dumped street cleanings and other material on top of the old fill. About three months ago additional filling on top of the old bank was commenced, in order to utilize the excavation at the site of the new retaining wall farther west for flattening the curve at the hollow in order to better the alignment of the boulevard.

On Oct. 29 the old masonry retaining wall at the foot of the hollow failed. The new and old fills together started moving. Part of the boulevard just above the hollow showed depression of the pavement and cracks, a city stable located on the fill was destroyed, and a large brick stable above the boulevard at the upper limit of the 1899 fill was cracked.

How Slide Acted

The slide in its further progress developed a typical glacial flow form, showing successive waves and hollows, and moved out over the Pennsylvania R.R. tracks (note arrow A on photograph herewith). Immediately two steam shovels were put to work by the railroad forces. Within four days nine shovels and two ditching machines were attacking both flanks of the slide. This process of removing the material at the foot of the slide with utmost rapidity has continued since then.

Tracks located at and in front of the slide have been raised in some cases as much as 10 ft. and have been repeatedly destroyed. It has been necessary to pull shovels out and rebuild tracks again and again. The nose of the slide, originally about 45 ft. high, has now (Nov. 22) settled about 10 ft. through effect of removal of material.

Eight tracks up to and including that marked by arrow B in the view have been put out of commission, and although two tracks have been partly restored eleven tracks in all have been taken from normal railroad use when those used for loading and shifting dirt cars are included (up to arrow C in photograph), leaving only eight tracks for traffic of the system east of Pittsburgh. Material is being hauled away in 51 Clark dump cars of 30-yd. capacity and 300 wooden dump cars of 12 to 16-yd. capacity; in addition many trains of 50-yd. gondolas have been loaded. Eight locomotive cranes with clamshell buckets are at work unloading cars at the points of disposal at Derry and Donahoe on the main line, Edgeworth on the Fort Wayne, and Mingo Junction on the Panhandle. The shovels working at the base of the slide have a total capacity of 30,000 cu.yd. per day, but have averaged only 6,000 and 7,000 cu.yd., due to the necessity of compromising with train operation. The total removal to date has been 70,000 to 80,000 cu.yd., with several times this amount still to be removed.

When the retaining wall failed a large section of it wrecked part of a two-story brick inspection and supply building 30 x 220 ft. at the foot of the slope, and with the continuance of the slide it has been necessary to pull down additional portions to prevent the falling of walls, so that a 160-ft. length of the original building has been completely destroyed, leaving only a 60-ft. length standing (arrow D on photograph).

In the inspection of the slide made by General Goethals on Nov. 20 no changes in the method of dealing with the slide developed. No formal statement was given out, but General Goethals will submit a written report to the mayor. He is quoted by newspapers as approving the present program of removing the material as fast as it comes down and as advising that nothing further be done except to continue surveys, borings, and investigations until all material has reached equilibrium up to the most remote cracks.

Shovels Gaining

Motion of the slide material has decreased at the date of writing and the shovels are gaining on the slide. All connected with the work feel confident that additional interference with the operation of the railroad is unlikely unless long rains set in. Plans are complete for detouring all traffic if necessary.

Rerouting of cars on the street railway system in order to handle the traffic diverted from the railroad and conversion of Forbes St. and Fifth Ave. into one-way streets are being considered; these two streets are main thoroughfares to the east end of the city.

Discussion of responsibility for the slide among the city authorities has been very active during the past week. The whole case will throw a heavy cost on both the city and the railroad, and the council has ordered a thorough investigation.

C. W. Richey, division engineer of the Pittsburgh Terminal Division, is in charge of work at the slide for the railroad, under W. D. Wiggins, chief engineer of the Central Region, Pennsylvania R.R. N. S. Sprague, chief of the Bureau of Engineering, and John Swan, director of public works, are in charge of the work for the city of Pittsburgh.

Am. Soc. C. E. Wants Engineer on Commerce Commission

The board of direction of the American Society of Civil Engineers on Nov. 9 appointed a committee composed of Charles Hansell, James L. Tighe, Edward H. Lee, Charles S. Churchill and Samuel Murray to take up with the appropriate committee of Engineering Council and with committees of other engineering societies the initiation of such action as may be proper to have an engineer appointed on the Interstate Commerce Commission.

New York Engineers Discuss Rapid Transit

Second Meeting of Am. Soc. C. E. Local Section Considers Broad Metropolitan Plan

New York's rapid transit problem—considered from the standpoint of the metropolitan district as a whole—was discussed at the second meeting of the season of the New York Section of the American Society of Civil Engineers, Nov. 17. The principal paper, "Urban and Suburban Transportaton in the Metropolitan District of New York," was presented by Henry M. Brinckerhoff, consulting engineer, of the firm of Parsons, Klapp, Brinckerhoff & Douglas, who proposed a plan for a unified rapid transit system which would not only serve the five boroughs of New York City but also the New Jersey metropolitan district by river tunnel connection. An abstract of Mr. Brinckerhoff's paper appears elsewhere in this issue. Other authorities on rapid transit joined the discussion, which brought out almost unanimous sentiment among engineers against municipal operation, but favoring consideration of the problem not only from the New York City viewpoint but also from the viewpoint of the metropolitan district as a whole.

Frank Hedley, president and general manager, Interborough Rapid Transit Co., New York, characterized Mr. Brinckerhoff's plan as "an engineer's dream," saying that it would be extremely difficult to carry out in practice since the City of New York has already used a substantial amount of its credit to build subway lines and would not be willing to extend its credit to help build up territory in New Jersey. Mr. Hedley said that the need was for immediate new construction to extend present rapid transit lines in New York City, and that the recent report of the Rapid Transit Construction Commission covering proposed extensions for the next twenty-five years was very much belated because a substantial part of the new lines should now be under construction.

The plan of the Rapid Transit Commission was outlined by its chief engineer, D. L. Turner, who prepared the report. It was explained that for the purposes for which the report was prepared it was impossible to give consideration to the extension of rapid transit lines by river tunneling into New Jersey. Mr. Turner considered rapid transit a municipal function, not a business proposition, but emphasized that the great problem was one of finance. He suggested that increased realty values resulting from extension of rapid transit lines be assessed, ultimately to pay for new construction rather than increasing fares. J. Vipond Davies, of Jacobs & Davies, consulting engineers, New York, questioned the advisability of extensive additions to present rapid transit construction that would materially increase present congestion in the downtown district of Manhattan. To this end it might be better to foster the development of community centers in New Jersey to reduce the volume of transportation.

Tribute to Engineers

A tribute was paid to the work of engineers in developing New York's rapid transit system by George McAneny, president of the Board of Aldermen during the Mitchel administration. He said that the existence of a metropolitan section extending into New Jersey should be recognized and that there was need for the preparation of a universal plan far in advance of requirements. Mr. McAneny asked the question, "Why should not the two states come together on the rapid transit question?" In the meantime he said that there should be no let up in the program of New York City extensions, but characterized a comprehensive rapid transit development as "infinitely difficult to finance."

Delos F. Wilcox, public utilities expert and a member of the Federal Electric Railway Commission, favored public operation (on the assumption of public ownership), saying that such a matter as rapid transit was a public function, that it was difficult to regulate, and that instead of the service-at-cost plan a much simpler way to effect practically the same results would be through public operation, and that communities should be assured against strikes. The present difficulty, said Mr. Wilcox, is that the public will not permit the necessary return on investment to insure success of private operation.

The steam railroads were represented by R. S. Parsons, general manager, Erie Railroad Co.; P. H. Woodward, general passenger agent, Long Island R.R., and George A. Harwood, assistant to the president, New York Central Lines. Mr. Parsons stated that suburban transportation in the metropolitan district had now reached such proportions that it is no longer profitable, due to the necessity of extending facilities from the time when the suburban transportation required but a small portion of the present plant. He outlined the plan for a proposed suburban passenger terminal to be used jointly by the railroads in New Jersey, which would be connected through a tunnel under Jersey City Heights and the Hudson River, with a moving sidewalk to Manhattan. Mr. Parsons also suggested the need for bridging the Hudson River, and said he thought it "a reflection against members of this society that a bridge is not already being built across the Hudson." Mr Woodward of the Long Island looked for the greatest increase in population in the Borough of Queens, and said that the single present trunk line must have help from additional rapid transit facilities. He said that no matter how large present plans may be they will not be large enough in twenty-five years. Mr. Harwood of the New York Central outlined the history of local steam road transit from the beginning

of operation on the Harlem R.R. in 1832. He suggested a transfer point at Mott Haven to connect with rapid transit lines entering Manhattan and said that the present steam railroad suburban traffic was unprofitable.

CROSS TRANSFER ROUTES

Frank J. Sprague, introduced as the "father of rapid transit," said that he was in entire accord with Mr. Brinckerhoff's view, and that a restricted plan would fail. He characterized the present plan as abortive, and said that the need was for cross transfer routes as well as the longitudinal system. The financial aspect of the subject was discussed by O. B. Wilcox, vice-president, Bonbright & Co., New York City, who emphasized the importance of security of principal and interest to investors in rapid transit projects. He said that private operation was successful except for the refusal of the public to permit an adequate return. He did not favor further congestion in downtown Manhattan.

A paper by L. B. Stillwell, consulting electrical engineer, New York City, was read by Colonel F. A. Molitor, citing the development of rapid transit in New York City as the engineer's accomplishment. Mr. Stillwell wrote that the moving platform today occupies about the same position as the proposition of electric traction did twenty years ago. A moving platform with a speed of 12 miles per hour as had been proposed would give three times the capacity of a subway route for the shorter hauls.

The meeting was presided over by Colonel W. J. Wilgus, president of the section. Colonel Wilgus announced that it was the intention, as a result of the series of eight discussions on engineering problems that affect the future of the metropolitan district, to refer these discussions to committees for the purpose of making reports and recommendations looking to the solution of each of the problems with a view to developing a comprehensive metropolitan plan. He proposed that the studies and conclusions be published in report form after the close of the season's meetings. The next meeting of the section will be devoted to consideration of "The Port of New York," Dec. 15. A report of the first meeting of the section, which was devoted to the local freight-handling problem of the metropolitan district, appeared in *Engineering News-Record*, Oct. 28, 1920, p. 865.

Immense Majority for New Jersey Bridge and Tunnel Bonds

The vote Nov. 2 on the $28,000,000 New Jersey State bond issue toward the cost of the Hudson River vehicular tunnel and the bridge over the Delaware River between Camden and Philadelphia was approximately 569,000 to 95,000 or nearly 6 to 1 in favor of the bonds. Every county in the state gave a good majority for the bonds.

Salem Water-Borne Typhoid Epidemic Declining

Some 800 Cases in Ohio City Due to Leaky Vitrified Clay Conduit—Preventive Measures

The typhoid epidemic at Salem, Ohio, noted in our issue of Nov. 18, p. 1012, according to a letter to this journal from W. H. Dittoe, chief engineer Ohio State Department of Health, is still believed to be due to pollution of the water-supply, although no final conclusion has been reached. Up to Nov. 19, Mr. Dittoe states, 763 cases had been investigated by the department, which is thought to be practically all the cases that had occurred. The peak of the outbreak was reached Nov. 1, when 54 cases were plotted on the "took to bed" chart. Since then the "to bed" curve has shown a rapid decline. The deaths to Nov. 19 had been ten, of which the latest was on Nov. 14. The following summary of the sanitary engineering activities undertaken to prevent the spread of the disease, not only in Salem, but down the river in both Ohio and West Virginia, is taken from Mr. Dittoe's letter of Nov. 19 to *Engineering News-Record*:

1. Chlorination of the public water supply was started Oct. 20 and is still in use. Also printed notices warning citizens to boil all water, whether from the public mains or from private wells, have been distributed and posted in prominent places. Also regular analyses of the water supply have been made since chlorination was started and these have shown freedom from contamination.
2. While no definite conclusion has been drawn, it appears likely that contamination reached the water from a gravity line of vitrified clay pipe conveying the water supply and since Oct. 27, this line has not been in use.
3. The usual disinfection of stools from typhoid patients has been rigidly practiced.
4. To prevent the use of dangerous dug wells on properties which are served by the public supply we have undertaken disinfection of such wells by introducing 2 lb. of chloride of lime.
5. In an effort to prevent spread of infection we have undertaken disinfection of all vaults by the application of 5 lb. of chloride of lime.
6. To prevent as far as possible the contamination of the stream receiving the partially treated sewage of the city, we have placed in operation a chlorinating machine applying chlorine gas to the tank effluent.
7. To avoid as far as may be the spread of infection to communities down stream from the city, we have notified the upper Ohio River cities in Ohio, also the West Virginia State Health Department regarding the occurrence of the epidemic, advising the boiling of water for those cities which use the river water without filtration and advising extreme care in the operation of filtration plants, also arrangements have been made to notify village and township officials in the territory between Salem and the Ohio River.
8. Requirements have been imposed that all milk delivered in the city shall be efficiently pasteurized. Also orders have been made to prevent the leaving of milk bottles at places where typhoid fever exists. Tradesmen are also prohibited from delivering milk over counters in bottles.

New Motor Taxes in England

The new automobile and motor truck taxes which have been under discussion in Great Britain and which substitute a horsepower and weight basis of taxation for the gasoline tax now in use, will become effective Jan. 1, 1921. These taxes were given in detail in the *Engineering News-Record* of July 1.

Am. Soc. C. E. Committees to Study External Relations

At its meeting Nov. 9 the board of direction of the American Society of Civil Engineers appointed two committees to consider the external relations of the society, the action being due to the negative vote upon entrance into the federation and the positive vote, in the April questionnaire, regarding active co-operation with other engineers and allied technical associations in promoting the welfare of the engineering profession.

The first committee is composed of corporate members whose duty it will be to consider and make recommendations "for determining and governing" the relations of the society to other engineering bodies. It is understood that the idea in mind was to appoint younger members of the society on this committee. There are two representatives of District 1 and one from each of the other districts. They are: R. C. Marshall, Jr., chairman; W. T. Chevalier, George A. Johnson, Ralph W. Horne, Charles A. Poole, Edgar M. Hoopes, Jr., Kenneth C. Grant, J. H. Dunlap, W. D. Gerber, W. J. Burton, John S. Means, S. B. Morris, Fred M. Randlett, C. H. Snyder.

The second committee will consist of all living past presidents of the society, and its duty will be to review and transmit to the board the report of the committee of corporate members above referred to. The first committee is to finish its work by Jan. 1 and the second committee then will have until Jan. 17 (the next regular meeting of the board) to prepare and submit to the board its commentary on the first committee's report.

As a necessary incident to the close of the matters bearing on the federation the conference committee was ordered to submit its final report not later than Nov. 20, when it was to be discharged.

At the same meeting the board also passed a resolution the closing paragraphs of which are as follows:

"Be it resolved, that the Board of Direction hereby instructs its representatives upon Engineering Council to state to Engineering Council that they cannot participate in any action by Engineering Council in transferring its activities to the Federated American Engineering Societies.

"Be it further resolved, that the Board instructs its representatives to express to the council its hope that Engineering Council will, for the present, continue to carry forward its work."

Nobel Prize for Physics Awarded

Discoveries in the field of nickel and steel alloys by Edouard Breteuil, head of the International Bureau of Weights and Measures, have brought to him the award of Nobel prize in physics for the year 1920 by the Swedish Academy of Science.

Panama Canal Surplus, $2,387,599

The sixth and best year of operation of the Panama Canal, ended June 30, 1920, shows a revenue of $2,387,599 in excess of the expenses for operation and maintenance, and thus reduced the deficit of the six-year period to $2,231,-091, according to the recently issued annual report of Brigadier General Harding, U. S. A., Governor of the canal. For the year 1919-1920 the revenues were $8,935,871, as against expenses of $6,548,272. For dredging the expense was $1,611,359, an excess of about $500,000 over the previous year owing to the slides in the Gaillard cut. The report states that the motion of the slides has been much retarded and that a new period of stability is approaching. The number of vessels passed was 2,745, of which 2,478 were in commercial service. Governor Harding predicts that within a reasonable period of normal world conditions the canal will earn an actual profit on its construction cost of $366,-650,000, this sum being exclusive of the expense for military and naval defense.

Separating the Mississippi and Atchafalaya Rivers

Partial closing of the connection between the Mississippi River and the Atchafalaya River, in Louisiana, by narrowing the present seven-mile gap in the levee system south of Point Breeze, is advocated in a resolution passed at a recent meeting of representatives of the federal and state governments and of landowners and property interests along the two rivers. Advocates of complete separation of the two rivers were unable to secure the endorsement of so radical a step, but the resolution as passed urges a further study of the question. Separation of these two rivers by closing the present connection through the old river channel, so that the Atchafalaya will no longer serve as a relief for Mississippi River floods, has been advocated for many years but is opposed by those who foresee serious effects of an increased flood stage in the Mississippi.

In the opinion of the Corps of Engineers, U. S. Army, the problem has been studied so thoroughly that nothing is to be gained by further study. The Atchafalaya basin can be protected against flood by levees, but this would be a very costly project. On the other hand, the closing of the present outlet would increase seriously the engineering problem of caring for the mouth of the Mississippi, owing to the increased amount of silt brought down. Further, the separation would so increase the flood stage as to necessitate raising the levees south of the Atchafalaya connection, and would also constitute an additional potential danger to the city of New Orleans. It is considered by some engineers that the raising of the levees and the work at the mouth of the Mississippi would involve greater expenditure than the construction of levees along the Atchafalaya.

Cleveland Clearwater Basin Suit Decided

City's Claim for Cost of Rebuilding Rejected — Findings of Master Upheld — Important Case in Contract Law

Terminating long litigation involving important new points in contract law, a decision rendered by Federal Judge Westenhaver at Cleveland Nov. 15 in the case of the West Side clearwater basin construction awards $38,879 to the Walsh Construction Co. and $20,932 to the city of Cleveland, so that the city now owes the contractor $18,000 in final settlement. The decision in its money awards apparently follows closely the findings of fact reached by Robert Hoffmann, chief engineer of the city's Department of Public Service, who was appointed by the court a special master commissioner to report on the issues in dispute.

Comparison with the figures set out in the master's report indicates that the decision, whose precise terms are not yet available, makes award to the contractor for (1) unpaid balance on work performed, (2) extras definitely ordered by the city, (3) additional cost of a conduit on account of leakage from the city's pipes and sewers into the trench, and (4) costs arising from a change in plan for part of the construction. It disallows the contractor's claims for more difficult work due to sliding of the hillside south of the basin, and for complications arising from the presence of a track on the site, existing when the contract was let but not shown on the plans.

On the same basis of comparison the city is awarded (1) liquidated damages for delay in completion, computed after accounting for various delays due to the city's own actions, and (2) damages of about $14,000 for defective concrete, this amount being computed from the yardage of such concrete determined from the testimony, at the contract prices per yard for the several classes of concrete in the structure.

Two major factors in the suit were decided against the city. By far the largest in amount of money involved was the city's claim that the complete reconstruction of the basin by jacketing it with reinforced concrete, carried out after a section of roof of the basin collapsed within a few months of completion of the original contract, should be charged against Walsh, contractor for the basin as first designed. The price paid for this reconstruction was $328,000, whereas the contract price for the basin as originally designed was about $272,000. The master found that the reconstructed basin is functionally different from the original structure, and that many defects in the original structure were due to the design, for which the contractor was not responsible. Tipping of the north wall due to inadequate foundation, and cracking of the basin structure, were among the defects discussed in this connection. The city's claim for reimbursement for the cost of reconstruction was disallowed.

An important question, though involving a smaller amount, hinged on the fact that the sum due the contractor for work done under the contract and ordered extras, at the bid unit prices, exceeded the sum certified by the city's Director of Finance by endorsement on the contract as available for the work. According to the master's findings the failure of the financial authorities to certify additional sums limits the contractor's claim to the amount certified, and he is held responsible for payments already made in excess of this sum. It appears however that the judge reversed this finding by allowing the full claim of the contractor for unpaid balance, and that on the other hand he reinstated the city's claim for liquidated damages for delayed completion, which had been disallowed by the master in consideration of automatic termination of the contract before its final completion.

A minor element of the case was the city's long delay in acceptance of the completed work. It was found that this delay was unwarranted, and a limiting date on which acceptance should have been made by the city was fixed in the findings.

The original contract for the basin was executed on March 29, 1915, and work was completed before the end of that year. On July 9, 1916, a section of the basin roof collapsed because of the presence of honeycombs in columns supporting this section. Reconstruction by jacketing with reinforced concrete was carried out in the following year.

The Walsh company then sued the city for about $40,000 on unpaid balance and other claims, and the city in reply made counterclaim for a sum in excess of $330,000. The court with the consent of the parties appointed Mr. Hoffmann master to hear the case; testimony was taken by him during seven months of 1919, and his report was rendered in December of that year, since which time the case has been in the hands of the court.

A fuller review of the case will probably be published when the text of the court decision becomes available.

Lowest Death Rate Ever Recorded in Registration Area

The lowest death rate ever recorded for the registration area of the United States is reported for 1919 by the Census Bureau. The rate is 12.9 per 1,000, compared to 18 per 1,000 for 1918, the year of the influenza pandemic. The total number of deaths recorded for 1919 is 1,096,436 in a total estimated population of 85,147,882, in 33 registration states, the District of Columbia and 18 registration cities in non-registration states. (See *Engineering News-Record*, April 8, 1920, p. 732, for map showing registration area.)

Federated Societies Meeting

(*Continued from p. 1057*)

organizations which may join the federation prior to July 1, 1921. The following six districts were approved: District 1, New England States and New York; District 2, Michigan, Wisconsin and Minnesota; District 3, Ohio, Indiana and Illinois; District 4, New Jersey, Pennsylvania, Delaware, Maryland and the District of Columbia; District 5, Southern States, including Louisiana and Texas; District 6, Pacific Coast States and others not included in the foregoing five districts.

Figured on a membership basis the national organizations are entitled to the following representation: Chemical engineers, 1; electrical engineers, 4; mining engineers, 3; agricultural engineers, 1; mechanical engineers, 4; industrial engineers, 1; Taylor Society, 1.

Executive Board Chosen

The following were named as members of the Executive Board: For the American Institute of Mining and Metallurgical Engineers, Edwin Ludlow, Arthur S. Dwight and Philip N. Moore. American Society of Mechanical Engineers, L. P. Alford, E. S. Carman, Arthur M. Greene, Jr., and Fred J. Miller. American Institute of Electrical Engineers, H. W. Buck, William McClellan, Charles F. Scott and Lewis B. Stillwell. American Institute of Chemical Engineers, Harrison E. Howe. American Society of Agricultural Engineers, Samuel H. McCrory. Society of Industrial Engineers, L. W. Wallace. Taylor Society, Morris L. Cooke.

For the local organizations the following members of the Executive Board were selected: District 1, W. B. Powell, Engineering Society of Buffalo, N. Y., or Bion E. White, Mohawk Valley Engineers Club, Utica, N. Y.; District 2, C. A. Parks, Grand Rapids (Mich.) Engineering Society, or D. J. Sterrett, Detroit Engineering Society; District 3, J. F. Oberlin, Cleveland Engineering Society; District 4, W. W. Varney, Engineers Club of Baltimore; District 5, O. H. Koch, Technical Club of Dallas, Tex.; District 6, L. B. Smith, Kansas Engineering Society.

Action was taken whereby the date for becoming a charter member of the federation for all those organizations which were invited to the Organizing Conference last June has been extended to July 21, 1921.

Headquarters at Washington

The location of the headquarters of the Council was a subject which elicited lively discussion. The contest eventually narrowed down to New York or Washington. Strong pleas for Washington were made by Philip N. Moore, of the mining engineers, and others. Calvert Townley argued in favor of a location other than Washington because of the danger, as he saw it, of the organization "being drawn into a political vortex." While many of the speakers conceded decided advantages, from the business standpoint, in a New York headquarters, it was pointed out that the establishment of headquarters in New York City would be construed, especially by local organizations in the Middle West and South, as a move to have the federation's policies dominated by the East. It was apparent, however, that sentiment was swinging toward Washington and when the vote was taken Washington was chosen by a vote of 29 to 6.

Hoover Accepts Presidency

The report of the nominating committee was made at the morning session Nov. 19, and the following officers of the American Engineering Council were unanimously elected: President, Herbert Hoover, American Institute of Mining and Metallurgical Engineers; vice-presidents, Calvert Townley, American Institute of Electrical Engineers, W. E. Rolfe, Associated Engineering Societies of St. Louis, Dexter S. Kimball, American Society of Mechanical Engineers, J. Parke Channing, American Institute of Mining and Metallurgical Engineers; treasurer, L. W. Wallace, Society of Industrial Engineers.

In accepting the presidency Mr. Hoover expressed his willingness to fill "any position which might render service to the engineering profession." He believes in a consolidation of engineer effort, not only in technical work but in civic and economic affairs, where the engineer's voice should be heard throughout the community. There has never been a time, said Mr. Hoover, when we needed more urgently than at present the engineer's kind of thinking.

Committee Reports

Constitution and By-laws. — Only minor changes in the printed constitution and by-laws of the federation were proposed by Prof. Scott, chairman. The title of the secretary was changed from "Executive Officer" to "Executive Secretary," and the meetings of the Executive Board made bimonthly, except during July and August, instead of monthly. Contributions of member societies are to be payable in advance quarterly, instead of semi-annually. A number of changes were suggested in the chapter of the by-laws relating to publicity, but after a lengthy discussion the charter was approved as originally drafted, and reads as follows: "The privilege of attendance at all meetings of the American Engineering Council, of the Executive Board and Committees, when not in executive session, shall be extended to any proper person, but this privilege does not include the right to speak or vote. Any proper person shall have the right to inspect and make true copies of the official records of all meetings of the Council, the Executive Board and committees."

Plan and Scope.—One of the most fruitful and important fields of endeavor for the federation, according to L. C. Nordmeyer, chairman, lies in contact with governmental legislation and the rendering of service in an advisory capacity to the end that sound engineering principles may be adhered to. The method of procedure of the original Engineering Council, whereby various subjects were handled through standing or special committees whose membership was composed of men best qualified to deal with specific subjects, regardless of whether they were members of the Council or not, was endorsed. Among the subjects on which it was suggested that the federation might take action are the following:

1. Serving the public interest by investigation and advice to the public and to governmental and voluntary bodies upon national problems which involve industrial and economic questions.
2. National Department of Public Works.
3. Conservation of natural resources, such as water, coal, oil, etc.
4. Maintenance of co-operative attitude toward other national organizations, both professional and commercial.
5. Technical education.
6. Transportation in its various forms, particularly highways.
7. Advice with and assistance to regional, state and local organizations upon their request.
8. National Bureau of Economic Research.
9. Public fire prevention.
10. Patents.
11. National Board of Jurisdictional Awards.
12. International affiliation of engineers.
13. State organizations of local affiliation.
14. Uniform licensing and registration laws.
15. Classification and compensation of engineers.
16. Bureau of employment.
17. Russian-American Engineers Committee.

The committee report concluded with this statement of principle: "Every care should be exercised to avoid any action partaking of political bias or partisanship, and to keep the activities and pronouncements of the Federated American Engineering Societies within the pale of sound engineering, good judgment and upon the broad basis of a real and mutual co-operation."

Budget.—Two estimates of income and expenses were made by the committee on budget, Calvert Townley, chairman. The first, or "minimum assumption," was based on an ultimate membership for the year of only those societies which had already definitely joined. The other, or "maximum assumption," included all present member societies and nine "participating" organizations, many of which were represented at the Council meeting but which had not taken definite action. The minimum assumption, on the foregoing basis, would provide a yearly revenue of \$59,000, while the maximum assumption would yield \$80,000. On the same basis minimum and maximum expenditures were estimated at \$56,500 and \$92,500, the latter figure covering more elaborate plans than it will be feasible to carry out at present.

Executive Board Meeting

At the first meeting of the Executive Board of the Council, held Nov. 20, the following committee was named to re-

port a list of qualified candidates for the position of Executive Secretary of the Council: Messrs. Wallace, Moore, Scott, Oberlin, Alford and Townley.

Resolutions of Board

On motion of Mr. Miller the Executive Board endorsed the plan of Mr. Hoover for an investigation of industrial wastes and authorized him to form an organization for that purpose.

The Board also approved a resolution, offered by Mr. Moore, which read: "Resolved, that this Board recognizes the great importance and value of the movement to secure the establishment of a National Department of Public Works, as initiated by Engineering Council and continued by the National Public Works Department Association, and that the Board declares itself in favor of continuing efforts toward that end."

L. P. Alford was appointed temporary secretary of the Executive Board to serve until its next meeting.

While it did not come officially before the Executive Board, a resolution passed by the American Society of Civil Engineers' Board of Direction at its meeting of Nov. 9, whereby the society forbids its representatives on Engineering Council to transfer the activities of that body to the Federated American Engineering Societies and expresses the hope that the old Engineering Council will "for the present continue to carry forward its work" was the subject of considerable discussion. It appears to be the purpose of the other three founder societies to withdraw from Engineering Council on or before Dec. 31, 1920, utilizing the new machinery of the federation for carrying on and enlarging the former work.

Membership of the Federated American Engineering Societies, Nov. 20, 1920

Alabama Technical Association, Birmingham, Ala.
American Institute of Chemical Engineers, Brooklyn, N. Y.
American Institute of Electrical Engineers, New York, N. Y.
American Institute of Mining and Metallurgical Engineers, New York, N. Y.
American Society of Agricultural Engineers, Ames, Iowa.
American Society of Mechanical Engineers, New York, N. Y.
Associated Engineering Societies of St. Louis, Mo.
Detroit Engineering Society, Detroit, Mich.
Engineering Association of Nashville, Tenn.
Engineering Society of Buffalo, N. Y.
Grand Rapids Engineering Society, Grand Rapids, Mich.
Kansas Engineering Society, Topeka, Kan.
Louisiana Engineering Society, New Orleans, La.
Mohawk Valley Engineers' Club, Utica, N. Y.
Technical Club of Dallas, Tex.
The Cleveland Engineering Society, Cleveland, Ohio.
The Engineers' Club of Baltimore, Md.
The Society of Industrial Engineers, Chicago, Ill.
Washington Society of Engineers, Washington, D. C.
York Engineering Society, York, Pa.
Taylor Society, New York.

Winfield to Have City Manager

After having twice defeated the City-Manager plan a proposal for its adoption was carried by a majority of 471 votes at Winfield, Kan., on Nov. 2.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Washington, D. C., Dec. 13-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City, Jan. 19, 1921.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. 25-27.

The Utah Society of Engineers, at a recent meeting, went on record in favor of the vigorous prosecution of a plan for the development of arid lands and the use of flood waters and the further development of irrigation in Utah in general as outlined by A. F. Parker, chief engineer of the Utah Water Storage association. Mr. Parker presented a draft of a bill which, it is hoped, will be brought in some form before the next Utah legislature. The bill would create a state development service, following the suggestion rather than the general outlines of the U. S. Reclamation Service.

The Technical Club of Dallas, Tex. has perfected an arrangement whereby its members will exchange engineering papers with members of a similar club in the City of Mexico.

The Engineers Club (Houston, Tex.), at a joint meeting with the Houston Realty Board held Oct. 28, was addressed by Mayor A. E. Ammerman, John T. Scott, M. E. Foster and M. E. Tracy. The Manchester purchase and port improvements were discussed.

The Rochester Engineering Society, at its meeting Nov. 12 was addressed by G. F. Stickney, consulting engineer of Albany, N. Y., on "The Siphon Spillway Dam." The fact was brought out that there are 25 dams of this type in this country and several more are proposed.

The Cleveland Engineering Society, at its noonday meeting, Nov. 26, will be addressed by E. Arthur Roberts on "European Impressions." At the meeting Tuesday evening, Nov. 30, Fletcher Collins will speak on "Wrought Iron Pipe by Puddling Process."

The Texas Section, Am. Soc. C. E., at its annual meeting late in October, adopted a resolution urging the defeat of the Smith Bill (H. R. 12,466) permitting the granting of irrigation rights in Yellowstone Park, and also a resolution urging Congress to pass an amendment to the Federal Water Power Act exempting national parks from use for waterpower purposes.

The California Section, American Water Works Association, held its first annual meeting in San Francisco Nov. 13, with about 75 members and guests present, representing the water departments of fifteen municipalities, the Railroad Commission and the Board of Fire Underwriters. Three papers were presented, as follows: "The Business End of the Waterworks," by O. E. Clemens, water sales manager, Spring Valley Water Co.; "The Centrifugal pump," by E. P. McMurtry, chief engineer, Krogh Pump & Machinery Co.; and "Chlorination in California," by Ralph Hilscher, state board of health, Berkeley. Chlorination experience in San Jose and Sacramento was reported by J. W. Ford and Livingston Jenks, respectively, and comments on loss in water systems was made by members familiar with the systems at San Diego, Pasadena and San Francisco. The morning session, closed by a round table discussion, was followed by a luncheon at the engineers' club and the afternoon was spent in an automobile trip over the peninsula properties of the Spring Valley Company.

The Engineers' Club of the Youngstown District will hold a regular meeting Nov. 30. The principal speaker will be F. C. Coey, general manager of the Celluloid Co. of America, who will deliver an address on "Celluloid: Its Manufacture and Uses."

Personal Notes

C. D. FLANIGEN, JR., has recently accepted a position with the Southeastern Underwriters Association, Atlanta, Ga., as engineer in the municipal service department. He was formerly mine engineer for the American Zinc Co. of Tennessee.

P. B. SPENCER, formerly assistant engineer of structures of the New York, New Haven & Hartford R.R. Co., has been made engineer of structures with headquarters at New Haven, Conn.

F. J. PITCHER, assistant engineer in the bridge department of the New York, New Haven & Hartford R.R. Co., has been promoted to the position of assistant engineer of structures with headquarters at New Haven, Conn.

P. S. SMITH of the U. S. Geological Survey, and E. A. Holbrook and O. P. Hood of the U. S. Bureau of Mines have been appointed by the Interior Department to serve on the American Engineering Standards Committee.

WILLIAM B. BAMFORD, consulting engineer, has been elected mayor of Belmar, N. J., and is planning the adoption of the borough-manager type of government. Mayor Bamford is a member of the American Society of Civil Engineers.

S. V. Roland, formerly superintendent of the Western division of the Chicago Great Western R.R. at Clarion, Iowa, has been transferred to the Northern division with headquarters at St. Paul, Minn.

H. S. Jones, valuation engineer, Gulf, Mobile & Northern R.R., has been appointed chief engineer with headquarters at Mobile, Ala.

Dudley P. Babcock, formerly assistant engineer, New York State Department of Highways, has been appointed assistant engineer, Bronx Parkway Commission, Bronxville, N. Y.

H. W. Williams, formerly assistant engineer in the electrical department, Chicago, Milwaukee & St. Paul Ry. at Seattle, has been appointed special representative to the general superintendent of motive power with headquarters at Chicago.

John S. Mitchell, formerly chief draftsman with Niles Forge & Mfg. Co., Niles, Ohio, has taken a position as chief engineer and assistant manager for Ohio Structural Steel Co. at Newton Falls, Ohio.

Curtis C. Coldwell, formerly connected with E. I. du Pont de Nemours & Co., as reinforced concrete designer, has taken a similar position with the Lackawanna Railroad.

E. Everett Harkness has resigned from the staff of the Emerson Engineers to accept a position as production manager with C. H. Root Co., Bristol, Conn.

Edwin D. Crumb, formerly in the engineering office of the Automatic Sprinkler Valve Co. of America, Youngstown, Ohio, has accepted a position as junior assistant engineer in the New York State Highway Department.

T. J. Strickler, chief engineer of the Kansas Court of Industrial Relations, has resigned effective Dec. 1 to accept a position as engineer for the Empire Gas & Fuel Co., Bartlesville, Okla.

E. O. Adee, recently assistant engineer on road work in Hamilton County, Kan., has been appointed resident engineer of Federal Aid Project No. 49 in Ottawa County, Kan.

L. K. Sherman, president of the American Association of Engineers, testified Nov. 10 before the Calder Committee on Reconstruction in Chicago. He presented facts regarding the housing shortage based on his experience as president of the U. S. Housing Corporation.

Howard L. Dick, acting city engineer, has been appointed city engineer, Kingston, Ont., Canada.

Lieutenant-Colonel W. C. Weeks, Corps of Engineers, U. S. A., formerly chief of the construction secton, under the engineer, 8th Corps Area, Ft. Sam Houston, Tex., has recently been assigned to duty as assistant to the district engineer at the Wilson Dam, Florence, Ala.

Ernest A. Taylor has resigned as district engineer for Fayette County, W. Va., and is now with the Missouri State Highway Department as project engineer, assigned to Division No. 1 at St. Joseph, Mo.

Allan F. Owen, for several years chief engineer for George C Nimmons & Co., Chicago, has opened an office as structural engineer in the Marquette Building, Chicago.

Frank Holbrook has recently been appointed superintendent of highways for Webster, Mass.

Obituary

Ward Baldwin, consulting engineer, died Nov. 15. He was professor of civil engineering at the University of Cincinnati for a number of years. He acted as consulting engineer for the Cincinnati Rapid Transit Commission and made a valuation of the properties of the Cincinnati Traction Co. for the city.

Thomas W. Clarke, engineer for the Standard Oil Co. of New Jersey, died in Tampico, Mexico, Oct. 28. He was born in Roxbury, Mass., 1872, and received his engineering education at Massachusetts Institute of Technology. Upon leaving college he was associated with Manning, Maxwell & Moore, New York. During the Spanish-American War he served as assistant to the chief engineer at the Mare Island Navy Yard. In 1902 he began his service with the Standard Oil Co. as plant engineer of the Eagle Works. In 1905 he was sent to China for the Standard Oil Co. of New York, where he was superintendent of construction and designing engineer in South China. In 1908 he returned to the United States and was assigned to the S. T. Baker Oil Co. to build a compounding and exporting plant for handling galena oils. He later supervised the construction of domestic trade plants for the Standard Oil Co. of New Jersey throughout the United States and Canada. In 1913 he left the service of the Standard Oil Co. to become vice-president and engineer, New England Foundation Co. During the World War he served as traveling engineer, Wood Ship Division, U. S. Shipping Board. In February, 1920, he re-entered the service of the Standard Oil Co. of New Jersey to do special engineering work. He was assigned to the Cia Transcontinental de Petroleo, S. A., arriving in Tampico, Mexico, March, 1920. While in Mexico, in addition to his company interests, he promoted the following projects not only to benefit the oil companies operating in Mexico but the whole community: Dredging of the Chijol Canal, increasing Tampico water supply, improvements to Tampico and Tuxpam harbors, and the cleaning up of Tampico and Tuxpam to prevent an epidemic of yellow fever.

Chester A. Thomas, engineer, died Nov. 11 at Dawson, Y. T., Canada. He was born in Los Angeles, Cal., 1874, and was graduated from Leland Stanford University, 1898. From 1899 to 1904 he was assistant engineer and chief engineer of mining operations, United Verde Copper Co., Jerome, Ariz. Later he was connected with the Montezuma Copper Co., Sonora, Mexico. From 1904 to 1906 he was in charge of mine examination for the Guggenheim Exploration Co. In 1906 he became resident manager, Yukon Gold Co., Dawson, Y. T., Canada. During his connection with this company his most important activities included the construction and operation of several hydraulic mines, seven gravel dredges, three electric grain elevators, a 2,500-hp. power-plant with 5-mile water system and 50 miles of transmission line.

Business Notes

Sues Engineering Company, structural engineers, announce the opening of an office in Chicago, Ill.

The Pacific Construction Co., the Pacific Dredging Co., and Loomis, White, Henry & McDonald have merged their interests with a capitalization of $5,000,000. Headquarters will be in Vancouver, B. C., with a branch in Montreal.

Clifford F. Messinger, for 11 years connected with the Chain Belt Company as Rex Mixer sales manager, advertising manager and assistant to the vice-president, has been appointed general sales manager for the company at Milwaukee, Wis.

R. F. Macdonald, formerly with B. F. Goodrich Co., Akron, Ohio, has joined the staff of Harrington, Howard & Ash, Akron, Ohio.

The Manistee Iron Works Co., Manistee, Mich., manufacturer of Roturbo centrifugal pumps, vacuum pumps, condensers, etc., has opened a Pacific Coast office in the Rialto Building, San Francisco which will be in charge of L. M. Page. The company expects to open branches also at Los Angeles, Portland and Seattle. These offices will also be under the supervision of Mr. Page.

Colonel Frank E. Smith has been elected director and first vice-president of the Republic Motor Truck Co., Alma, Mich.

Arthur G. Spurlock, for the past four years treasurer of the American Refractories Co., has been appointed treasurer of the H. H. Robertson Co., Pittsburgh.

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—James H. McGraw, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. Mehren, Editor

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Annihilating Space

FROM Cleveland, Ohio, to Mineola, L. I., a distance of 423 miles, in exactly three hours time, the record-breaking trip of a mail airplane on Nov. 19, is a fresh reminder of how space is being annihilated and the world made kin by the persistent efforts of the engineer in the field of transportation.

Commendable Water Saving

NOTWITHSTANDING a large increase in population the total pumpage at the Buffalo water-works on a recent day was two million gallons under the lowest previous record for some twenty years—thanks to waste preventive work. The actual figures were 97,340,000 on Nov. 14 last and 99,311,000 on Nov. 21, 1909. Compared with 1916, the saving of coal is nearly 1,500 tons a month. This is a commendable record. Philadelphia might well take note of it.

Highway Research

THOUGH a most important step has been taken, through the recent organization of the Advisory Board on Highway Research (see *Engineering News-Record*, Nov. 18, p. 1010) toward the accumulation, co-ordination and dissemination of problems relating to highway construction and economics, so many of which are yet indeterminate, too much stress cannot be laid upon the need that exists for getting under way. The time element is very important. The sooner the board begins to function, and the sooner it begins to publish the results of its research, the greater the benefit to highway organizations and the less the loss due to expenditures on unsound designs and methods. If the advisory board is to be of maximum value its permanent organization should be effected as soon as possible, and research be put under way with all reasonable speed.

French Reconstruction

FRENCH reconstruction, it is shown by official figures as of Oct. 1, 1920, continues at the high rate recorded previously in this journal. Of the 4,241 factories damaged or destroyed, 3,239, or 76 per cent, are again in operation, employing, however, only half as many men as they did before the war. Progress has been equally rapid in practically all industries, only food-product plants being notably below the average in percentage of rehabilitation. Agriculturally, too, the progress continues to be excellent. Probably less than 4 per cent of the churned-up land will be in crop next spring. The country's financial condition is not so encouraging, but the revenues have increased very largely. Add to these evidences of progress the swing away from radicalism on the part of French labor, and we get a hopeful industrial picture. If all other continental countries were doing as well, there would be no cause for the present legitimate discouragement over European industrial conditions.

A Common Misconception

CONDEMNATION proceedings to attain municipal ownership of water-works and other public utilities is frequently advocated. The Federal District Court at Fargo, N. D., has just ruled that the City of Bismarck has no authority to acquire the property of the Bismarck Water Supply Co. by that means. It might save other cities delay and expense to know that there are few if any cases on record of municipal acquisition of any privately-owned utility under a city's general authority to take private property for public use by condemnation.

The World's Debts

HUGE INDEBTEDNESS, it is generally known, has been one of the war's aftermath's, but it is not so widely appreciated that the indebtedness has continued to increase at a tremendous rate in the two years since the signing of the Armistice. Figures on the subject have just been compiled and published by O. P. Austin, of the National City Bank, New York. The world's national debts, which totaled 43 billion dollars in 1913, had increased to 212 billions at the close of the war. One year later the figure was 256 billions and in November, 1920, 300 billions. In other words, many governments are running on credit; their expenditures still exceed their receipts. In fact three-fourths of the governments of the world are showing budget deficits. Not only has the bonded indebtedness gone up, but the total of outstanding paper currency has increased. The figures are: 1913, 7½ billion dollars; at the Armistice, 43 billions; November, 1919, 55 billions; November, 1920, 82 billions. The ratio of gold to currency has, in the same period, dwindled from 66.3 per cent to 9.2 per cent. All money figures are computed at pre-war currency values, but all obligations and currencies of the Russian Soviet government are excluded. It is obvious that this condition of affairs increases the difficulties of commercial rehabilitation. Strenuous efforts are being made in most of the countries to balance budgets —a movement given emphasis at the recent Brussels financial conference of the League of Nations. To us the condition has a very practical interest, since the depreciated currencies are a handicap to our export trade. We shall have to finance Europe on a large scale to stimulate the export trade we are capable of supplying.

Industrial Standardization

IT IS INTERESTING to find that a recent discussion of standardization of motor car parts in our London contemporary, *Engineering*, makes the point that such standardization "is a trade matter rather than one for the British Engineering Standards Association." The statement is particularly significant because made in England, where very little industrial joint action to establish commercial standards of shape and size has

been possible, and where, on the other hand, centrally controlled standardization has been in active progress for nearly twenty years. The slowness of industrial self-standardization, in fact, was a main motive for the organization of the Engineering Standards Committee, now transformed into an association. Even today this trade standardization is so difficult and slow, over there, that our contemporary says, with a hopelessness rather out of harmony with the facts, "We do not know if this country will ever attain to it. It is possibly of too radical character to be accepted by our motor firms." That in spite of this statement the journal urges the motor trade to enter on the undertaking suggests that the association's work, in spite of its great scope, does not do away with the need for other standardization by the industries themselves. Many conditions existing in our own country support this conclusion. In fact, engineering and industrial standardization may exist side by side to mutual advantage, and possibly they have distinct fields of service, as the English writer assumes. If this latter be the case, a conscious delimiting of these fields would be eminently desirable. It would place upon each set of interests a definite responsibility for results within the limits marked out. Today there is no such clearly placed responsibility.

No General Code

CODES OF ETHICS are before the profession in a definite way because of the proposal of the chairman of the code committee of the American Society of Mechanical Engineers that there be a universal code for all engineers and architects. We do not believe that careful consideration will win support for this proposal among civil engineers. The feeling is widespread, and correct, that the point of view regarding professional standards differs essentially between the electrical and mechanical engineers on the one hand, and civil enginers on the other. It is inevitable that it should be so. The admixture of manufacturers and salesmen among the electrical and mechanical engineers, and the employment in technical capacities of so many of these engineers themselves by manufacturing enterprises, where the exigencies of selling the product are so constantly forced on them, produces in their circles a commercial atmosphere quite at variance with strict professional views. The feeling that there is a fundamental difference in point of view is becoming more, rather than less, emphasized and was one of the principal reasons for opposition to the civil engineers' entry into the federation. We need a code and we need enforcement, but results that the civil engineers should seek are not to be obtained through cooperative efforts.

Arkansas Road Boom

ONE OF THE PURPOSES of the Federal-aid highway acts has been to so strengthen highway administration in each state that road work may proceed along sound economic, engineering and administrative lines. The influence of the highway department, it was thought, would go beyond the Federal-aid roads themselves; the example was expected to be beneficial to every road building agency in the state. How much a strong influence is needed is shown in the example of Arkansas, whose highway situation is reviewed on page 1099. In a few years its projected highway expenditures have jumped from an exceedingly small figure to $56,000,000. The state highway department, save for Federal-aid projects, is powerless. All roads are built under specially organized road districts. The engineers are consultants, hired by commissioners who have little appreciation of engineering services, highway practice or wise handling of large sums of money. The results are just what one could have predicted—wild financing, bad highway practice, incompetent engineering. To date there must be much condemnation; praise only for the desire the Arkansas people show for wanting to get out of the mud. Evidently, though, as it appears from our article, there is an awakening. Some good work, it appears, has been and is being done. The need is felt for wiser expenditure and for close supervision by a competent authority. The latter, close supervision, can be attained without large state expenditures. Iowa did it very successfully. Arkansas may well follow her example. A continuance of the present course can only result in very heavy losses to the people of the state. The present depression, very severe in some parts of Arkansas, will help to bring about saner conditions.

Engineering Service Discredited

AS ONE of its eleventh-hour acts last month the Board of Estimate and Apportionment of New York City, in its revision of the municipal budget for the new fiscal year, lopped $3,000 from the salary of its chief engineer; the cut was from $12,000 to $9,000 a year. No justification for such a reduction exists, as the post is one demanding not only high technical qualifications but also sound business judgment, a thorough knowledge of municipal engineering and finance in all of their ramifications and a character capable of resisting political pressure brought to secure approval of public improvements of doubtful economic value. The action of the Board of Estimate, however, has a far wider significance than the mere reduction of the salary of a city employee. It can be interpreted only as open disparagement by the administration of the value of technical advice in matters involving the expenditure of millions. The board's action deserves to be condemned particularly at the present time when the salaries of professional men have lagged far behind the rising scale of living costs and, instead of reductions, merit substantial advances to maintain them on the same relative plane of compensation as existed prior to the war. The post of chief engineer of the Board of Estimate and Apportionment demands the best there is in the way of technical and administrative skill and has been ably filled for many years by Nelson P. Lewis, who retires from the city's service, at his own request, this month. If the Board's action was taken on the grounds of "economy" it has shot wide of the mark. Quibbling over a paltry few thousand—which are insignificant in the aggregate of the city's budget but which mean much to the incumbent of the office of chief engineer—the Board of Estimate has failed to appreciate the broader aspects of the problem, namely, that the proper kind of engineering advice demands adequate compensation and will save the city many times the salary of the chief engineer and his entire staff. It cannot be secured by the present unjustifiable policy of "economy." The situation is one involving a principle important enough to demand immediate action by local organizations of engineers. Engineering societies have interested themselves in getting salaries raised. Why then not try to hold that which they have!

The Pittsburgh Slide

EARTH slides and slips such as the exceptionally interesting one at Pittsburgh make appeal to laymen and engineers for precisely the same ultimate reasons. They break in with startling suddenness on our every-day belief in the stability of the ground on which we travel and build, and in their nature they remain largely strange and cataclysmic, even after full study. Nearly always they contain an element of dramatic interest, too, whether in the destruction done, or in the fight to check the movement, or in the very mystery of continued creep of solid earth in response to actions that proceed out of the range of our vision and in response to obscure laws. Fortunately the Pittsburgh slide is free from the element of destructiveness, and for the time being it claims attention mainly because of the aggressive fight being made to master its progress in order that complete blocking of a railway trunk line may be prevented. At a later stage, when permanent control of the slide area is undertaken, the nature of the earth movement will have better opportunity to be studied, and deductions may become possible that can be applied elsewhere in foreseeing, preventing or controlling slides. For the present the case brings us face to face with the fact that slides especially of the flowing type are unknown phenomena in the sense that they are not amenable to prediction or to measurement; yet at the same time we know them to be related closely to other facts in the physical behavior of soils, with which the engineer is constantly concerned. Our working concepts of soils are fitted to the behavior of a normal talus slope, a mass whose superficial particles are the first to move under any disturbing influence, but they help us little in understanding how a sloping mass with stable surface may have an unstable interior in spite of the fact that every particle there is restrained by its neighbor. It is likely that the next decade or two will bring fuller investigation of earth, that will throw light on phenomena now hopelessly obscure. Until that time most slides are bound to contain a large ingredient of mystery, and we cannot hope to deal with them by other than empirical methods, and after the fact.

Hoover in a New Role

HERBERT HOOVER'S acceptance of the presidency of the American Engineering Council, the governing body of the Federated American Engineering Societies, will mean more to that organization than the inspiration of a strong leadership, important as that may be. By no other means could the engineer and his work be brought more effectively to the notice of the general public, for Hoover is *news* and any movement with which he associates himself is sure to receive recognition by the daily press, which is one of the important means by which the public can find out what the engineer is doing. One of the certain results of Mr. Hoover's work with the federation will be to make the engineer a much more important figure in the public eye than he is now. This result is urgently needed. The day after his election at Washington the big metropolitan dailies devoted much space to the proposed industrial wastes survey which he suggested as the federation's first contribution to public service and gave to the engineering profession, as a whole, invaluable publicity. In marked contrast to the recognition accorded by the press to the first meeting of the American Engineering Council are the annual meetings of other engineering societies which, if they receive any notice whatever, are dismissed with a paragraph or so, generally constituting a "filler" in some inconspicuous space at the bottom of a column. It is not to be inferred, from the foregoing, that the chief aim of engineering organizations should be to have their activities reported by the daily papers. Nevertheless that result is very much to be desired, for it is a reflection of the importance with which their efforts are regarded by the world at large.

Electrification Cost Data

DEFINITE and authoritative information as to the net financial results of the Chicago, Milwaukee & St. Paul Ry. electrification, described on p. 1063, would be of the utmost value to those promoting and considering other projects for electrification, but although it is stated officially that all results are such as to warrant further application of electric traction no actual figures of these results have been made public. The electrification on the above road is of special importance from the great length of line operated and from the fact that it is a main line and not a terminal or suburban electrification. Further, the first 440-mile section has been in operation long enough to give some really reliable data.

Accepting without reservation the statement of the railway officials as to the successful results of operation, it is difficult to see why there should be such reticence as to the figures upon which the statement must be based. This reticence must tend to retard development, since engineers and executive officers cannot be expected to enter upon costly projects without some more substantial information as to actual experience on earlier projects. As a bold pioneer in long-distance main-line electrification the Chicago, Milwaukee & St. Paul Ry. is in a position to render exceptionally valuable assistance.

In respect of operating results the recent engineering discussion on steam and electric traction was barren (see *Engineering News-Record*, Oct. 28, pp. 823 and 853). It is unfortunate that the advocates of electric traction have devoted so much energy to disparaging the steam locomotive, their arguments being largely of a destructive rather than a constructive character. Great as the advantages of the electric locomotive may be its introduction must of necessity be slow and gradual. No engineer or railway man believes that the steam locomotive is within sight of being obsolete or that it has reached the limit of its development. The aim of the electrical engineer is, or should be, to show how and where and why the electric system may produce eventual economic and other advantages which will more than offset the heavy investment and the scrapping of costly existing plant. It is not difficult to do this for certain conditions of congested main-line traffic, terminal traffic, suburban service, long or numerous tunnels or heavy grades. It is much less easy to show convincingly an argument for electric traction for open main-line operation.

The description of the Chicago, Milwaukee & St. Paul Ry. electrification is of wide interest, but its value would have been increased a hundred-fold if the desired information had been made available as to investment cost, maintenance charges, operating expenses and the balance between the net cost of steam and electric traction under practically identical conditions.

Chicago, Milwaukee & St. Paul Railway Electrification

With Section Opened This Year Total Is 647 Miles, Including Heavy Grades Over Five Mountain Ranges —Types of Locomotives—Reported Operating Results

WITH the opening this year of the 209-mile electrified division of the Chicago, Milwaukee & St. Paul Ry., from Othello to Tacoma, Wash., the total length of electrification on the Milwaukee is 647 miles of main line, or 860 miles of track including passing tracks and sidings—by far the greatest in extent of electrification on any one railroad. The 438 miles between Harlowton, Mont., and Avery, Idaho, were put in electric operation January, 1916. The shorter line is operated as a single division and the longer line constitutes two divisions. Each electric division includes two divisions formerly operated by steam locomotives, as the necessity of cleaning fires of such locomotives limited runs to about 100 miles. The two electrified sections are separated by a stretch of 212 miles which is still operated by steam. This section does not present the severe operating conditions which obtain on the two adjacent sections.

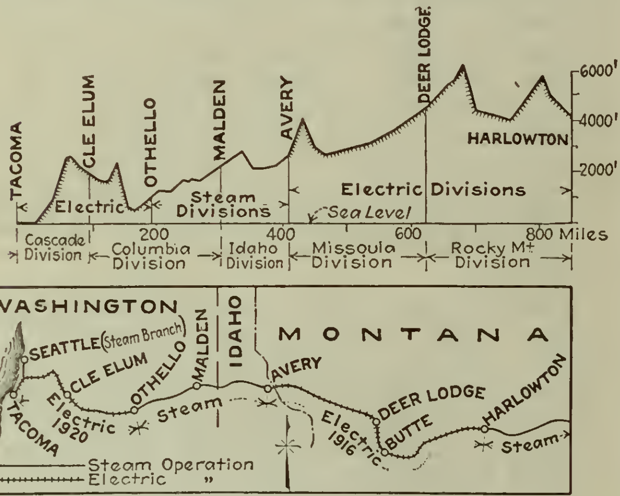


FIG. 1. ELECTRIFIED SECTIONS OF CHICAGO, MILWAUKEE & ST. PAUL RY.; 647 MILES

From Harlowton to Avery three mountain ranges of the continental divide are crossed, with summit elevations of 5,788, 6,322 and 4,150 ft. Heavy grades and a large proportion of curvature are encountered, the maximum grade being 2 per cent for 21 miles and maximum curvature being 10 deg. on the main line. Of 36 tunnels the longest is the $1\frac{1}{2}$-mile St. Paul Pass tunnel through the Bitter Root range. This 440-mile stretch of electrification was described in *Engineering News* of Jan. 7, 1915, p. 22, and July 6, 1916, p. 24, and in *Engineering Record* of Oct. 23, 1915, p. 518.

The newer electrified division extends west from Othello, Wash., to Tacoma, 209 miles, with a 9-mile branch from Black River Junction to Seattle which has not yet been converted to electric traction. This division crosses two summits of the Cascade range at Boylston (El. 2,390 ft.), and in the Snoqualmie tunnel (El. 2,564 ft.), as shown by the profile, Fig. 2. Westward, the maximum grade is 2.2 per cent for 18 miles to the Boylston summit, followed by a descent of 1.6 per cent. Grades to the Snoqualmie summit are relatively easy, 0.4 to 0.7 per cent. On the western slope, however, there is a descending grade of 1.74 per cent for about 20 miles, followed by a ruling grade of 0.8 per cent for 25 miles, the latter bringing the line down to the coastal plain. There is about the same proportion of curvature as on the Rocky Mountain electrification, with the same maximum of 10 deg. for main track curves.

Power Supply and Transmission—Current for the Cascade electrification is purchased from the Intermountain Power Co. and is transmitted from the plants of two supplying companies. A transmission line of 113 miles extends from the Long Lake plant of the Washington Water Power Co. to the railway substation at Taunton, Wash. Two lines extend from the Snoqualmie Falls plant of the Puget Sound Traction, Light & Power Co. to the substation at Cedar Falls and Renton, ten and twenty miles respectively. The second of these lines continues 26 miles to the last substation at Tacoma

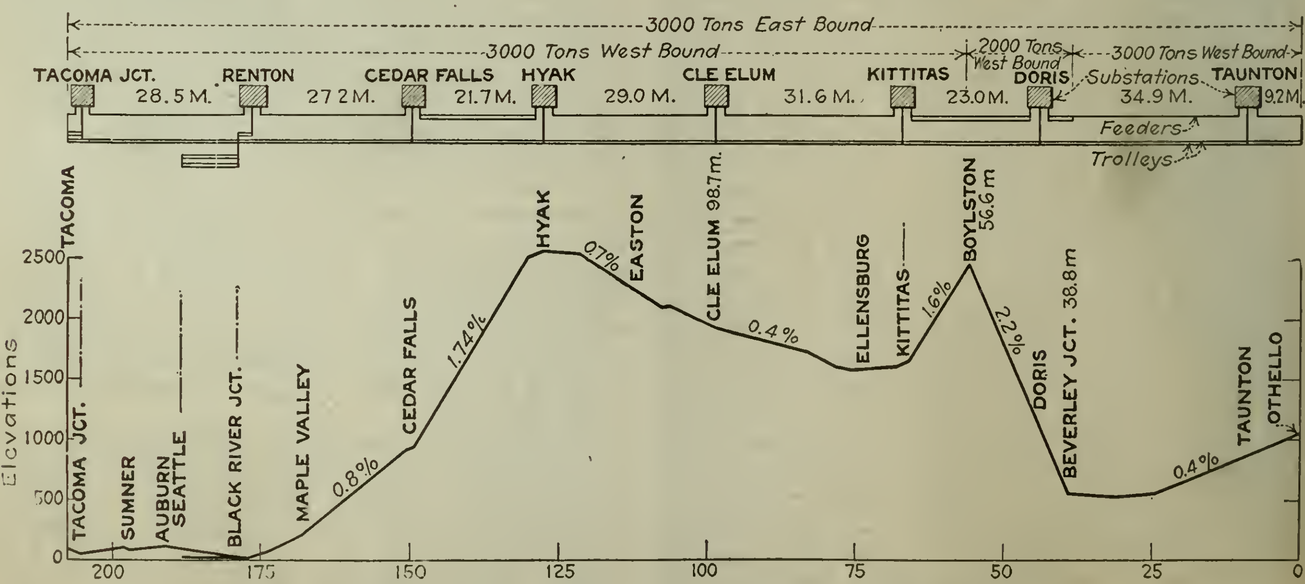


FIG. 2. PROFILE OF CASCADE ELECTRIFICATION OPENED THIS YEAR

Junction. There are eight substations, each with either one or two motor-generator sets of 2,000 kw., and space for an additional set.

FIG. 3. PASSENGER TRAIN ASCENDING THE WESTERN SLOPE OF THE CASCADE RANGE

Transmission lines from the power plant are carried by steel towers and wood poles. Those along the railway are carried mainly by 50-ft. wood poles with an average spacing of about 300 ft. The trolley line on main track consists of two parallel wires hanging side by side, thus giving greater flexibility and greater area of contact than a single wire. These wires are suspended by hangers from a catenary cable carried by bracket arms on single poles or by span wires between pairs of poles. On tangent line and single track poles are spaced 150 ft. For passing and yard tracks a single trolley wire is used. Current at 100,000 volts on transmission lines is stepped down to 3,000-volt direct current for the trolley wire. For the return circuit the 90-lb. track rails are supplemented by a wire carried on the poles and connected to the rails at intervals of about 8,000 ft. This wire connection serves to compensate for defective or broken rail bonds. Regenerative control or braking is a feature of the electric system, as on the older line, the motors acting as generators when the train is descending grades and delivering current to the trolley line. In this way the speed is controlled by the current returned to the line, the air brake being used mainly to stop the train and as an auxiliary while running. Automatic block signals are installed on both districts.

Locomotives and Traffic—Electric locomotives of two radically different types are employed, mainly for the reason that after extended investigations it was considered desirable to have service experience with these types under the actual operating conditions of the line. The motive power equipment of the two districts comprises 15 passenger engines, 42 freight engines and four switching engines. On each district the traffic averages two passenger trains and from three to four freight trains in each direction daily.

Freight locomotives are of the 4-8-8-4 type, composed of two connected units. Those used on the new line were formerly passenger engines on the older line, the gear ratio having been changed for freight service. In the original equipment of the older line the passenger engines were similar to the freight engines, except for a lower gear ratio, since it was thought that a suitable type of engine for passenger service should be determined on the basis of actual electric operation, the older passenger locomotives being then converted for freight service. These engines have 52-in. driving wheels with a motor of 375 hp. (continuous rating) geared to each axle. Freight train tonnage varies from 2,500 tons on 2 per cent grades to about 5,000 tons on grades of 0.4 per cent, helpers being employed on continuous grades of over 1 per cent. For passenger service, fifteen new locomotives were built in 1919, five being used on the new line and ten on the older line. They are of two different types, but are all designed to meet the railway company's requirements for hauling a train load of 950 tons (twelve steel cars) at 25 m.p.h. on grades of 2 per cent and 30 to 37.5 m.p.h. on grades of 1 per cent. The maximum speed is 65 m.p.h. on level tangents and the engines have to be sufficiently flexible to pass curves of 16 deg. in yards as well as 10 deg. main-line curves. Current is taken from the trolley line by pantagraph collectors.

On the newer Othello-Tacoma line there are five General Electric passenger locomotives having 24 driving wheels, with a two-wheel truck at each end. The wheels are grouped in four trucks with articulated connections. Each of the end trucks has six wheels, four of which are drivers while the end wheels have lateral play and have no motors. Each of the two inner trucks has eight driving wheels. The two cabs for apparatus and operating crew are integral with the eight-wheel trucks, the front of each cab being supported by rollers on its six-wheel truck. The heater cab in the middle is supported by a three-point suspension from the inside ends of the two main cabs and is carried entirely free of the trucks. Thus the locomotive forms a single and inseparable articulated unit, having both the trucks and the cab articulated. These engines are of the gearless type, with a bi-polar motor of 250 hp. (continuous rating) on each driving axle (see *Engineering News-Record*, Dec. 11, 1919, p. 1034). One of these is shown in Fig. 3.

For the Harlowton-Avery line, there are ten Westinghouse-Baldwin passenger locomotives (Fig. 4) having a 4-6-2-2-6-4 wheel arrangement (with twelve driving wheels), the running gear being composed of two separate 4-6-2 units coupled back to back but not articulated. A single cab is mounted on these two units. Each unit, with its six driving wheels, has six twin motors, each motor frame housing two armatures. The pinions of these two armatures engage a single gear mounted on a quill which surrounds the driving axle, the torque

FIG. 4. ELECTRIC LOCOMOTIVE WITH PASSENGER TRAIN AT BUTTE, MONT.

being transmitted to the driving wheels by helical springs fitted between the arms of the quill and the spokes of the wheels. The motors, which have a continuous rating of about 540 hp., are mounted on the frame of the locomotive.

In these Westinghouse engines, therefore, the six driving axles have six motors with twelve armatures, while in the other design each of twelve axles has a single motor. The main dimensions of the two types of passenger engines are given in Table I. Each engine has an oil-fired boiler with capacity of 4,000 lb. of steam per hour for heating the engine and train, and air-compressor capacity of 150 cu.ft. per minute for the brakes, pantagraphs and other equipment.

TABLE I. ELECTRIC PASSENGER LOCOMOTIVES; C., M. & ST. P. RY

	Westinghouse	General Electric
Wheel plan	4-6-2-2-6-4	2-4-8-8-4-2
Driving wheels, diameter	68 in	44 in.
Truck wheels, diameter	36 in.	36 in.
Weight on drivers, in working order	345,000 lb.	492,000 lb.
Weight, total, in working order	562,000 lb.	551,000 lb.
Non-spring borne weight per driving axle	7,800 lb.	9,500 lb.
Total wheelbase	79 ft. 10 in.	67 ft. 0 in.
Maximum rigid wheelbase	16 ft. 9 in.	13 ft. 11 in.
Number of driving axles	6	12
Number of motors	12	12
Total tractive effort; 1-hr. motor rating	66,000	46,000
Total hp., one-hour motor rating (contract)	4,000	3,240
Total hp. continuous (contract)	3,200	3,025

Operating Results—In most respects the general results of electrification have exceeded expectations and in no case have they fallen below the expectations, according to R. Beeuwkes, electrical engineer of the railroad. He states that even allowing for the increased investment charges the items of operating expense depending directly upon motive power are so reduced and the additional benefits indirectly obtained are so great as to justify consideration of extending the electrification even on sections with easier grades.

A summary of cost of electrification on the older line in 1914-16 has been given recently by Mr. Beeuwkes, this cost being considered more representative than that on the new line, where the work was done under conditions of delay and difficulty due to war conditions in 1917-18. The figures in Table II cover the work for 440 route miles, 364 miles of transmission line (exclusive of lines built by the power companies), 14 substations with a total capacity of 59,500 kw., 12 passenger locomotives, 30 freight locomotives and two switching locomotives. The figures in the table are intended mainly to show the relative importance of different items; they could not be applied in estimating the cost of similar work without a knowledge of the unit prices.

TABLE II. CONSTRUCTION COST FOR 440 MILES OF ELECTRIFICATION, 1914-1916; C., M. & ST. P. RY.

	Average Cost Per Route Mile	Average Unit Costs	Per Cent of Total Costs, Exclusive of Locomotives
Trolley system complete	$8,390	....	47.7
Transmission system, complete	2,360	....	13.3
Transmission line, per mile	....	$2,835	...
Substations, complete	6,050	....	34.4
Substations, each	....	189,400	...
Substation buildings	....	38,400	...
Substation apparatus	....	144,900	...
Operators' dwellings	....	6,100	...
Miscellaneous: Right of way, change to electric lines, storehouses, minor apparatus at shops and roundhouses	265	....	1.7
Engineering and administration, except for substations	514	....	2.[illegible]
Road locomotives, delivered	....	122,500	.
Switching locomotives, delivered	....	37,700	..
Total per route mile (exclusive of locomotives)	17,579	....	100.[illegible]

In Table III are shown comparative operating costs of freight traffic on the two older electrified divisions and the two steam-operated divisions adjoining them during the second half of 1918. For the purpose of comparison the figures for the Missoula electric division are taken as unity. Besides the more important reasons for the advantageous results of electrical operation, Mr. Beeuwkes considers that further improvement in operating cost is to be expected under normal conditions of operation. The marked decrease in cost of engine repairs is due to the fact that the cost of repairs per engine mile is much less for the electric locomotives than for the average steam locomotive replaced, and that the number of engine miles per 1,000 ton miles is also less on account of the greater capacity of the electric locomotive. On the Missoula division the total of engine miles per 1,000-ton miles was only about

55 per cent of that for the corresponding period in 1915 under steam operation.

TABLE III. COMPARATIVE OPERATING COSTS OF FREIGHT TRAFFIC (PER 1,000-TON-MILES); C., M. & ST. P. RY.: JULY-DEC. 1918

Division	Idaho	Missoula	Rocky Mountain	Musselshell
Motive power	Steam	Electric	Electric	Steam
Locomotive repairs	2.34	1	0.86	2.26
Train crews	3.05	1	1.46	1.61
Engine crews	2.17	1	1.30	1.21
Fuel or power[1]	2.34	1	1.04	1.38
Enginehouse	2.50	1	0.80	3.71
Yard service[2]	1.12	1	0.99	0.71
Total of items affected by motive power[3]	1.90	1	1.11	1.33

Note: Cost on Missoula Division taken as unity.
1. The item of "Fuel" is based on the average price for the system.
2. Considerable part of the switching was done by steam, as a sufficient number of electric switching engines had not been received.
3. In addition to the items tabulated this covers superintendence and maintenance of substations, transmission and trolley systems, water and fuel stations, shops and enginehouses; also locomotive and train supplies.

Reduction in expense for train crews is due to increased tons per train-mile and increased train speed. The expenses on the Missoula division were about 10 per cent less in 1918 than in 1915, but on the Idaho steam division they had more than doubled, according to Mr. Beeuwkes. For the expense of engine crews the same conditions obtain; with only a slight increase from 1915 to 1918 for the Missoula electric division but an increase of about 100 per cent for the Idaho steam division.

The relative reliability of electric and steam operation is considered an important point. Records for the six months from Oct. 1, 1919, to March 31, 1920, show that the 440 miles of electrically-operated territory had less delay than four steam divisions aggregating 945 miles, except for the steam divisions from Avery to Cle Elum, which are particularly favorable as to climatic, topographical and other conditions tending to cause delay. A summary of these results in three districts is shown in Table IV.

TABLE IV. RELIABILITY OF STEAM AND ELECTRIC FREIGHT TRAIN SERVICE

(Time in minutes per mile of line operated for six months).

	Marmouth to Harlowton	Harlowton to Avery	Avery to Cle Elum	Average for Four Steam Divisions
Miles	340	440	325	945
Motive power	Steam	Electric	Steam	Steam
Train delays affected by motive power (*A*)	62.95	52.73	35.34	74.75
Train delays not affected by motive power (*B*)	37.85	46.30	33.86	46.77
Total	100.80	99.03	69.20	121.52
Accidents and derailments (Included in *A*)	2.25	0.15	3.85	.....
Time lost	69.7	8.94	0.00	.....
Time made up	35.6	100.0	81.00	.....

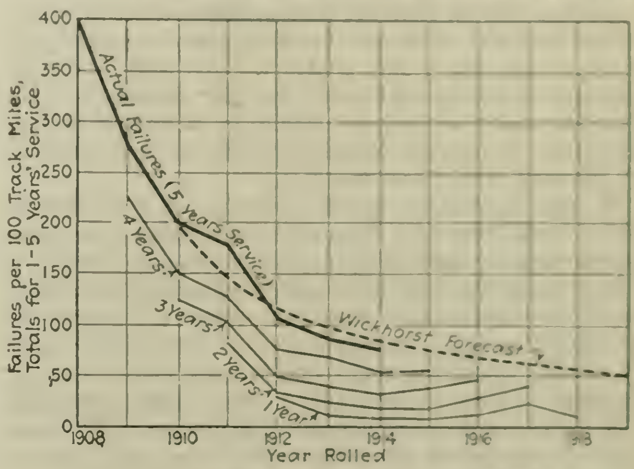
A. Delays due to other trains, signals, slow orders, excess time in switching, extra cars on train, bad weather, poor coal, trolley and substation defects, engine conditions, and accidents and derailments due to engines.
B. Delays due to waiting for connecting trains, handling heavy mail and express, extra stops, car conditions, slides, snow and accidents not due to engines.

Records for the year 1919 show that with a freight traffic of 2,476,085,000 gross ton miles behind the engines, the cost per kw.-hr. per 1,000 ton miles was 22.3c. For 378,080,000 passenger ton miles, the cost was 38.1c. per kw.-hr. per 1,000 ton-miles. The cost of power, including operating and maintenance expenses of substations and transmission lines, was 1.1c. per kw.-hr. as delivered at the locomotive.

This electrification work is under the direct charge of R. Beeuwkes, electrical engineer, Chicago, Milwaukee & St. Paul Ry.

Decrease in Rail Failures Confirmed by Latest Statistics

PUBLICATION of the 1919 rail failure statistics prepared by M. H. Wickhorst, engineer to the Rail Committee of the American Railway Engineering Association, in a bulletin just issued by the association, confirms with astonishing accuracy forecasts made four or five years ago concerning the probable future improvement in rail service. In the diagram herewith is repro-



RAIL FAILURES FOR PRINCIPAL CARRIERS

duced from the bulletin the curve of rail failures during the sixth year of service (marked five years' service), and for comparison with it the forecast made by Mr. Wickhorst several years ago (shown by dash lines). In addition the curves of failures after four years, three years, two years and one year of service have been plotted from the tables in the report. The abscissa in every case represents the year during which the rails in question were rolled. The several curves are quite consistent. All of them show a hump at the year 1912, and a further abnormal rise for the years 1916 and 1917.

The data of the tables cover about 85 railroads, including all the large systems of the United States and Canada and a considerable number of the shorter lines. Ten rolling mills are represented as producers of the rails. Both bessemer and openhearth rail are included, but the former is increasingly unimportant in the later rollings. Only rail lots of 1,000 tons or more were used in the tabulations, as it was concluded that a lot of less than 1,000 tons furnished by a given mill to a given railroad in one year would not affect the group totals and averages. Reduction of the data to 100 miles of track covered by the particular rolling brings the resulting figures to a uniform basis.

In the report are included detail tables and diagrams showing the performance of each lot (of 1,000 tons or over) of rail furnished by each mill to each railroad in a particular year, and summing the results for railroads and for mills in various ways. Irregular variations occur in all these summaries, however, none of them apparently tending to point in the direction of the main responsibility for rail weakness. The only consistent feature of the records is the continuous improvement shown by the diagram here reproduced. It means that the rate of failure of rails, amounting to nearly 400 per year per 100 track-miles for 1,908 rails after five years of service, has been decreased by more than 80 per cent in seven years.

Garbage Disposal in the District of Columbia

Operations for the Year Ending June 30, 1920, Reviewed—Estimates for Disposal by Pig Feeding, by New Reduction Works and by Improvements to Existing Works, Point to Latter as Most Economical

By F. S. Besson
Major, Corps of Engineers, U. S. A., Assistant to the Engineer Commissioner of the District of Columbia.

FOR the City of Washington the actual handling of garbage has been a municipal function since July 1, 1918, at which time the past practice of performance by contract had to be abandoned because of inability to make a satisfactory new contract. This work is one of the four major operations of the City Refuse Division that are today carried out wholly by municipal forces. The four are street cleaning, collection and disposal of garbage, ashes and trash.

2. The population of the District of Columbia is 437,500 and the land area 60 square miles. Garbage is not collected from outlying thinly populated sections. The area of the city from which collections are made totals 45 square miles, having an estimated population of 400,000 people. During the fiscal year ending June 30, 1920, collections were made from 62,200 private residences, 825 apartments, 400 lunch rooms and cafés, 135 hotels and miscellaneous institutions, 975 combination residences and stores and from 2,075 stores; a total of 66,610 places.

3. Throughout the year and previously during the war, the transportation by private individuals of table refuse to points outside of the District of Columbia was permitted. This license was taken advantage of by a number of pig feeders and always caused more or less unsatisfactory conditions. Also these private collections meant a real loss to the District in that the pig feeders selected only the garbage richest in fats from cafés and similar places, leaving for the District forces all the smaller lean collections. The amounts taken for these private enterprises fluctuated greatly from day to day and varied with the seasons of the year. The collectors had no responsibility; they would sell their pigs and with notice to no one discontinue collections with resultant complaints by the Health Department and calls upon the City Refuse Division for emergency collections.

4. The appropriation act for the fiscal year ending June 30, 1921, contains a provision repealing the law that permitted private collections and now the District has full control over all table refuse in the city. It is estimated that this repeal will add at least 10 per cent to what the collections would otherwise be under former conditions. Garbage service is rendered daily by the City Refuse Division during the months April to October inclusive and three times a week during the remainder of the year. The maximum monthly collection during the fiscal year ending June 30, 1920, was 5,863 tons during August and the minimum 3,401 tons during February. The total for the year was 52,800 tons, or 1,585 lb. for each of the 66,610 premises; or 264 lb. per capita based upon the 400,000 from whom collections are made.

5. The dividing line between collection and disposal is taken as being immediately after the transfer station receives the garbage from the collecting units and delivers it to the transportation equipment belonging to the disposal plant. Disposal therefore consists of (1) transporting the refuse from the central transfer station located at New Jersey Ave. and K St. S.E., within the city, to the reduction plant at Cherry Hill, which is on the Richmond, Fredericksburg & Potomac R.R., 31 miles south of Washington; and (2) extracting grease and reducing the garbage to tankage for fertilizing purposes.

6. In 1918, when the work was first started by city forces, plant and equipment were obtained from the contractor who had previously had it in hand. Most of the property was very old and almost worn out. The reduction plant had been used for twenty years continuously for the disposal of Washington's garbage. The amount paid the contractor was $49,890. Making allowance for depreciation and betterments during the year, it may be estimated that the value of the reduction plant on July 1, 1919, the beginning of the fiscal year, was $50,000, and of the transportation equipment, $8,000.

7. The city, at the beginning of the year, July 1, 1919, owned 16 rack cars, all of which were so old that not more than 50 per cent of them could be maintained in service at any one time. A rack car is capable of carrying approximately 20 of the wagon bodies in which the garbage is collected. These bodies are of sheet metal and hold slightly more than 2 cu.yd. or 1.4 tons of refuse each. They are lifted bodily from the running gear of the wagons and replaced by empty ones. This number of rack cars is not sufficient and therefore gondolas are rented from the railroad company. The garbage is dumped from the collecting units into these, a large gondola holding about 55 tons. The transportation account for the year totaled $29,243, itemized as follows:

Six per cent interest on investment of $8,000	$480
Twenty-five per cent depreciation of $8,000	2,000
Repairs and maintenance	2,400
Gondola rental at $3 per day	5,268
Freight, 1,273 car trips at $15 per round trip	19,095
Total transportation expense	$29,243

52,800 tons carried at a rate of 55½c. per ton.
Value of equipment July 1, 1920—$6,000.

8. Upon arrival at Cherry Hill the tank bodies are hoisted to the second floor of the plant and emptied onto the receiving platform. In the case of gondola cars a clam-shell bucket is used for raising their contents. The garbage is cooked in Chamberlain digestors and pressed in Thomas-Albright hydraulic rack presses. The liquids are passed through settling and skimming basins and the grease removed. The pressed cake is dried in a direct heat dryer and sold as tankage. The plant account was as follows:

Six per cent interest on investment of $50,000	$3,000
Twenty per cent depreciation of $50,000	10,000
Rent for land	416
Total	$13,416
Value of plant July 1, 1920	$40,000

9. The operating account, including force for repairs and maintenance, for reduction was as follows:

Supervisory:		
Administration	$3,000	
1 Superintendent	2,740	
1 Assistant	2,340	
1 Timekeeper and clerk	1,200	
2 Watchmen	3,000	
		$12,280

POWER PLANT AND REPAIR SHOP:		
3 Engineers	$5,320	
3 Firemen	5,200	
5 Laborers	6,600	
1 Seamstress	350	
		17,470
UNLOADING RAW GARBAGE:		
1 Engineer	$1,660	
6 Laborers	8,300	
		9,960
COOKING AND PRESSING:		
3 Cookers	$4,500	
8 Pressmen	9,800	
18 Laborers	18,800	
		33,100
DRYING SECTION:		
1 Fireman	$1,560	
5 Laborers	7,950	
		9,150
MISCELLANEOUS:		
1 Foreman	$1,250	....
1 Greasman	1,650	
9 Laborers	12,800	
		15,700
Total operating account		$98,020

10. Expenses for supplies, including those for repair and maintenance, were as follows:

Unloading	$1,284
Boiler room	31,886
Engine room	4,799
Pressing equipment	33,007
Drying	1,433
Miscellaneous	5,255
Total supplies	$77,664

11. The total expenditures for disposal of the city's garbage were therefore comprised of the following:

Par. 7.	Transportation	$29,243
Par. 8.	Reduction plant	13,416
Par. 9.	Operating account	98,020
Par. 10.	Expenditures for supplies	77,664
	Total disposal charge	$218,343

The 52,800 tons collected were thus disposed of at a rate of $4.15 per ton.

12. In treating pressed cake in order to make a salable tankage a residue of cans, metals, paper, etc., called tailings, is obtained which during the year amounted to approximately 2,500 tons or 4.7 per cent of the total. Since the plant is equipped with neither magnetic separator nor grinder the tailings in a combined state had to be wasted on a near-by dump. From the settling basins after removal of the grease a liquid called tank water had to be wasted. The grease extracted amounted to 1,853,496, or 35 lb. per ton of raw garbage, a grease salvage of 1.76 per cent. It sold for an average of 9.7c. per lb. Tankage amounted to 3,048 tons or 0.058 tons per ton of raw garbage, a showing of 5.8 per cent. It sold for an average of $12.11 per ton. By percentages the garbage analysis was therefore: Grease, 1.76; tankage, 5.8; tailings, 4.7; stick, moisture lost in cooking, etc., 87.74. Receipts from sales summed up as follows:

1,853,496 lb. grease	$179,668
3,048 tons tankage	36,922
Total receipts	$216,590

For the 52,800 tons of raw garbage collected, receipts were obtained at the rate of $4.10 per ton.

13. Total charges were $218,343. Total receipts, $216,590, and the balance of $1,753 shows the cost to the district for garbage disposal. Based upon the 400,000 from whom collections were made the per capita cost per annum was slightly less than one-half cent. On a tonnage basis the figures are:

Par. 11.	$4.15 per ton charges.
Par. 12.	4.10 per ton receipts.
	.05 cost to District.

14. There is a feeling current that the Washington reduction plant has passed its economic period and that its continued use is but a temporary expedient. It has been proposed that disposal should be by sale to pig feeding contractors. An alternate proposal has been the building of an entirely new plant at a location other than the present, and also a combination of these two schemes has been contemplated. In addition, in the paragraphs following, consideration is given to an elaboration of the present plant as advocated by both Mr. Hacker the Supervisor of City Refuse, and Mr. Crane, the Superintendent of Garbage Reduction. It must be realized that garbage disposal is not carried on because of its profit-making possibilities. It is one of the essentials of city life and only such economies may be considered as are justified from the standpoint of public health and welfare.

15. Under the law garbage may not be fed to pigs within the limits of the District of Columbia. A farm for the purpose would of necessity therefore be located either in Maryland or in Virginia and the persons handling the enterprise would have to be conversant with and adhere to the laws of the state relative to the admission, quarantine and maintenance of pigs brought therein for feeding purposes. It may be considered that transportation from the city transfer station to the farm might be either by rail or by truck, though it will be found that a site suitable for either is very difficult of obtainment. In the case of rail haul, by taking over the District's present equipment, the contractor's shipping expense, if his farm were located within the minimum rate area, would be 55½c per ton. If the pig farm were so located that rail shipment could not be made, trucks would have to be used, in which case it may be stated that a location could not be found with a haul sufficiently short to permit more than a maximum of three trips daily for each truck, which operating experience shows would be about 800 trips per year.

16. If a fleet of 5-ton dump trucks were used charges per year for each would be as follows:

Drivers wages	$1,[illegible]
Depreciation (20 per cent on $6,000)	1,[illegible]
Interest (6 per cent on $6,000)	360
Insurance	[illegible]
Garage	[illegible]
Maintenance, minor repairs, and supplies	[illegible]
Complete overhaul once a year	[illegible]
License fees	[illegible]
Tires	[illegible]
Lubricants	150
Gasoline	1,[illegible]
Total for 800 trips	$6,[illegible]
One trip with delivery of 5 tons of garbage	$[illegible]
Rate per ton	1.[illegible]

A scheme using trailers might be worked out satisfactorily under the city's traffic regulations to do this hauling at somewhat less than the above but in any case the rate would be much above that of 55½c. for rail transportation.

17. The City of Washington is in a position to guarantee to a contractor two conditions vital to garbage feeding: (1) Excellent separation. The municipal regulations are sufficient for this purpose at present and are enforced, so that the presence of ashes and trash in the garbage is minimized. (2) All the garbage accumulated in the city where collection service is rendered would be supplied the contractor (see par. 4). He would not lose the rich garbage because of private collections. His supply would be steady and affected by seasonable conditions only and not by the erratic collections of miscellaneous pig feeders. Feeding tests under District of Columbia conditions give the following data pertaining to such an enterprise as is under discussion. An average of 7,000

pigs is necessary for the daily consumption of 52,800 tons of garbage; 7,000 feeders, 105 lb. each, at 15c. per lb. require an investment of $110,250. Complete installation for farm @ $10 per pig is $70,000. The herd should have a complete turnover three times yearly, the pigs selling at a weight of 225 lb.

YEARLY DEBITS

Purchase of 21,000 pigs, each 105 lb., at 15c.	$330,750
Six per cent interest on feeder investment, $110,250	6,615
Six per cent interest on installation investment, $70,000	4,200
Ten per cent installation depreciation	7,000
Farm rental	1,000
Immunization and dipping at $2 per pig (21,000 annually)	42,000
Shipping and quarantine costs at $2 per pig	42,000
Medical attention at 50c. per pig	10,500
Five per cent of 21,000 or 1,050 pigs lost, sickness, etc.	16,537
Labor at $1.50 per pig	31,500
Transportation, 52,800 tons at 55½c.	29,304
Six per cent on working capital of $100,000	6,000
Premium on surety bond	1,000
Overhead	15,000
Total debits	$543,406

The sum realized from the sale of 19,950 pigs, each weighing 225 lb., @ 15c. per lb, amounts to $613,312, showing a yearly credit balance of $129,906.

18. This analysis tends to the belief that certainly a prospective pig feeding contractor would be willing to pay a considerable sum for raw garbage f.o.b. his transportation equipment at the District's transfer station. Prior to accepting such a conclusion as final it should be noted that the data which have been presented are based on favorable circumstances and good pig management, two conditions that the history of garbage feeding shows are not often existent. It has been assumed that the selling price per pound of the pigs would be the same as the purchase price. With a long-term contract, of five years at least, under ordinary conditions this assumption would probably be true; purchases and consequent sales would be made as often on a rising market as on a falling one. But under present-day conditions it can hardly be expected otherwise than that, though there may be fluctuations up and down, the general trend during the coming five years will be downward. Accordingly, if in the yearly operating account set forth herein the sale price were but one cent lower, or 14c., with a purchase price of 15c., the credit balance would be reduced to $85,019.

19. In case an economical site could not be obtained for pig feeding with rail shipment, it would be no more than conservative to estimate that transportation charges by truck would be $1.70 per ton instead of the 55½c. used in the account statement. This would further reduce the credit balance to $24,563. By good pig management, it is possible to hold hemorrhagic septicemia and other losses down to the 5 per cent allowance entered in the data, but 10, 15 and even 20 per cent losses have been all too common throughout the country. Under such conditions the credit balance would be further lowered to a point where, even if receiving little or no payment for the garbage supplied, the District would undoubtedly have a failing contractor on its hands. The chances that this combination of events might occur are so great that the District would have to keep the reduction plant in readiness for use on short notice. This would mean an expense of $10,000 yearly, which would include capital charges, watchmen, fire protection and proper maintenance. Also there would be certain expenditures necessary for administrative and inspection purposes.

20. A feeding enterprise from a contractor's viewpoint can be operated successfully only when prospective profits are sufficiently large to allow leeway for all contingencies. It is thought that worthwhile bids would not be received for the delivery of garbage, f.o.b. contractor's equipment at the District transfer station. Confirming this statement is the fact that bids in other cities per ton of garbage for deliveries f.o.b. the feeding farm have varied from three to eight times the price per pound of live hogs on the Chicago market. With the contractor charged with the transportation from the city to the farm, the prospects of receiving any offer at all are entirely wiped out. In order that pig feeding may give satisfactory results it must be reasonably certain that the contractor will make a fair profit. With this in mind, it is evident that from the municipal viewpoint a feeding project cannot compare favorably with the money returned and satisfaction guaranteed the public under the present conditions of disposal by reduction.

21. Detailed estimates have been made covering two types of proposed new reduction plant. These two are usually known, one as the Cobwell, which reclaims the grease through solvent stills without the use of mechanical presses, and the other as the Chamberlain, which is similar to the existing plant, with the addition of percolators. Without entering into the relative merits or costs of these two systems it may be stated that the least practicable amount for which a new plant could be constructed has been determined to be $700,000. The plant account for such an outlay would be as follows:

Ground rent	$1,000
Six per cent interest on investment	42,000
Six per cent depreciation	42,000
Total plant charge	$85,000

22. The operating account, including force for repairs and maintenance, would be:

Supervisory	$15,000
Power plant and repair shop	20,000
Unloading raw garbage	5,000
Cooking, etc.	16,000
Drying section	10,000
Miscellaneous	10,000
Total operating account	$76,000

23. Expenses for supplies, including those for repairs and maintenance, would be as follows:

Unloading	$1,300
Boiler room	60,000
Engine room	7,500
Drying	2,000
Processing equipment	40,000
Miscellaneous	5,000
Total supplies	$115,800

24. Various sites have been proposed for the location of a new plant. Some would require barge transportation, others rail. In any case it would be fair to assume that transportation charges would be the minimum possible under most economical conditions (see par. 31). The total expenditures involved in the adoption of this $700,000 new proposition would then be:

Par. 31.	Transportation	$20,860
Par. 21.	Plant account	85,000
Par. 22.	Operating account	76,000
	Supplies	115,800
	Total disposal charge	$297,660

Based upon a collection of 52,800 tons the disposal rate would be $5.64 per ton.

25. The grease and tankage recovery with this new contemplated plant would be appreciably greater than under existing conditions. The quality of grease would be such as to demand a somewhat lower price than is received for Cherry Hill grease. For comparative purposes it may be assumed that the money return from grease and tankage would be approximately 20 per cent

greater than that shown for the fiscal year 1920 as stated in par. 12 herein.

26. Total charges would be $297,660, total receipts $260,000, and the balance of $37,660 would show the cost to the District for garbage disposal. On a tonnage basis these figures would be:

Par. 24.	$5.64	per ton charges.
Par. 25.	4.92	per ton receipts.
	.72	per ton debit using new plant.
For comparison with		
Par. 13.	.05	per ton credit under existing conditions.

27. It is necessary to work two labor shifts with the present equipment at Cherry Hill. Using the existing buildings and substituting large digesters and improved pressing and garbage conveyor equipment, it would be practicable to handle the work, running a day shift alone, for about nine months of the year and a day and night shift three months during the summer rush. The improved installation would afford a considerable labor saving, estimated at $18,000 yearly. Twenty 6-ft. diameter digesters could be installed, four of the smaller 4½-ft. size would remain because of limited space available in certain bays of the building. A green-garbage conveyor in the upper part of the building would permit direct spouting into the digesters, thereby doing away with a great deal of the present manual labor.

28. Two digesters of the type desired have already been installed and others must be installed in the immediate future. At least four of those now in use will have to be discontinued, even if extensive repairs were made, within the next six months, due to failure to pass the boiler inspector's test. The proposed reconstruction of the plant may be considered as of date July 1, 1921, at which time the value of the existing plant would be $30,000.

29. The necessary expenditures would be:

Digester equipment	$50,000
Pressing equipment	34,000
Conveyors	12,000
Magnetic separator	3,000
Grinder for tailings with building	10,000
Recovery of stick in tank water	10,000
Engine room betterments	15,000
Increased boiler capacity and building	10,000
Main building construction	25,000
Total	$169,000

This sum added to the $30,000 investment represented by the existing installation would give a total of $199,000 and a plant account as follows:

Ground rent	$461
Six per cent interest	11,940
Eight per cent depreciation	15,920
Total plant charge	$28,321

It may be noted that no provision is made for percolators. They are omitted because of the determination that the value of the additional grease obtained would not compensate for the extra fuel and solvent consumption required for percolators.

30. The elaborated plant would show a saving of $18,000 in labor and $15,000 in supplies over that of the plant today, on which basis the operating account would be $80,020 and the supplies account $62,664. The returns from the sale of grease and tankage would approximate 10 per cent more than those of today, thereby giving a total of $238,249.

31. To complete the development of the project estimates should provide for improved transportation facilities. The sixteen rack cars owned by the District and used for carrying the wagon bodies to Cherry Hill are in such continual bad order that it is imperative that they be replaced at the earliest opportunity. In doing so advantage should be taken to change from the present use of rack cars to that of entire use of gondola cars. Ten such cars would ordinarily be sufficient, and others would have to be rented during peak loads. Transportation expenses subject to the adoption of this scheme would be as follows:

Six per cent on investment, $37,500	$[illegible]
Six per cent depreciation	[illegible]
Rental of cars at $3 per day	[illegible]
Freight on 960 car trips (round trip) at $15	[illegible]
Maintenance	[illegible]
Total transportation charge	$[illegible]

On a basis of a collection of 52,800 tons per year, this charge would be at the rate of 39½c. per ton. The saving over the charges sustained in using the present equipment is a total of $8,383 or 16c. per ton. Even though this favorable saving were not shown the ten gondolas should be obtained. Means for taking the garbage from the transfer station must be certain and dependable and this is not the case at present. As many as 51 collection wagons have been seen lined up waiting for cars so that they could be unloaded. Such delay interferes materially with the collection service and can be entirely obviated by purchasing the new gondolas.

32. The total charges using the reconstructed plant and improved transportation would be as follows:

Par. 29.	Plant account	$28,321
Par. 31.	Transportation	[illegible]
Par. 30.	Operating account	[illegible]
Par. 30.	Supplies	[illegible]
	Total disposal charge	$[illegible]

With receipts of $238,249, the balance to the credit of the District for garbage disposal would be $46,334. On a tonnage basis these figures would be:

	$3.63	per ton charges
	4.51	per ton receipts
	.88	per ton profit using elaborated plant
For comparison with		
Par. 13.	.05	per ton debit today
Par. 26.	.72	per ton debit entire new plant

33. With rejection of pig feeding projects, the comparison of the plant today with an entirely new proposition and with an elaboration of itself shows conclusively in favor of such present plant development. The figures used in the comparison are all based upon those pertaining to operation during the fiscal year ending June 30, 1920. The freight charge per round trip from Washington to Cherry Hill was assumed at $15. A few years ago it was but $7, and in the immediate future it may be $25. Fluctuations in freight costs, labor wages, byproducts selling prices, etc., would not affect the conclusions. It is plainly evident that an expenditure of $169,000 for the reduction plant proper and $37,500 for transportation would be real economy. In addition the expenditures are necessary from a sanitary viewpoint and in order to do away with the unsafe working conditions at the reduction plant.

Directory of State and Insular Health Authorities

A directory of state and insular health authorities for the current year appears in *Public Health Reports* (U. S. Public Health Service, Washington, D. C.,) for Aug. 6, 1920. Names and addresses of the members of the boards are given, together with those of executive state health officers and department heads. The appropriations for the fiscal year or biennium are also given. Full-time health officers and department heads are indicated. In contrast with earlier directories, professional degrees other than M.D. are reported.

The Bigelow Boulevard Slide at Pittsburgh

By Maurice R. Scharff
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Engineers in the Pittsburgh district have had considerable experience with earth slides. Clays which when watersoaked provide excellent lubrication for sliding surfaces are found on the hill tops of the region on top of the flat-bedded shales, drifted in the hollows and gullies, and occasionally stratified between beds of shale. These conditions with the steep slopes and the long periods of rain met with from time to time have given the district a reputation for slides, particularly in connection with highway and railroad construction.

Some of these past slides have been of substantial magnitude. The Mt. Washington slide on the Panhandle Division of the Pennsylvania Lines West, for example, deposited about 150,000 yd. of shale and clay upon two of the four tracks of the railroad opposite the Point at Pittsburgh in 1902, and required two steam shovels, working for several weeks, for its removal. Another important slide destroyed several hundred feet of third and fourth track construction on the Ft. Wayne Division of the Pennsylvania near Beaver Falls in 1901 and eventually required a relocation, after more than 100,000 yd. had been removed. And a slide on the construction of the Brilliant Cut-Off of the Pennsylvania R.R. in 1904, involving the motion both of a fill and the underlying shale, threatened for a time the Brilliant pumping station of the Pittsburgh water-works, then under construction.

The slide now in progress east of the Union Station at Pittsburgh is distinguished from those that have gone before in three principal respects: First, because the depth and quantity of earth in motion is probably somewhat larger than in any of the cases mentioned; Second, because the present slide appears to have its origin in the disturbance of the equilibrium of filled material, no evidence yet being available of any contributory failure in the natural ground or the underlying shales; and third, because, by virtue of its location, it has threatened to cut in two both an important local traffic artery and a great trunk line railroad system.

A brief news report was published in *Engineering News-Record* a week ago. It is now believed that some further details will be of interest. It will be necessary to wait until some future time, however, when additional data shall have become available, before the weight to be given to the several contributory causes, and the steps to be taken to repair the damage and prevent future difficulty, can be intelligently discussed.

The portion of Bigelow Boulevard (originally Grant Boulevard, but renamed after Edward M. Bigelow, Director of Public Works, who conceived and carried out the project) adjacent to Kirkpatrick St. was constructed in 1898, following the contour at the upper end of Jones Hollow, a steeply sloping gully. The location is shown in Fig. 1 herewith, although the topography shown was taken in October, 1920.

Historical

In connection with the Boulevard construction an ashlar masonry wall consisting of a curved central section about 100 ft. long and two curved wing-walls about 40 ft. and 70 ft. long was built in the lower part of the hollow, as shown in the plan. The center section had a maximum height of 63.04 ft., and thickness as shown by a section adjoining the map. The foundation and the ends were tied into the solid shale.

As fill from the Boulevard construction was placed in the hollow during 1898, cracks developed in both wing-walls, and engineers for the Pennsylvania R.R. recorded an outward movement of the top of the center wall which reached about 4½ in. The filling was then stopped, and, the weep holes in the wall being stopped up, a hole was drilled through the base, releasing a considerable amount of impounded water, after which the wall settled back, closing the cracks. The weep holes were then cleaned out, and broken stone placed back of the base of the wall for drainage to the drill hole. Two catchbasins, connected to a 24-in. terra cotta sewer, were also installed back of the wall to prevent the accumulation of surface water.

The fill for the 60-ft. roadway of the Boulevard was then completed, placing a rock-filled wooden crib at the toe of the slope, about 100 ft. above the wall, to relieve the wall of further thrust. This crib was completed in October, 1899, and the fill was placed back of it in layers, starting at the crib and working up to the roadway, being completed in April, 1900.

About five or six years later a slip developed on Jones Ave. (now Brereton Ave.) at the east side of the hollow, and wooden cribbing and piling were put in below this roadway in order to maintain it.

Ever since the completion of the Boulevard the Bureau of Highways and Sewers, which is charged with the maintenance of Pittsburgh's streets, has used Jones Hollow as a dumping place for material removed from the Boulevard and other street cleanings, including a certain amount of clay and shale which after heavy rains has washed down upon the lower end of the Boulevard from the steep hillsides above it. In addition, contractors and others have from time to time been permitted to waste material at this point. In this manner a considerable area of ground was made outside the curb, which formerly constituted the top of the slope, and the frame city stable north of the Boulevard (shown in the map) was built on this fill.

During the current year plans were completed for improving the Boulevard by a retaining wall along its uphill side, some distance west of Jones Hollow, to prevent the washing down of material from the hillside. It was also determined to relocate the Boulevard at Kirkpatrick St., eliminating the present curve and securing increased traffic capacity by maintaining the present roadway in addition to the new one, with a safety island

*Special attention is directed, in connection with the present full report, to an error contained in the preliminary telegraphic report printed in our news pages last week (p. 1058). Mr. Scharff, author of that report as well as of the present one, advises us that misinterpretation in transcribing and combining two dispatches containing the report resulted in making him appear to state an opinion which he does not hold, namely that the slide was caused or started by the dumping of earth in the fill for the improvement of the boulevard. Mr. Scharff states that it was his intention to refrain from any expression as to cause, as being premature at this time; that a number of different factors may all or any of them have been contributory, to an extent not yet determinable; and that it would be imprudent at this time to express any final opinion as to the cause of the slide.—Editor.

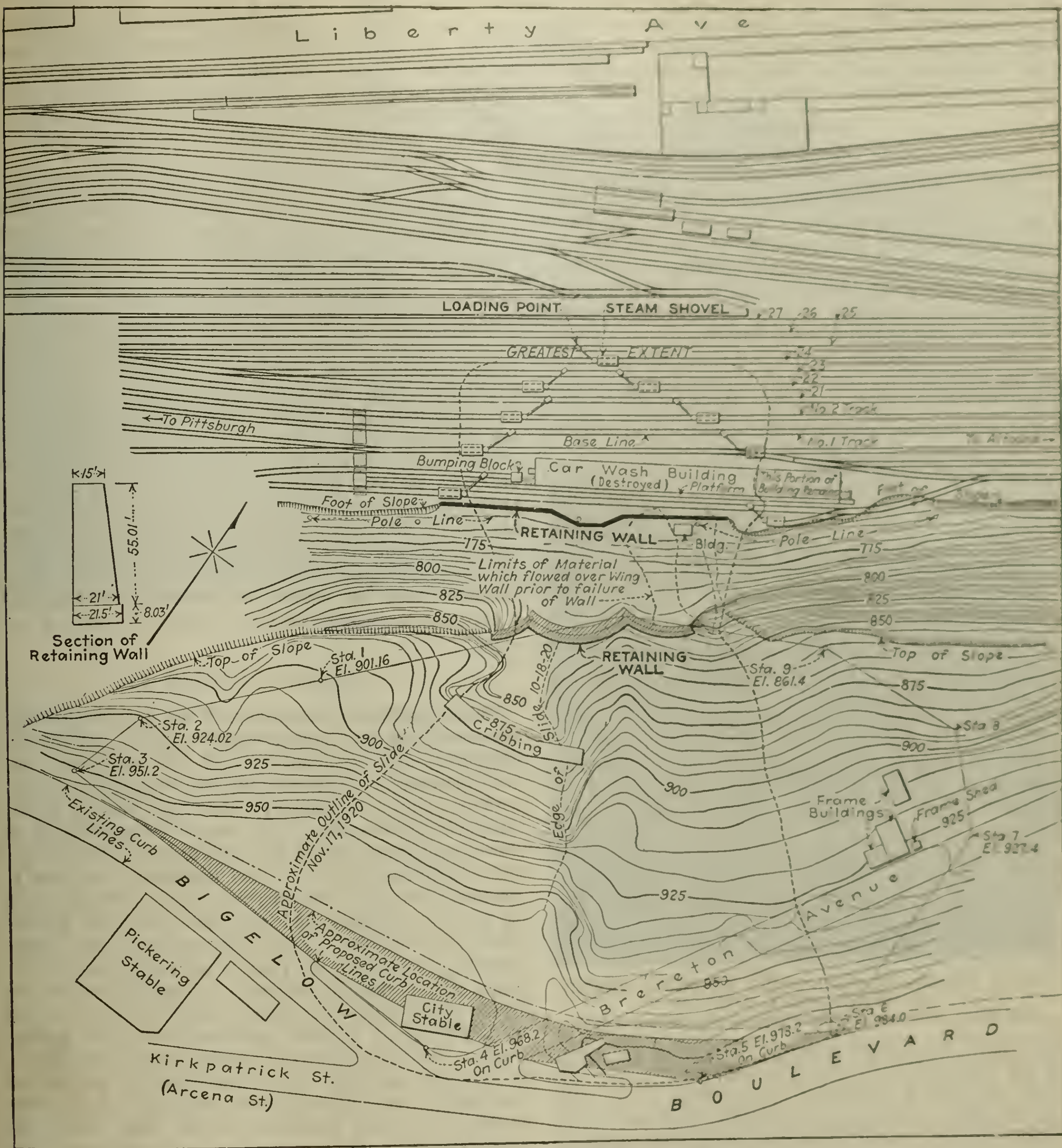


FIG. 1. PRIOR TOPOGRAPHY AT SLIDE SITE BELOW BIGELOW BOULEVARD, PITTSBURGH, WITH INITIAL AND MAXIMUM SLIDE LIMITS

between. This work was commenced several months ago, and beginning about August, 1920, material from excavation for the retaining wall has been placed in position for the proposed fill.

Early in October, 1920, settlement of filled material adjacent to the Boulevard was observed, and about the middle of the month engineers for the Pennsylvania R.R. observed material flowing over the east wing-wall of the retaining wall. At the same time the old cracks in the wing-walls were noticed to be opening up, and these cracks continued to widen at the rate of about 1 in. a day.

Some effort was made to unload the fill, using a clamshell bucket at the Boulevard, and some material was thrown over the retaining wall from just behind it, using shovels and wheelbarrows. But before anything could be accomplished the east wing-wall collapsed, and finally, on Oct. 29, the top 30 ft. of the center wall fell. Fig. 2 shows the wall just prior to its failure.

The fill adjacent to the Boulevard then commenced to settle more rapidly, developing extensive cracks, as shown in Fig. 3, taken Nov. 5. The Boulevard roadway also was cracked at this time, and part of it sank. A timber bridge, supported on wooden piles driven down to the rock, was then constructed and has made possible the continuance of the Boulevard in use up to the present writing (Nov. 26). Some of the piles have moved a few inches, but the bridge has been

closely watched and shored and braced wherever settlement appeared, so that it has continued to be safe for use. Traffic has, however, been much retarded, due to the constriction at the bridge.

The Effects

The most serious effects of the slide, however, have resulted from its invasion of the main line passenger tracks and the passenger car yards of the Pennsylvania R.R. at the foot of the hill. When the retaining wall failed on Oct. 29 a large section of it struck the west end of the inspection and supply building, a two-story-and-basement brick building 30 x 290 ft., and demolished a portion of the building up to the first firewall. Later, two more sections had to be pulled down.

When the top portion of the wall failed the remainder of the wall and its foundation turned slowly through about 90 deg. in place, retarding the movement of the earth above until Nov. 2, when it moved out, burying

FIG. 2. RETAINING WALL BADLY CRACKED, VIEWED ON DAY OF FINAL FAILURE
East (far) wing has already collapsed, west wing has split.

itself in the nose of the slide and permitting the motion of the material to proceed at a more rapid rate. The slide, carrying in front broken fragments of the wall, moved across the tracks immediately adjacent to the hillside and on Nov. 4 reached the main-line passenger tracks (Nos. 1 and 2 on map), putting them out of commission.

The extent of the invasion of the yard by the slide is shown by the map, though this does not fully indicate its relation to yard operation. In all, eight tracks were put out of commission by the slide, and, inasmuch as it was necessary to use three additional tracks for shifting and classifying dirt cars, the railroad had left for handling all of its heavy traffic east of Pittsburgh, and the necessary shifting and express car operations in this portion of the yard, only eight additional tracks.

Furthermore, it was recognized that there was danger, in case of long-continued heavy rains, of the slide moving so rapidly as to cut the entire yard in two all the way through to Liberty Ave. It therefore became necessary to make plans for diverting all traffic. They involved the use of East Liberty as the local terminal station for all trains originating or terminating at Pittsburgh and serving the territory on the main line east, while similar trains for points west would continue to use the Union Station. Through trains would be diverted via the Brilliant Branch to Federal St. station, and via the Port Perry Branch and the Monongahela Division to Smithfield St. station.

One of the interesting features observed by the railroad engineers was the heaving up of track in front of the nose of the slide. In some cases tracks were raised as much as 10 ft. vertically, and the tracks on which steam shovels were operating were repeatedly destroyed and required to be rebuilt.

Interference with trackage, however, was not the only form of interference with railway operation. Four trunk telegraph and telephone cable lines connecting Pittsburgh with the eastern part of the system and originally located behind the inspection and supply building were moved to the front of the building and placed underground several days before the wall failed in order to prevent their loss. Even in this position, however, they were not long safe and it was necessary to remove them twice again to successively more distant underground locations before they were placed finally beyond the reach of the nose of the slide. Water, Pintsch gas, steam and compressed air lines and a car-charging cable also were cut by the earth movement.

Removal of Earth

In anticipation of the failure of the wall the railroad engineers had two steam shovels on the job at the beginning, and by about Nov. 6 this equipment had been increased to 9 shovels and two ditching machines, with one shovel in reserve, which have been in operation ever since—one of the largest concentrations of shovel equipment within so small a space ever seen in the Pittsburgh district. This equipment includes 10 Barnhart, Atlantic, Bucyrus and Marion shovels, with 2½ to 4-yd. buckets, and two Erie revolving shovels with ⅝-yd. buckets. The arrangement of the steam shovels, as shown on the map, is interesting, as it illustrates how it became necessary to *échelon* them on the flanks of the slide, so that each could protect the shovel to the front of it from envelopment by the moving earth. This formation was carried out all the way to the nose of the slide, one shovel attacking at the nose and loading on a through track, while all other shovels loaded on adjacent tracks cut by the slide, loaded cars being classified and assembled on three through tracks and eight cut tracks. Dirt was loaded on 77 Clark steel side-dump cars of 30 cu.yd. capacity each and 300 12- to 16-yd. wooden dump cars, which were obtained on short notice from contractors all over the territory surrounding Pittsburgh. In addition 1,200 50-yd. gondolas have been loaded.

Flood lights mounted on poles have been maintained to illuminate the work at the slide, as well as at the dumps, and work has proceeded continuously 24 hours a day since the beginning.

The available shovel equipment is estimated to have a capacity of 30,000 cu.yd. per day, but due to the necessity of compromising with railroad operation and to the difficulty of disposing of loaded cars as promptly as they are loaded the actual output has averaged only 6,000 or 7,000 yd. per day, and the total removal to the time of this writing (Nov. 26) is in the neighbor-

FIG. 3. FISSURING IN MADE GROUND AT TOP OF LOWER SLOPE, SHORTLY AFTER START OF SLIDE
View taken Nov. 5. Pavement of boulevard to left of picture developed many large longitudinal cracks at this time.

hood of 80,000 or 90,000 yd. This has not only kept up with the movement but has made substantial inroads on the slide. Of the eight tracks put out of service two have been partially recovered already and it is momentarily expected at the time of this writing that the two main-line tracks can be cleared.

Throughout these operations the railroad engineers have made frequent observations on the rate of motion of the slide, establishing transit points on the tops of the neighboring hills and making measurements upon stakes set in top of the nose of the slide. The rate of motion so observed has varied from about 1 ft. per hr. at the commencement of the principal movement on Nov. 2 down to a minimum of about ½ in. per hr. on Nov. 20 and 21. Following light rains on the latter date the motion increased on the following day to about 6 in. per hr., but has now decreased again to between 1 and 3 in. per hr. During the same period the top of the nose of the slide, which rose at one time about 45 ft. above the level of the tracks, has settled approximately 10 ft.

Organization

One of the most interesting features of the dirt removal operations is the organization which has been built up by the engineer in charge for the railroad. In the beginning it was necessary to utilize existing facilities for shifting and classifying dirt cars, and this required running dirt trains into the portion of the yard just east of the Pennsylvania Station controlled by the interlocking system and removed them effectively from the control of the force in charge of dirt removal.

The engineer in charge, however, succeeded in getting authorization to stub-end the main-line tracks beyond the interlocking system and to cut in ladder tracks at both ends, so as to throw the main-line tracks into the passenger car yard and to convert this yard into a self-contained system which could be used most effectively for pushing the work. Within this yard the engineer in charge has built up a complete, independent railroad organization having, in addition to the construction forces and equipment and rolling stock already mentioned, a complete staff of day and night yardmasters, dispatchers, electricians, repair men, etc. The possibility of developing this centrally controlled organization is believed to have contributed considerably to the success of the work that has been done.

General

While the work of dirt removal has gained considerably on the slide it is recognized by those in charge that all danger has not yet passed. A large quantity of earth remains to be removed, and though the exact quantity is not known it may well run to several times that which has already been removed. It is still possible, therefore, that long-continued heavy rains might start a movement that would add materially to the damage already done. To the time of this writing, however, the weather has continued reasonably satisfactory, and with good progress the work will be completed without further interference with operations.

Upon the recommendation of the city council Mayor E. V. Babcock requested General George W. Goethals to come to Pittsburgh for the purpose of reviewing the situation. General Goethals did so on Nov. 20, and submitted the following report under date of Nov. 22:

Sir—In compliance with your request I submit herewith a report on the Bigelow Boulevard slide.

My information is based upon data in possession of the city engineer; upon statements made by him and the Director of Public Works; by inspection at the site, and from the history obtained from Mr. Ritchey, engineer in charge of removing the slide.

The original boulevard was constructed on a fill built across a ravine in the hills. During its construction the material slipping down endangered the Pennsylvania R.R. tracks at the foot of the slope and an injunction was secured

by the railroad company. The difficulty was overcome by the construction of a retaining wall. As the fill progressed additional precautions became necessary and a timber crib, probably filled with rock, was built higher up the slope to relieve the overcharge on the retaining wall. While some attempt was made to drain the fill and to carry off water that had access to the slope, the drawings exhibited show that it was not adequately accomplished, and this is confirmed by the consistency of a part of the material being removed by the steam shovels.

The saturated condition of the material due to lack of proper drainage, combined with overloading the bank, resulted in overcoming the resistance offered by the crib and retaining wall and caused the slide. While the additional load was undoubtedly the straw that broke the camel's back, I have no doubt from the fluidity of part of the mass that it was only a question of time when the slide would have occurred.

FIG. 4. AT THE NOSE OF THE SLIDE—SHOVELS WORKING ON TRACKS LAID ON UPHEAVED MATERIAL

There is nothing that now can be done to stop the movement; the only thing remaining is to dig out the material as it reaches the lower level. No satisfactory method can be devised or used to reduce the weight on top.

From Mr. Ritchey's records I agree with him that upheaving of the tracks at the foot of the slope is caused by the forward movement of the mass of the retaining wall which remains intact, shoving the material out ahead of it, similar in action to a plow. The present indications are that this upward movement will cease when the old retaining wall is removed.

It is difficult at this time to say what the exterior limits of the slide will be. All the material within the cracks that now appear on the ground will move and the bulk of it will have to be taken out. As the material moves out, allowing a settlement at the top, additional cracks may develop, and will then become the bounding lines for the slide or unstable area. I should not be surprised if it took in all of the material in the old ravine up to the retaining wall in rear of the stable.

As explained to the engineers a record ought to be kept of the movement as it progresses by levels taken on stakes scattered over the surface of the slide, from which indication can be obtained of what is likely to happen.

Efforts should be made to keep all the water possible from the slide area and none of it should be allowed to stand in pools on the surface if it can be carried off economically. Cold weather may to some extent retard the movement, but unless water is kept off freezing is liable to produce additional difficulties.

The situation is serious from the railroad standpoint, not so from the highway standpoint. The engineers can proceed with their borings to determine the location and character of rock over all of the area except that which is in motion, and with the preparation of their plans based on the data obtained, so that there need be no delay in the preparation of the budget. The temporary roadway that is now built across the ravine should be watched carefully to guard it against undermining which may result from movement due to the breaking away of additional material. These movements as a rule are not precipitate and generally consist in the first instance of a settlement, so that no calamity to users of the boulevard is anticipated.

I learned of the output of the steam shovels prior to visiting the site at which they are working when it seemed that they were not securing efficient results. An examination of the locality along the railroad caused me to modify my views. The necessity of maintaining as many tracks open as practicable and the rapidity with which the earth is moving leads me to the conclusion that they are doing all that can be expected of them under the circumstances, and that the railroad engineers are justified in maintaining all the shovels at work in the positions where they were operating in respect to the slide. When the upheaving and consequent breaking up of the tracks have stopped a loading track can be maintained without interruption, a redistribution of the shovels will be practicable and some of them can be withdrawn.

Further study regarding the cause of the slide, the extent to which each of several possible factors contributed to it, and the methods to be adopted in order to prevent further difficulties will have to be postponed until after the immediate problems of earth removal and maintenance of traffic are out of the way and until the large amount of additional information now being collected by borings, surveys and other observations is available.

Information regarding the history of the original Boulevard construction has been furnished from records in his possession by Capt. James Wells, chief inspector for the city during the original construction of the Boulevard. Information regarding previous slides on the Pennsylvania system has been furnished by Robert Trimble, chief engineer of construction, and W. D. Wiggins, chief engineer of maintenance-of-way of the Central Region of the Pennsylvania R.R., and others. Photographs, survey data, plans and complete information regarding the work of dirt removal have been furnished by C. W. Ritchey, division engineer of the Pittsburgh Terminal Division, who is in complete charge of the work at the slide under the direction of Mr. Wiggins. N. S. Sprague, chief of the Bureau of Engineering of the Department of Public Works, is in charge of work being carried on by the city, under the direction of John Swan, Director of Public Works.

Surface Shrinkage of Rapid Filter Sand Beds

Further Discussion of Wolman-Powell Article—Hydraulics, Design and Operation Greater Factors Than Adsorption

By Weston Gavett
With Clyde Potts, Consulting Engineer, New York City

IN TWO instances of sand shrinkage cited by Abel Wolman and S. T. Powell in their article July 29, p. 210, *Engineering News-Record*, on "The Surface Shrinkage of Rapid Filter Sand Beds," fine sand was found in the beds. It is shown that laboratory experiments on samples of these and other sands demonstrated high adsorptive capacities. It is then shown that the adsorptive power and surface area, a measure of the fine material present, of the sands were interrelated. The observed data available on which an explanation of the sand shinkage in the two plants may be based are: (1) the presence of fine sand in both filters, (2) the demonstration that the adsorptive capacity of the sands was high by virtue of the fine material present.

Factors other than sand were not considered because in one case no shrinkage occurred until after the addition of a layer of unsuitable sand. It should be noted that the high adsorption in the two sands was due to the fine material present and aside from this accepted undesirable condition it is not shown that the sands differ from normal sands.

It is stated that the shrinkage was caused by a strong internal contracting force, presumably induced by adsorption. It is not shown that this force was not aided by the hydraulic conditions of the filter during operation. Had the filter been allowed to stand idle after washing with the sand in the fairly normal condition observed, additional data of value might have been obtained as to the velocity of the contraction phenomenon.

In developing their hypothesis, the authors point out that (1) the shrinking sands were adsorptive and plastic, (2) in clays, air shrinkage and plasticity vary with the amount of colloids present, as measured by dye absorption (3) in various instances of "syneresis" under-water contraction is proportional to surface area, (4) in various arts and sciences the phenomena dealing with shrinkage plasticity, etc., have the one explanation—adsorption. In view of these facts the authors suggest that the malachite green test should give data of value on the action taking place in the filters. Their data also seem to show that a test for a sand of large surface area or containing a high percentage of fine material will give the same information.

It is shown that shrinkage in clay is produced by the addition of colloids. It is then the colloidal material naturally in the water or resulting from treatment that causes the shrinkage. The presence or absence of a colloidal organic film on the sand is not believed to affect shrinkage, the authors state. No doubt the adsorptive sand retains its colloidal coating during washing as it is difficult to conceive great contraction possible in a bed of clean sand of fairly uniform size when it has subsided after washing.

In giving the method of testing the sands for adsorption it is stated that the flask containing sand and dye was allowed to stand 24 hours after shaking to permit the fine material in the sand to settle. If the depth the material had to settle was say 5 cm. the velocity of settling would be about 0.00053 mm. per second, indicating a size of particle of 0.0009 mm. One pound of material of this size would have a surface area of around 12,500 sq.ft. This is rather fine material to include in a test for the adsorptive capacity of sands. A test on sands separated into particles of the same size would be of interest and would emphasize the high specific adsorption in the three sands mentioned, the coal filter material, the synthetic silicon dioxide and the Ottawa sand. No mention is made of shrinkage caused by any of these materials, and it seems yet to be proved that shrinkage would result from their use.

The writer has seen some instances of sand shrinkage in rapid sand filters. All seemed possible of explanation by causes other than those advanced by Wolman and Powell.

In one case a number of horizontal pressure filters were operated under a low head, practically as gravity filters. Large longitudinal cracks were always in evidence and were found immediately after washing and before the filter had been put in service. This case is not typical as it was no doubt caused by the circular cross-section of the filter and therefore not comparable to true sand shrinkage. Bacterial results from these filters were equal in quailty to those from open, vertical-sided filters with no side cracks, operated in parallel with the same water. This fact indicated that the crack was not opened suddenly during operation, but that a loss of head was built up on the sand surface of the crack allowing it to act as an effective part of the filter surface. Where the sand surface breaks or cracks at the sides or elsewhere it follows that a poor quality of effluent will result, the crack acting as an orifice in a relatively impervious surface.

In another instance the cementing of the sand caused the whole area of sand to rise when washing was commenced. This phenomenon in the case of Springfield is cited by the authors as an illustration of the internal contracting force in the filter sand. The writer noted the occurrence after the filters had been under a heavy load, and attributed it to an excessive amount of suspended matter removed from the water, combined with the pressure developed on the sand by the flow of water through it under high loss of head. The filter returned to its normal condition after the character of the water had changed. Mechanical agitation of the sand by hand raking during washing was found of value during the period of cementation.

Persistent contraction and side cracks were observed in another plant where the presence of fine sand may have been the contributing cause. It is believed that the filters were washed at too low a rate, which was limited to that at which no sand would be wasted. Under these conditions the presence of fine sand in the beds would result in a low wash-water rate being used and the fine sand would remain in the filters.

Other cases have been described to the writer, of filter beds breaking during operation when the character of the applied water appeared to be the causative factor. In one instance it was said that breaking occurred at a time when iron and lime were used on a water more amenable to treatment by alum. These cases suggest an opportunity for investigation along lines outlined by Wolman and Powell on the nature of the material removed by the filter. The theory might be advanced that

a plastic highly adsorptive matt would be superior to a more granular, less adsorptive coating in tending to resist breaking under the forces acting upon it.

In investigating sand shrinkage and other problems of filter performance, the science of hydraulics and the design and methods of operation of the filter should not be neglected. The following factors may have some bearing on the subject.

Air and Water Washing—Advocates of high-rate water washing claim that the use of air is not necessary. Operators using air point to long periods of good service and testify to its value. Perhaps we cannot say that water washing will be successful in all cases because it has worked in others, any more than we can predict that a coagulant efficient with one water will be equally successful with another supply. In one of the cases before mentioned water wash alone was sufficient at most times, but under certain conditions additional agitation by raking was of value.

Strainer Systems—A good strainer system is essential to a good filter. The double bottom system approaches the ideal condition. The writer has operated small filters

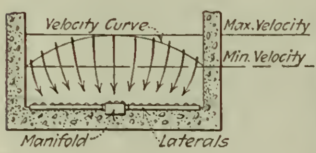


FIG. 1. CENTRAL MANIFOLD ACCENTUATES CENTER WASH-WATER RISE

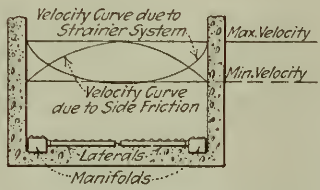


FIG. 2. SIDE MANIFOLD NEUTRALIZES WALL FRICTION

of this type and they leave nothing to be desired either from a mechanical or bacterial standpoint. It is claimed that manifold-and-lateral systems are as efficient as double bottoms, especially when water passages of large area are used. The writer has seen a manifold-and-lateral piping strainer system, that had been subject to an incrusting water, uncovered. Probably over half of the total orifice area had been completely sealed. The strainers near the inlet were clear. The incrustation increased with the distance from the inlet, and became a maximum at the further corners where the strainers were completely sealed. The action is progressive, starting at the point of least pressure and working back. Even in a filter with large passages it is conceivable that the velocity distribution during filtration and washing is not entirely uniform over the whole bed. Certainly with some strainer systems this is the case, the velocity curve having the form indicated in Fig. 1 with the direction of flow indicated by arrows. Under these conditions, if the filter contained fine sand would it not have a tendency to work towards the sides of the filter? Would the divergence from vertical flow lines suggested in Fig. 1 aid in contracting the sand away from the sides?

Assuming the velocity distribution from the strainer system is perfect, the friction on the sides of the filter will tend to reduce the velocity at this point. When the filter is washed and the sand is in suspension, we should expect the velocities to be lower at the sides than in the center, analogous to flow conditions in pipes. If the velocities are low at the sides due to the strainer system as well, the condition is aggravated. We may then expect to find, and do find, instances of poor washing at the sides of filters, with attendant evils of caked sand and dirt at that point. The thought suggests itself that if a manifold system must be used, it should be of advantage to place the manifolds at the sides to compensate somewhat for the reduction in velocity due to friction of the sides as indicated in Fig. 2.

If a filter is suspected of having a non-uniform distribution of pressure the fact may be readily ascertained experimentally, by testing the loss of head in different parts of the bed by the method used by James H. Fuertes in the Harrisburg negative-head case. The writer once used the following simple method for obtaining the loss of head through the sand while the filter was operating under a positive head. A piece of small pipe, long enough to extend to the desired depth in the sand and above the water surface in the filter, was placed in the desired position while the filter was being washed, and held until the subsiding sand gripped it firmly in place. The water level in the pipe was obtained by sounding with a small weight and cord. In this instance several pipes were located at the same part of the bed but at different depths. Measurements taken during a filter run showed that the increase in head was practically confined to the few inches at the top of the bed.

Rise of Sand During Washing—The writer does not altogether agree with Wolman and Powell that fine material in a filter will not be removed hydraulically by washing, provided that the filter is properly washed when the sand is clean. He once constructed a demonstration filter from a glass tube 2 or 3 in. in diameter with a copper wash-water trough at the top and a strainer set in a rubber stopper at the bottom, with connections and valves for wash water and filtered water. The sand and gravel were taken from the filter beds of the plant. This plaything was useful in showing the delicate relation between the rise of the sand and the vertical velocity of wash water. A slight change in the wash-water rate was indicated by the sand rise.

Tests on the rise of sand are described by Langdon Pearse in the *Engineering News-Record*, Mar. 18, 1916, p. 385, and the plotted relation between velocity and rise shown. In general the finer sand shows a greater rise with the same wash-water rate.

J. W. Ellms gives the results of a thorough investigation of the behavior of sands while washing, in the Proc. Am. Soc. C. E. Vol. LXXX, p. 1016, and shows the height of sand during washing to be affected by the depth of sand, its fineness and the velocity of wash water.

It does not seem that sand, greatly finer than the main bulk, would stay in a filter unless the sand were heavily coated, the rate of washing too low, the wash water trough much higher above the sand than necessary or the distribution of wash water poor.

Fine Sands in Filters—Aside from adsorption, fine sand may be harmful in other ways. No doubt most sands tend to accumulate a coating of colloidal matter, especially if the filter is not sufficiently washed. If the sand is relatively large and uniform in size this may not be harmful unless the coating is too thick and plastic. On fine sand the film may be a considerable percentage of the diameter of the particle and compression or shrinkage can be conceived when it is considered that

there may be several feet difference in head between the surface of the sand and a level a short distance below it.

To digress from the subject of sand, the work of Wolman and Powell suggests that the malachite green adsorption test may be an admirable means of obtaining a measure of the fineness of the suspended matter in the water. The writer has long sought such a test without results. The best solution seemed the use of the Tyndall cone, comparing the unknown water with prepared standards of different fineness. Unpublished experiments interrupted by the war indicated that the coefficient of fineness of the standard methods of the American Public Health Association is of little value except for a limited range of large particles. The malachite green test would seem to have possibilities for application as a fineness test, modified by the selective action or variable adsorptive power of different materials present.

Wolman and Powell have done a work of value in their careful study and presentation of data from many sources relative to the subject that might otherwise have remained buried, but further data are needed before it can be definitely stated that adsorptive power is objectionable rather than a quality to be desired in filter sand. If shrinkage occurs, the filter operator or engineer should not hasten to replace all his sand on the supposition that it is a highly adsorptive undesirable material until he has looked into other factors.

Old Air Drill Cuts Pavements for Los Angeles Water-Works

By C. W. Geiger
San Francisco, Cal.

For cutting through asphalt and concrete pavements in making excavations for water mains the Los Angeles Water Department uses an old air drill.

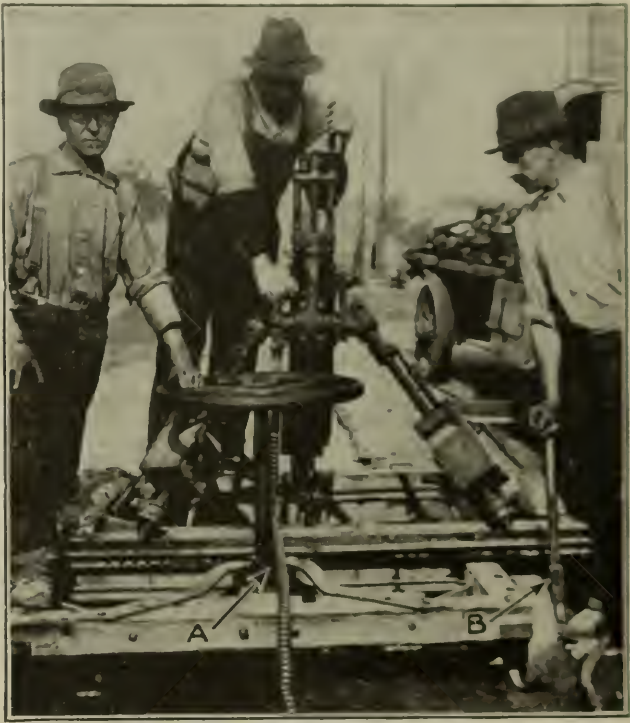
The drill is mounted on a carriage which in turn is mounted on a four-wheel truck. A handwheel attached to the truck is provided with a pinion which engages a rack on the carriage, by means of which the carriage can be moved sideways. This is shown at the point of the arrow marked "A" in the accompanying view. The carriage can be moved sideways so that a strip of pavement about 4 ft. wide can be cut. A ratchet working on one of the wheels of the truck moves the truck forward as the cutting progresses. This ratchet is shown at "B" in the view.

In actual operation, one man is required to start and stop the air drill, one operates the handwheel for the purpose of moving the drill sideways, and a third manipulates the ratchet for the purpose of moving the truck forward.

To cut through asphalt a sharp bit is used. The asphalt is cut through along the two sides of the strip, broken up and loaded onto a motor truck. The drill is then equipped with a blunt bit and the truck retraces the same path. The operator of the drill directs the bit against the surface of the concrete until the continuous pounding breaks it up for several inches in all directions. Then, without stopping the drill, the carriage is moved sideways several inches, and the pounding concentrated until this area is broken up. When the entire width is broken up the truck is moved forward and the carriage is moved to the opposite side of the strip, the drill being kept in operation while this is being done.

In one day this apparatus can cut through asphalt and break up a 4-ft. strip of concrete foundation for a distance of 120 ft. This has proven to be considerably cheaper and easier than the method usually employed for doing this kind of work. The cost of cutting through good pavement and concrete base varies from 2 to 5c. per square foot.

Compressed air is furnished by an air compressor mounted on a motor truck just back of the driver's seat. The truck is also equipped with a centrifugal pump, which is used principally in pumping water when



OLD AIR DRILL RIGGED UP TO CUT PAVEMENTS

there is a leak or break in a water main. It has a capacity of 900 gal. per minute. A small air pump, mounted on the water pump, is used to prime the latter. By means of special transmission gear, either the main air pump or the centrifugal pump can be operated by the 40-hp. motor that operates the truck.

The Los Angeles Water Department is planning to try steam power in place of compressed air to drive the apparatus. An air-driven pavement cutter and breaker, supplied by the local Ingersoll-Rand agency, is used by the Los Angeles street railways.

Germans Underbid Americans for Locomotives

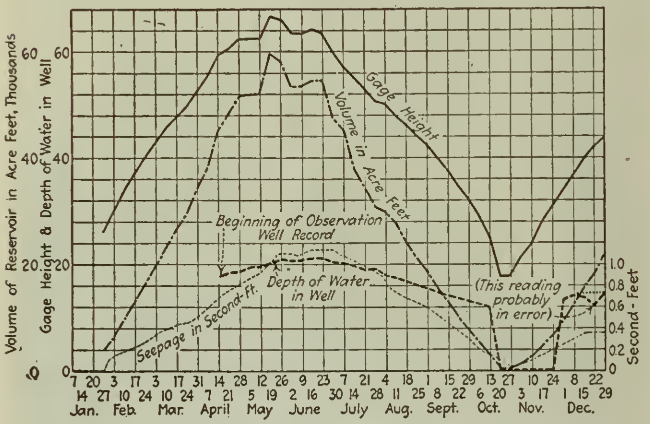
According to a statement in a recent issue of *The Engineer*, London, Krupps, of Germany, have underbid American locomotive manufacturers for electric locomotives for the Java State Rys. The contract was for eighty-three locomotives. It is suggested in the English paper that the depreciation of the mark may have enabled Krupps to put in the lower tender, but the fact that the German factory is able to take such a large contract at a reasonable price is particularly commented upon.

Improvements on a State Irrigation Project in Utah

Piute Earth Dam Strengthened with Porous Fill After Study of Seepage—Spillway Enlarged—Cylinder Gates—Diversion Dam on Gravel Foundation

By J. C. Ullrich
Deputy State Engineer, Salt Lake City, Utah

IMPROVEMENTS made and under way on the State controlled Piute irrigation project in Utah, in order to insure continuity of service to the water users, involve an expenditure of nearly $230,000. Investigations of seepage through an earth dam during a period of five years resulted in plans for strengthening the dam by a heavy non-impervious fill of sand and gravel placed on the downstream slope over a well-drained foundation. A comparatively small spillway was increased in capacity to care for three times the greatest flood of record and to take a flood which might be caused by the breaking of a dam above the Piute structure. Experience with an air-slaking rock added much to the cost of the wasteway. To insure delivery of water should one set of gates break (as did happen) an auxiliary set of gates of the cylinder type is now being installed. A 6-ft. diversion weir had to be constructed on a porous foundation requiring special consideration.

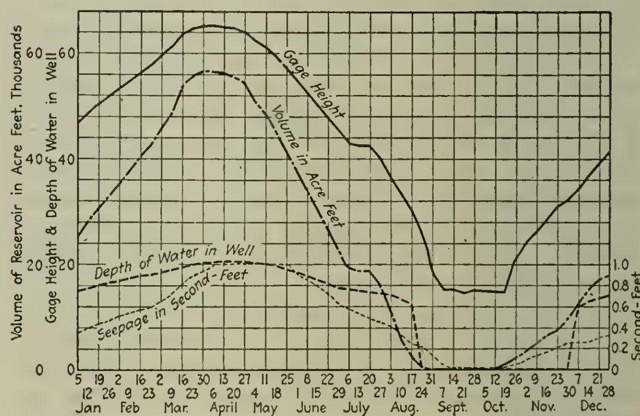


GRAPH SHOWING WATER HEIGHTS IN WELL AND RESERVOIR, 1917

This project, which was built by the State Board of Land Commissioners, was begun in 1908 and put into service in 1914. It comprises a storage unit of 90,000 acre-feet capacity and a canal system of 64 miles. The Piute reservoir storing winter and flood flows is located on the Sevier River about 12 miles above Marysvale. A concrete diversion dam 25 miles below the dam conveys the stored water through the canal system to 20,000 acres of land. The first 20 miles of the system is an enlargement of the Sevier Valley Irrigation Co.'s canal, from which practically no Piute project water is diverted. The remaining portion serves the acreage under the project, the land lying in a narrow strip along the upper west side of the Sevier Valley where 14,000 acres have already been brought under irrigation.

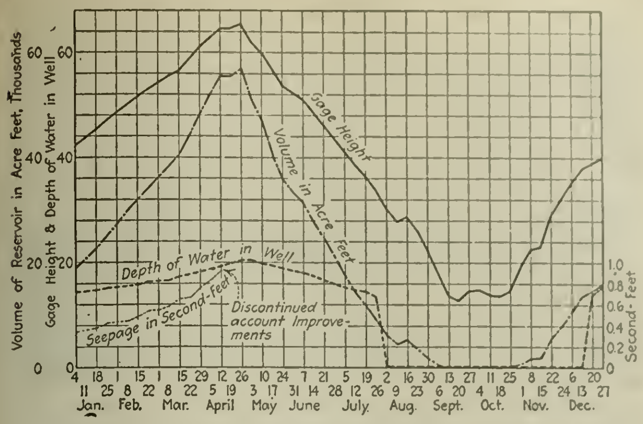
The reservoir dam, put into service in 1914, is a hydraulic fill structure 508 ft. long on top, 95 ft. high above stream bed with upstream and downstream slopes of 3 to 1 and 2 to 1 respectively. (See *Engineering Record*, July 17, 1915, p. 80.) A core trench was excavated to bedrock, 40 ft. below the bed of the stream, a concrete cut-off wall 4 ft. high being built on the rock and the trench re-filled to the original ground surface with clay puddle. (See *Engineering Record*, Nov. 8, 1913, p. 522.) An outlet tunnel 6 ft. wide by 8 ft. high was driven through the ledge rock forming the west abutment. This tunnel is equipped at its upper end with three 4 x 6-ft. cast-iron slide gates designed to operate under a maximum head of 80 ft.

Seepage Fluctuates.—Shortly after the dam was put into service, considerable seepage appeared at various places along the lower toe. At first it was thought that this seepage would decrease after the dam was in operation for a while and the slopes had a chance to silt up, but as time went on the seepage increased. While there was no evidence that the dam was being undermined or that the seepage was removing material from the body of the dam, the indication was considered of sufficient importance to warrant close study. In the spring of 1915, therefore, a drain ditch was constructed along the toe of the dam, the seepage water collected being passed over a V-notch weir and a daily record kept of the amount. It was soon discovered that the seepage fluctuated with the height of water in the reservoir and amounted to as much as 1.1 sec.-ft. when the water reached a height of 67 ft. In the fall of 1916, plans were prepared to sink a number of observation wells into the lower half of the dam to determine the line of saturation, but owing to a lack of funds for this work, only one well was sunk. It



GRAPH SHOWING WATER HEIGHTS IN WELL AND RESERVOIR, 1918

is located in the central part of the dam, two-fifths of the distance up from the downstream toe, and was constructed by sinking a shaft 4 ft. in diameter to a depth of 40 ft., bringing the bottom of the shaft to the original ground surface. In the center of this shaft was placed 40 ft. of 16-in. wood-stave pipe, the bottom 15 ft. of which was perforated spirally with ⅜-in. holes spaced 3 in. apart vertically. The well was then filled with selected material graded from coarse gravel around the pipe to sand around the periphery



GRAPH SHOWING WATER HEIGHTS IN WELL AND RESERVOIR, 1919

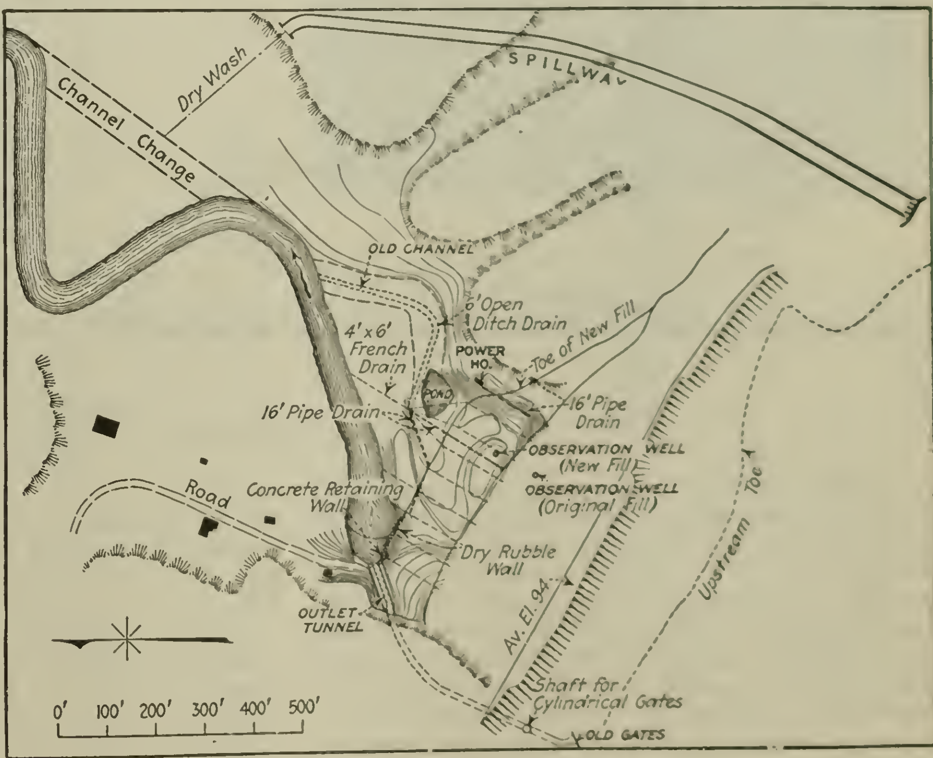
of the well. A record of the depth of water in the well was taken every week and plotted on a profile of the dam. By connecting the height of water in the reservoir with the depth of water in the well, an approximate idea of the line of saturation through this portion of the dam was obtained. While the line of saturation determined by these two points never intersected the downstream slope of the dam above the toe, there were times when the downstream face showed sweating to a height of 5 or 6 ft. above the toe, although no water was ever noticed actually oozing out of the fill.

Hydrographs for the years 1917, 1918 and 1919 show the relation between the height of water in the reservoir, the depth of water in the observation well, and the amount of seepage appearing at the lower toe. Taking equal increments of increase in the height of water in the reservoir the rate of increase of the seepage water is approximately in the ratio of 2 to 1. This ratio appears to hold equally well when the reservoir is being emptied. The diagrams also show a fairly well-defined lag between the increase and decrease of the water in the reservoir and the increase and decrease in the amount of seepage.

The curves representing the depth of water in the observation well also show a direct relation between the water in the well and the height of water in the reservoir. They show, however, that no water appears in the observation well until the water in the reservoir reaches a height of approximately 30 ft., when the water in the well suddenly rises to a depth of 12 ft. (records were taken once a week) and then continued to rise and fall as the water in the reservoir rises and falls. The fact that the water suddenly appears to a depth of 12 ft. in the observation well, when the height of water in the reservoir reaches the 30-ft. stage, is a strong indication that there is a porous stratum extending through the dam or at least through a part of the dam in the immediate vicinity of the observation well. The hydrographs further show that for the same stage of the reservoir, for the several years over which records have been obtained, the depth of water in the observation well and the amount of seepage appearing at the lower toe of the dam are the same.

A study of these diagrams led to the conclusion that the seepage water appearing at the lower toe of the dam was the direct result of water percolating through the dam. While it was realized that the record of this one observation well disclosed the internal condition of the dam at only one section, nevertheless an earth dam is no stronger than its weakest spot. This condition, together with the fact that the downstream slope is entirely too steep for a dam of this size, was considered by both the state engineer and the Board of Land Commissioners to justify their taking immediate steps to strengthen the dam.

Strengthening the Dam.—The plan adopted provided for the placing of an 80,000-cu.yd. earth fill against the downstream side of the dam and the construction of a drainage system in the foundation for the new fill. This foundation covers an area of approximately 2.3 acres, the greater portion of which was wet and boggy. A system of French drains 50 ft. apart was constructed throughout the foundation at right angles to the dam. These drains intersect a small rock toe constructed at the lower toe of the old dam and discharge into the river below the toe of the new fill. They were constructed by excavating trenches 3 ft. wide and 3 ft. deep, on a grade of 2 per cent, filling them with a 2-ft. layer of cobble rock varying in size from 4 to 8 in., on top of which was placed a 6-in. layer of coarse gravel which in turn was covered with a 6-in. layer of pea gravel. The original plans contemplated only the installation of eight French drains,



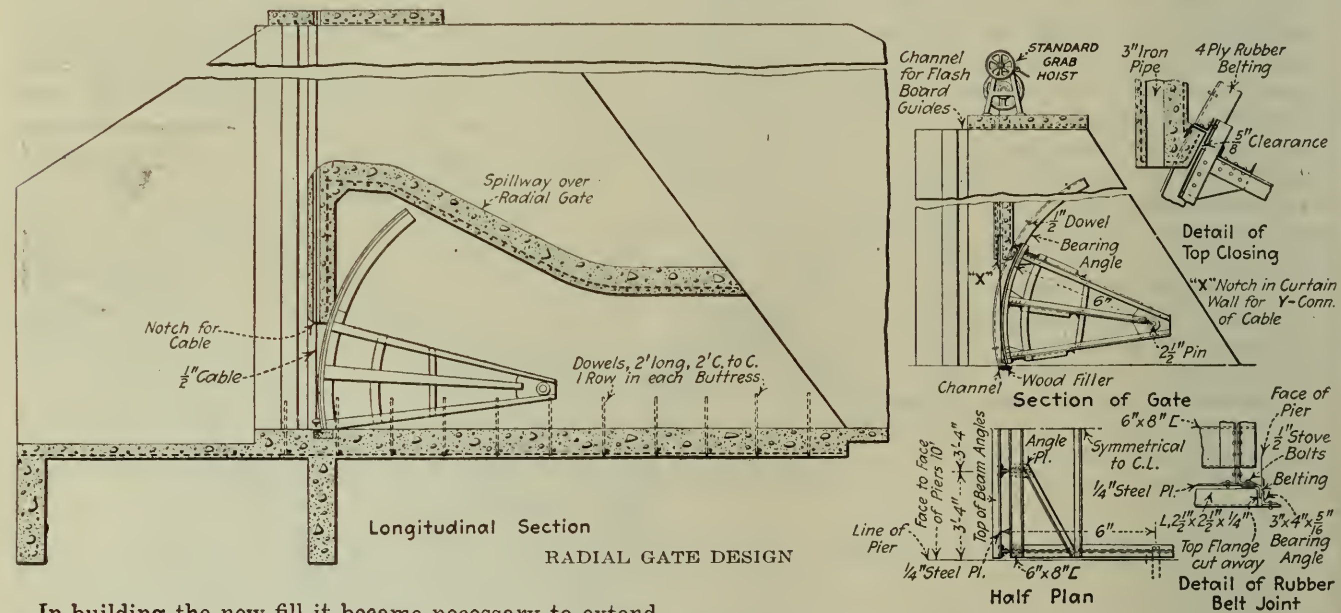
IMPROVEMENTS ON PIUTE DAM

but during construction the resident engineer installed several additional 16-in. wood-pipe drains surrounded with rock, at points where the saturation was the greatest. The pipe drains are connected with a 6-ft. open drain leading to the river. Old redwood pipe stored at the dam was used.

The purpose of the drains is two-fold (1) to dry up the foundation for the new fill; (2) to carry off all water that may seep through the old dam. Within a week after the drains were in operation they had dried up the foundation site so that the contractor could haul loaded 1½-yd. dump wagons over the foundation.

The cobble rock riprap which partially covered the downstream face of the dam was removed, and such rock as was not needed in the construction of the French drains and a riprap retaining wall at the mouth of the outlet tunnel, was placed in a 6- to 8-ft. wall at the toe of the new fill.

FILLING POROUS MATERIAL ON BACK OF DAM



RADIAL GATE DESIGN

months. The average length of haul was 500 ft.

A saturation well, similar to the one sunk into the old dam, was built into the new fill in line with the original well. Though this well has been under observation for the past two irrigation seasons no water has appeared in it, while during the same period water has risen in the original observation well to a maximum depth of 23 ft. The French drains are working perfectly and are keeping the new fill dry.

In building the new fill it became necessary to extend the outlet tunnel, which emerged from the cliff forming the west abutment of the dam at a point just below the lower toe. From this point the water was conveyed in a concrete flume 20 ft. wide to the river. Using this flume as a foundation the outlet tunnel was extended as a concrete section, having the same inside dimensions as the original tunnel, to the toe of the new fill. Dry rubble masonry walls on concrete foundations form the wing walls for the portal and protect the new fill against the action of the water flowing from the tunnel.

In preparing the foundation for the new fill, the soil to a depth of 1 ft. was removed and wasted and the surface roughened by plowing furrows 3 ft. apart. Steps were also cut in the downstream face of the old dam at intervals. No material of an impervious nature was allowed, nor was rolling or compacting required. The purpose of this loose fill was to insure a layer that would be pervious to the extent of allowing all water that might find its way through the old dam to filter down into the drains, thus keeping the new fill dry and firm. The new fill extends to within 20 ft. of the top of the dam, making this portion of the downstream face on a slope of 3¾ to 1. The fill was placed by means of a steam shovel and dump wagons in 4½

Spillway and Wasteway.—The original wasteway through a saddle east of the dam was 450 ft. long, 40 ft. wide, and was carried down 20 ft. below the top of the dam. From the wasteway the water was to pass down a natural draw to the river. As the wasteway was cut through a soft decomposed rhyolite, which air-slacks on exposure the cut became partially filled with talus after several years. No spillway or control device was constructed at the head of the wasteway. During this early period the water in the reservoir was never allowed to rise to the point where it would flow through the wasteway, but was regulated entirely by means of the outlet gates.

The improvements at the dam include completion of this wasteway and the construction of a spillway at its head. The channel was lowered 5 ft., extended 900 ft. and lined with concrete for the entire distance.

The spillway is a concrete structure consisting of piers with four ogee spillway sections between them and above four steel radial gates, the bottoms of the

gates being 10 ft. below the crests of the spillway sections. Concrete curtain walls extend from the spillway crests to the tops of the radial gates. The piers are 20 ft. high, 10 ft. apart and rest on a rock foundation. Each pier is equipped with stop-log slots faced with steel channels so that each gate opening may be closed if it becomes necessary to remove the gate for repairs while under water pressure.

Each of the radial gates is 4 x 10 ft. and operates on a 6-ft. radius. The gates consist of two truss bearing segments built of three ribs of 2½-in. x 2½-in. x ¼-in. angles crossed by three 6-in. channels which support 2½ x 2½ x ¼-in. angles bent to the required radius and having riveted to them a ¼-in. faceplate. A ½-in. clearance is given between each end and the pier, these spaces being made water-tight by means of flexible membranes which are bolted to the ends of the gates and slide on steel-bearing angles bent to the same radius as the gates and set in the concrete piers. To insure the gates operating smoothly within this clearance, they were well braced laterally to prevent them from warping or racking. When closed the gates rest on wood filler blocks anchored to 6-in. channels concreted into the floor. Bearing pins are so arranged in the piers that they may be easily withdrawn, allowing the gates to be removed. One-man hoisting winches on top of the spillway operate the gates by means of wire cables.

When the contract for the improvements on the spillway and wasteway was first let, it was deemed sufficient to line the wasteway for the first 450 ft. to a natural draw as it was thought that this draw was underlaid with a rock formation similar to that through which the cut was made. After the wasteway had been cut down to the lower elevation the bed of the draw was found to consist of sand and gravel to a considerable depth. It was then decided to extend the wasteway 900 ft. through the next ridge to a second natural draw. The entire wasteway is lined with 6 in. of reinforced concrete. The first 450 ft. is on a grade of 0.05 per cent with the concrete lining carried up the sides to a height of 10 ft. Beyond this point the grade was increased to 1.75 per cent, the section reduced to 20 ft. in width and the concrete lining extended up the sides to a height of 5 ft.

As the distance between the mouth of the wasteway and the river is 400 ft. and the difference in elevation is 25 ft., it is planned to construct a number of concrete cut-off walls to prevent scour in the bed of the draw.

A maximum discharge capacity of 10,000 sec.-ft. is provided in the spillway and wasteway for two reasons: (1) The Otter Creek reservoir which has a capacity of 50,000 acre-feet is located on the East Fork of the Sevier River about 25 miles above the Piute reservoir, and it was decided to provide sufficient capacity to take care of the flood that might result through the failure of the Otter Creek dam without danger of the Piute dam being overtopped; (2) the history of most earth-dam failures shows that the dams were overtopped during extreme flood stage due to insufficient spillway capacity.

As a rule floods which overtop dams are of an unprecedented nature, far greater than any of record. While the maximum flood flow of the Sevier River of which there is any record is 3,300 sec.-ft. it was deemed advisable to have a spillway of a capacity of at least three times this amount. Another feature that entered into the design of this spillway is the fact that at the present time reservoir right-of-way has been secured only up to the 70-ft. contour. To impound water above this elevation will cause it to back up into the town of Junction, located at the upper end of the reservoir. No arrangements have been made as yet to utilize the storage between the 70- and 80-ft. contours nor has the project developed to the stage where this additional storage is required. It was therefore deemed advisable to bring the bottom of the spillway to El. 70 so as to have absolute control of the water above that elevation.

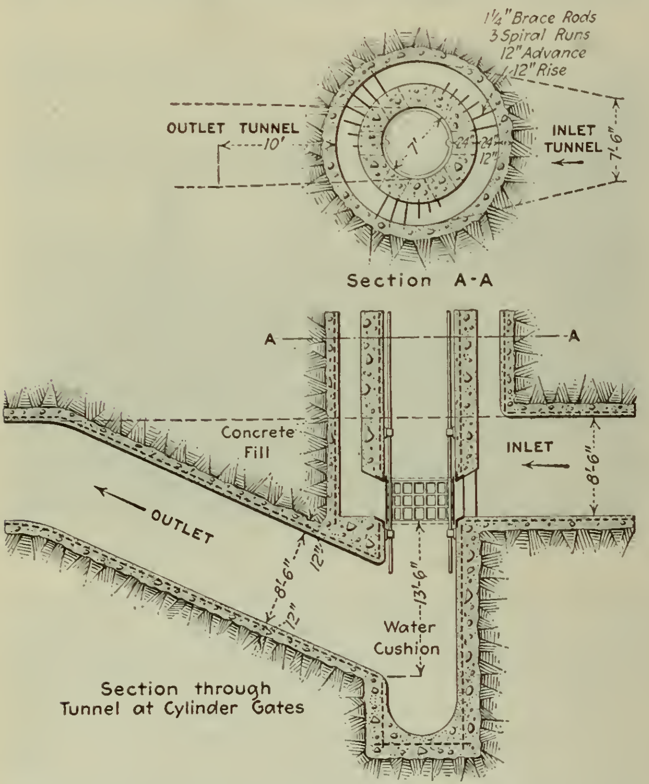
Cylinder Auxiliary Gates.—Auxiliary outlet control

SPILLWAY WITH RADIAL GATES CLOSED

gates of the cylinder type are a feature of the improvements. It was considered that all dams impounding large quantities of water for irrigation purposes should be equipped with a dual outlet control so as to obviate the danger of loosing the stored water in case one set of gates becomes broken or disabled while in operation. This necessity at the Piute dam was illustrated forcibly several years ago when it was discovered that two of the three slide gates at the head of the outlet tunnel were cracked and a piece about 1 ft. square broken out of one of the gates. Had the gates broken during the irrigation season, releasing the water in the reservoir, it would have resulted in the loss of the season's crops valued at approximately $1,000,000. The gates were made of cast iron designed to operate under a maximum head of 80 ft. Cracking was due probably to excessive vibration. New cast-steel gates were placed and have been in operation since then.

A short tunnel was driven from the crest of the dam into the ledge rock to a point above the outlet tunnel, a shaft 17 ft. in diameter being then sunk to intersect the outlet tunnel 100 ft. back of the old gates. Within this shaft and concentric with it is an inner shaft formed by a reinforced-concrete cylinder 7 ft. inside diameter with walls 2 ft. thick, this cylinder being anchored to the outer shaft wall at intervals of 20 ft. with 6-in. I-beams. The outer shaft is lined with 12 in. of reinforced concrete. The annular space connects with the upper portion of the outlet tunnel while the inner shaft extends 15 ft. below the floor of the tunnel and connects with the lower portion of the outlet tunnel by means of an inclined shaft. The outlet tunnel immediately below the outer shaft is closed with a block of concrete 4 ft. thick.

In the inner shaft are set two steel cylinder gates, one at el. 0 and the other at el. 40, these gates fitting into cast-steel frames in the concrete cylinder. Each frame has six 2 x 3-ft. openings. The water entering the outlet tunnel rises in the outer shaft to the same height as the water in the reservoir. By raising the cylinder gates the water is admitted into the inner shaft, falls to the bottom and is forced up the incline shaft into the lower end of the outlet tunnel from which it flows without being under any appreciable hydraulic head. The cylinder gates when raised expose the same discharge opening for each intake. The



SECTION THROUGH TUNNEL AT LOWER CYLINDER GATES

intake openings in each gate frame are arranged in pairs diametrically opposite so that the water rushing through them has a tendency to balance the hydraulic pressure. The purpose of carrying the inner shaft 15 ft. below the floor of the tunnel is to provide a water cushion for the water falling down the shaft.

The gates are operated by means of specially designed man-power gate hoists set on a steel platform over the top of the shaft. Each gate is connected to a gate hoist by two 3-in. stems 180 deg. apart. These stems are kept in alignment by means of specially designed torsion guides anchored into the concrete cylinder. The upper gate will be used when the water in the reservoir is above el. 40 and the lower gate when the water is below this elevation.

In sinking the outer shaft the contractor first sank a hole 4 ft. square to the outlet tunnel. He then enlarged this hole to the dimensions of the outer shaft, allowing the material to fall down to the floor of the tunnel from whence it was mucked out in cars. The construction of this auxiliary control was begun in the winter of 1919-1920, but when the irrigation season began it had to be discontinued on account of the opening of the reservoir gates. The work is half complete and will be resumed as soon as the reservoir gates are closed for the 1921 season's storage. These cylinder gates will be used in operating the reservoir, leaving the slide gates at the head of the outlet tunnel for emergency use.

Diversion Dam.—The Sevier Valley Irrigation Co., years ago, built a rock and brush dam across the river at the head of its canal to act as a diverting structure. This structure was 110 ft. long, 15 ft. high and of very porous construction allowing fully 50 per cent of the water to pass through it. Furthermore, the dam would have to be partially replaced after almost every flood. One of the provisions in the agreement between the State and the company for the enlargement of the latter's canal was that the State should build a permanent diverting structure across the river at the head of the canal. The old diverting dam being located at a sharp bend in the river was in an unsuitable location for a permanent structure, so a more suitable site for a new dam was selected ¼-mile upstream.

This new diversion dam is a concrete structure of the combination spillway and headgate type. The spillway is 87 ft. long, 6 ft. high, has an ogee section and rests on a sand and gravel foundation. It was designed according to the Bligh theory of weirs on porous foundations, using a value of 10 for C. On this basis with three concrete cut-off walls 4 ft. deep, an apron 25 ft. in length was required. The spillway section was so placed on this apron that 8 ft. of the apron extends upstream from the upstream face of the spillway. In addition a heavy riprap floor, cement grouted into place, was constructed across the entire river bed for a distance of 25 ft. from the downstream edge of the apron to prevent scour immediately below the apron.

The headgate portion of the structure is 48 ft. over all and contains four 4 x 10-ft. steel radial gates set between concrete piers with concrete curtain walls above the top of the gates. These gates are similar to those installed at the Piute dam. The piers are provided with stop-log slots so that any one of the gate openings may be closed to allow the removal of the gate for repairs. The headgate is set at an angle of 112 deg. with the spillway so as to draw water from the stream at right angles to the main current. As the Sevier River, especially during flood stages, carries considerable silt it was hoped by this arrangement to reduce to a minimum the amount of silt that might enter the canal. In addition, a sluiceway 4 ft. wide was constructed at the point where the spillway and headgate join. The sluiceway is kept open at all times, allowing a portion of the water, that must pass by the structure to satisfy prior rights below, to pass through the sluiceway.

The structure has been in operation now for the past two years. During this time it has been discovered that it operates best when a 12-in. stop log is placed across the bottom of each gate opening. There is less silt deposited in front of the gates and less enters the canal than when there is no obstruction in front of the gate openings.

Immediately below the spillway the river wound around in shape of a letter S within a distance of 2,000 ft. This portion of the river has been straightened by making a preliminary excavation sufficiently large to start the water down it. Forcing the water through this excavation made it cut its own channel.

The turnout gates installed in the canal at the time it was constructed were built of wood but these

are now being replaced with cast-iron turnout gates. The latter are designed with the face and frame supporting the operating stem on a slope of 45 degrees.

The cost of this improvement work was as follows:

Strengthening dam	$67,763.84
Spillway and wasteway	92,453.09
Auxiliary gates (estimated)	39,189.10
Diversion dam	17,569.14
Lateral turnout gates	12,581.00
	229,556.17

The entire improvement work on this project was under the direct supervision of George F. McGonagle, state engineer. E. S. Borgquist was the resident engineer directly in charge of the work at the dam. He also designed the structure for the cylinder gates. The plans for strengthening the dam and for the spillway, wasteway and diversion dam were designed by the writer. The cylinder gates were designed and furnished by the Lynch Construction Co., of Salt Lake City. The Heiselt Construction Co., of Salt Lake City, had the contracts for the improvement work at the dam. The diversion dam was constructed by force account with H. S. Kerr as engineer in charge.

Committees on Highway Maps and Co-ordination Present Reports

TWO reports, regarded as being of special importance, were submitted at a meeting of the Board of Surveys and Maps held in Washington, Oct. 12. One of the reports was from the Committee on Highway Maps and the other from the Committee on Co-ordination. In addition, the Committee on Hydrographic Charts called attention to the importance of the International Hydrographic Bureau which is now being established. According to the procedure of the board, committee reports are referred to the advisory council and copies are sent to each member of the board. In some cases it is expected that important changes will be made in the reports before they are accepted. The report of the Committee on Highway Maps supplements a previous report. The report is signed by C. D. Curtis and reads as follows:

1. The committee has considered the recommendations of the executive committee in commenting on its preliminary report to the effect that the surface condition of roads be indicated on the maps and has reached the conclusion that it would not be feasible to do this. This conclusion is based largely on the fact that with the present large program of highway improvement the maps would in many respects be out of date soon after being issued. In considering this matter the Chief of the Bureau of Public Roads was consulted and he concurs in this opinion. The question was also discussed with the members of the executive committee of the American Association of State Highway Officials. They were unanimously in favor of indicating the highways in accordance with a classification placing them into groups of equal or like importance.

The highways of France are divided into five principal classes. It is the belief of the committee, however, that four classes will adequately cover practically all of the highways in the United States. These four classes can be named as follows: National or Interstate, State, County, and Local; or Main through routes, important secondary routes, lateral or branch roads, and local roads. In isolated cases it might be found necessary to provide a fifth class which would include semi-private and private roads.

The matter of names given to the various classes of highways is relatively unimportant and the committee will be governed in its recommendations by the advice of the American Association of State Highway Officials.

2. In its preliminary report the committee expressed the belief that a quadrangle type map would most nearly meet the general need. We are now prepared to recommend a quadrangle map covering one degree in latitude by two degrees of longitude on a scale of 1:250,000, or approximately 4 mi. to the inch. This map to carry a 2-mi. overlap in each direction in order to provide for ready transfer from one sheet to another.

In sections where, owing to a multiplicity of roads, the 1:250,000 scale is not sufficiently large to prevent confusion, it is recommended that the scale be changed to 1:125,000 covering ½ deg. latitude by 1 deg. longitude with a 1-mi. overlap.

3. The committee does not wish to encroach on the work of the committee on technical standards but desires to suggest that a distinctive legend be chosen for each class of highway, that the width of highway be exaggerated, that the data shown on the topographic atlas sheets with the exception of isolated buildings be reproduced in so far as possible on the highway maps and that a tinted background be used. It will be necessary of course to eliminate many of the contours and the interval cannot be kept constant.

Co-ordination Committee Report

In reporting upon the proposition of co-ordination of all map-making agencies, the Committee on Co-ordination stated that the advantages to be secured at this time from such consolidation were purely problematical and the committee deemed it unwise to make such a radical recommendation under existing conditions. It pointed out that each map-making agency only supplied its bare need, and were consolidation of all map-making agencies secured it would be almost inevitable that subsequent decentralization of control would result. In other words, with all map-making agencies under a central control, the diversity of interest would lead to the establishment of practically the same independent agencies as now exist.

Consolidation of map-making agencies might be practical and desired later on, particularly should a general appropriation be made by Congress for the support and administration of the single map-making body. Under present conditions, each map-making agency spends so little of its entire appropriation upon map making that such money as it would be able to set aside for the administration of a central organization might not be adequate.

In view of such conditions the committee headed by C. O. Sherrill, therefore, made the following recommendations:

(1) That for the present, no general consolidation of the mapping activities of the various Federal organizations be advocated.

(2) That as recommended in the report of the conference of representatives of the Federal map-making organizations, the United States Coast and Geodetic Survey be charged with the execution of the precise and primary control of the area of the United States, and the United States Geological Survey be charged with the execution of the tertiary control and the topographic mapping.

(3) That every legitimate effort be made to secure such appropriations for these two organizations as will insure rapid progress in a mapping program which will meet the needs of the map using organizations of the government. This will soon result in an absolute cessation from topographic work by at least four of the nine Federal organizations now actually engaged in such work.

(4) That the Board of Surveys and Maps prepare specifications for surveying and mapping and urged that these be followed by such organizations as may properly continue to do such work.

(5) That the co-ordination committee be empowered to take such steps as may be proper to keep in touch with the mapping progress of the various Federal organizations

and arrange for the execution of the various projects and the fullest possible co-operation with other organizations. Personal contact with the officials in immediate charge of the various surveying and mapping activities will bring results more quickly and more satisfactorily than will formal action by the board. Considerable progress has already been made by the committee along these lines.

The committee reported that it believes there to be greater and more serious duplication in map compilation and map reproduction than in the actual carrying out of field operations. For the purposes of study and comparison the committee grouped Federal map-making organizations into three classes, the first being those whose principal function should be surveying and mapping and including The Coast and Geodetic Survey; Topographic Branch, Geological Survey; Surveying Service, General Land Office; International Boundary Commission; Lake Survey, and Hydrographic Office. The various services which the committee named as possessing surveying and mapping as an incidental function included the Corps of Engineers, Forest Service, Bureau of Soils, Reclamation Service, Bureau of Indian Affairs, and the Mississippi River Commission. As map compilers it cited the Topographic Branch, Post Office Department; Bureau of Public Roads; and the Military Intelligence Division, General Staff.

Changes in St. Paul City Charter To Facilitate Paving

THE adoption by popular vote of two amendments to the city charter of St. Paul, Minn., designed to facilitate pavement construction by (1) limiting assessments for benefits to abutting property to a strip 12 ft. wide (on either side of the street) and by (2) allowing the use of wheelage taxes for paving, repaving and repairing streets, was noted briefly in our news pages Nov. 11, p. 961. The two amendments, each being an addition to Section 235 of the charter, follow:

Provided further, that the amount which may be assessed against abutting property for paving any street, boulevard, parkway, or other highway shall not exceed the cost of a strip of such pavement 12 ft. wide adjacent to the property thus assessed. The cost of the pavement, over and above the amount assessed against all property benefited, shall be paid out of city revenue or from money raised by bond issue or both. Where a permanent pavement has once been laid and paid for, in whole or in part, by special assessment such benefited property shall not again, for a period of fifteen years, be assessed for repavement or for repairing pavement.

Provided further, that nothing herein shall prevent the council from appropriating such sums as it deems advisable, from the moneys collected as the license fee on vehicles for the use of the streets, toward defraying the cost of repairing paved streets and the cost of new paving or repaving of streets and boulevards, and expenditures made from the proceeds of said license fee on vehicles shall not be considered as part of the cost of government as such cost is limited and defined by Section 201 of the charter.

Prior to these amendments the charter provided that all paving in St. Paul must be paid for by the property benefited, but in cases of property of low value the council had authority to order the cost of paving street intersections to be met by the general fund of the city. We are informed by George H. Herrold, managing director of the city Planning Board of St. Paul, that the Assessment Bureau never has assessed paving benefits for the street paved upon any property back of the center of the block.

Cement Plaster Lining for Wood Irrigation Flumes

Experience on Three Flumes Aggregating 1,560 Feet Indicates Success at Cheaper Cost Than All-Wood Flume

By Everett N. Bryan
Chief Engineer, Waterford Irrigation District, Waterford, Cal.

THREE flumes in the distributing system of the Waterford Irrigation District, Waterford, Cal., have been constructed with box siding and flooring of 1-in. No. 2 Oregon pine lumber to which was applied a 1-in. cement plaster lining in order to secure watertightness. The success which has attended the application of this type of construction to flume building warrants a description, together with notes on the experience of some earlier instances of similar construction by other parties.

As an experiment the Modesto Irrigation District, Modesto, Cal., in 1908 lined 50 ft. of an old wooden flume 5 ft. deep and 12 ft. wide across Dry Creek with 1 in. of cement plaster applied on a ⅜-in. galvanized plain wire mesh tacked to the wooden floor and sides. The box was made of 2-in. select, surfaced redwood. Owing to age the flume had decayed until it was difficult and very expensive to calk sufficiently to prevent excessive leakage. In an attempt to prevent excessive leakage the experiment was entirely successful but the treatment was not extended to the remainder of this flume nor to other flumes of the system because both the flume box skeletons and the substructures were badly decayed and the flumes were not designed with sufficient capacity. Locally the use of this method for patching old flumes has been employed and some short flumes of small cross-section were designed and constructed after this fashion.

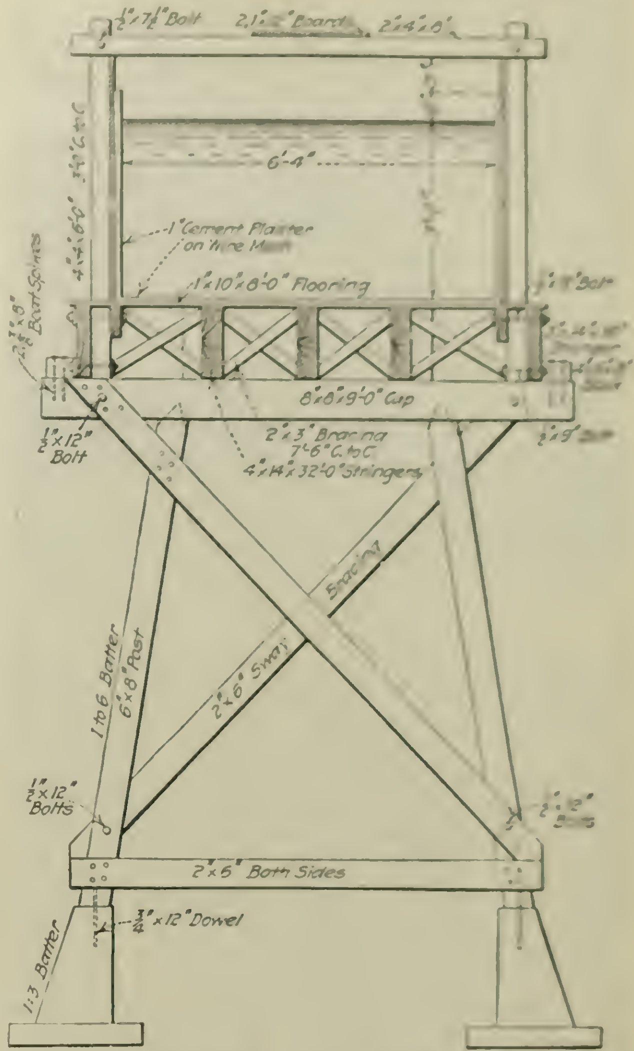
In 1913 T. K. Beard, general contractor, lined an elevated tank at Cooperstown, Cal., with cement plaster for the storage of crude oil. The tank had a base 15 ft. square, a depth of 5 ft. 8 in., and a capacity of 9,500 gal. In this case a ¾-in. lining was applied in two coats to expanded metal lath tacked to 1-in. rough board siding. There has been no occasion to use this tank recently but it served its purpose satisfactorily when needed. A recent examination showed it to contain a 12-in. depth of crude oil and rainwater. Above this mixture the sun and rain had thoroughly cleansed the sides so as to admit close inspection. Only fine hair cracks appeared.

The success of these local experiments led to the consideration of this type of construction by the Waterford Irrigation District for three of its larger flumes. Comparative estimates made of metal, wood and plaster-lined flumes indicated that the latter could be built at least first cost. It was also believed that the plaster-lined flume would have a longer life and a much less annual maintenance cost than the plain wooden flume.

In the winter of 1916-17 the first experiment was made on a flume 900 ft. long 6 ft. 4 in. wide and 4 ft. deep. Bents, stringers and box skeleton were of "merchantable grade" Oregon pine. The box siding and flooring were of No. 2 Oregon pine, 1 in. in thickness. A ⅜-in. wire mesh of No. 20 gage, with "V"-shaped metal ribs attached transversely 8 in. c. to c. was first tacked securely to the inside of the box. The

metal ribs held the mesh out approximately ¾ in. from the lumber siding and the scratch coat of plaster was made just thick enough to cover the mesh. The second coat brought the thickness up to the required minimum of 1 in. The plaster was composed of one part cement, three parts sand, and dry hydrated lime equivalent by weight to 10 per cent of the cement.

Attention is directed in the drawing to the absence of cross-sills for the floor, the box flooring being laid crosswise and nailed directly to the stringers. It will be noted that the side posts of the box are bolted to the inner side of the outside stringers and no braces are used to prevent them from spreading at the bottom when the box is filled with water. They are held at the bottom solely by the outside stringers, which are themselves tied together by the nails in the ends of the floor boards and further stiffened by toe blocks on top of the bent caps and 4 x 6-in. cross-ties dapped and spiked to the bottom of the stringers half way between bents. So great was the rigidity thus secured for the side posts that even before the siding was nailed on or the top cross-ties were in place, the posts would break off above the floor, if sufficient pressure were exerted near the top, without in any manner displacing the base. Bents were usually low and it was pressure of the top of the post against the side grain in the cap rather than stresses as a column which governed the design of the posts. Mudsills were entirely eliminated by placing the base of the posts directly upon a concrete footing, thus eliminating another frequent point of initial failure for wooden bents.



TYPICAL BENT OF PLASTERED FLUME

Expansion Joints

It was not possible to place this flume in actual service during the irrigation season of 1917, but as a test bulkheads were built at the lower end and at the middle to permit filling by pumping soon after completion. Some fine cracks showed in the lining but the leakage was negligible and it was decided to build two more flumes of the same type. Plans were drawn and the flumes were constructed during the following winter, one being 330 ft. long, 5 ft. wide and 3½ ft. deep and the other 330 ft. long, 7½ ft. wide and 4 ft. 10 in. deep.

No expansion and contraction joints were provided in the first flume built and in a few months it had separated from the headwalls at each end, leaving a crack almost ⅜ in. in width. A home-made expansion joint was developed and installed at each end. Joints of a similar design were built into the two new flumes at the time of their erection. The joints consisted of a 14-gage galvanized-iron tongue bolted to the concrete headworks and projected beneath the plaster lining on the sides and bottom, where it was enveloped by a slot which was a narrow strip of 20-gage iron bent back upon itself. The tension of the slot upon the tongue was regulated by bolts at intervals—the tongue being split at these points to admit of its free movement to and fro. The workmanship upon these joints was crude, and while their operation has met with a fair degree of success it is believed something more positive in its operation should be recommended. The gap between the headwalls and the plaster lining has widened on the first flume since the joints were put in and on the two later flumes it is plain that had no joint been provided there would have occurred a similar rupture at each end of the lining. As it is, the tongue has simply been withdrawn from the slot. There is some movement both ways at these joints but the principal movement is due to shrinkage of the flume box in length.

There are no longitudinal cracks of any consequence in any of the flumes—the only tendency to crack seeming to be in almost straight transverse lines over the "V" ribs of the mesh, where the cross-sectional area of the plaster is diminished by approximately one half. In some places traces of these cracks may be detected over almost every rib for a short distance but it has been found easy to close all of them on the short flumes, and all those near the ends of the long flume, by painting the interior of the flume boxes with hot asphalt. The middle third of the length of the long flume, however, contains some transverse cracks up to $\frac{1}{16}$ or $\frac{3}{32}$ in. in width which cannot be closed by the asphalt coat. Apparently there is movement at these points too great for the asphaltic film to withstand. The absence of cracks in the oil tank described above and their character in the flumes would seem to indicate that expansion joints should be placed not farther than from 300 to 400 ft. apart.

The coating of asphalt applied required approximately 125 lb. per 1,000 sq.ft. A crew of three men put on 12,000 sq.ft. in three days. At first an attempt was made to brush the asphalt on with ordinary house brooms

but the results so obtained were not satisfactory. The best method was to apply the paint to the sides with paint or whitewash brushes and to the bottom with an ordinary floor mop.

On the first flume common labor was paid an average of $2.75 per day, carpenters and helpers from $3.50 to $4.50 per day and the plasterer $4 and $4.50 per day. The work was carried out under contract with Gorrill Brothers, contractors, San Francisco. Unit costs were as follows:

Cost of Woodwork per 1,000 ft. b.m.	
Lumber delivered	$25.44
Nails, bolts, washers, etc.	3.66
Labor erecting	11.30
Total	$40.40

Cost of Plaster Lining, per Square Yard, Cents	
Mesh delivered	25.4
Laying mesh	6.1
Labor and tools applying mesh	14.0
Watering and curing	3.3
Cement, lime and sand	18.4
Total cost per square yard, cents	67.2
Total cost per 1,000 sq.ft.	$74.65

The No. 2 grade of Oregon pine used for box siding and flooring cost $20.50 per 1,000 ft. b.m. delivered. It was ordered to length so that no cutting was required for the siding and only one cut was required for each two floor boards. No effort was made to secure a close fit of these boards—in fact for the later two flumes it was specified that cracks of ½ in. should be left between them to prevent bulging when the boards became wet. Common labor was used mostly in putting the box together and, though no separate costs were kept of this part of the work, it went together quickly at a cost which may be safely assumed at less than $5 per 1,000 ft. board measure.

The cost of the flume box was therefore very close to $100 per 1,000 ft. of surface. Had it been built entirely of wood it would have been advisable to use 2-in. select cedar or redwood. To compete in first cost with the plaster-lined flume this wooden box would have to cost less than $50 per thousand feet board measure including battening and calking. Such lumber was at the time worth considerably more than that in the yard.

The annual maintenance cost, as was anticipated, has proved lower than for a wooden box flume, the recalking and reasphalting of which is necessary each time the water is out for a short time. It has been found that no matter how long the water is out of the plaster-lined flume it may be safely turned back without extensive repairs.

Coatings Reduce Bond Strength of Steel

Results obtained in a special series of tests of bond strength of steel embedded in concrete are reported by the Bureau of Standards as follows: Galvanizing reduces the bond strength, but painting reduces it considerably more. Any coating allows a noticeable amount of slip in the case of deformed bars before the corrugations or lugs reach a firm bearing, but when they come to bearing the bars act substantially as do uncoated bars of the same form. However, coated bars develop a smaller fraction of their maximum bond strength in attaining a slip limit of 0.001 in. than do uncoated bars. Lap splices require a lap length of about 48 diameters to give a satisfactory splice; this result was reached with ½-in. bars embedded in unusually strong concrete (5,000 lb. per square inch).

Engineering Details of Newspaper Publishing Building

Mechanical and Business Needs Govern Layout and Structural Design of New Springfield "Republican" Plant

By Charles F. Dingman
Engineer, Flynt Building & Construction Co., Palmer, Mass.

When competition between rival newspapers for circulation becomes very keen, the saving of even a few minutes in the time of getting the papers on the street assumes a commanding importance. In fact, this saving of time is so vital that it becomes the dominating feature of the layout when the construction of a new publishing plant is undertaken. In the design of the new plant for the Springfield, Mass., *Republican,* described by the owners as "the last word in practical newspaper housing," every portion of the entire plant layout, as well as the structural design of the building, was governed by the dominant idea that the papers must be on the street in the least possible number of minutes. This condition was responsible for a rather unusual column spacing and also made it impossible to use any of the standard types of column caps or pintles for most of the locations.

NEW BUILDING FOR THE SPRINGFIELD *REPUBLICAN*
Note irregular column spacing and large window space.

The building is of modified mill construction, a basement and three stories in height, and occupies the entire area of a plot practically 100 ft. square at the northeast corner of Cypress and Boylston Sts. Since the location is off of the principal business street of the city, architectural attractiveness was not permitted to exert as strong an influence on the exterior design as did considerations of utility and economy, but it is felt that the final appearance is entirely satisfactory.

The basement, which is rather deeper than usual (11 ft. 11 in.), houses the heating plant, fuel storage, ink storage, transformer vault, print paper storage and a fireproof vault which will contain a complete file of the *Republican* since its establishment in 1824.

The first floor contains the press-room, the second floor the offices. The composing and stereotyping departments, as well as the staff photographer's laboratory are on the third floor. This arrangement of departments is part of the general plan to secure the most efficient production and quickest delivery.

All of the editorial work is done in the offices on the

second floor, the rooms of the various editorial and reportorial departments being arranged along the west and north walls of the building, the business offices along the front or south wall and the stairway, toilet rooms, emergency hospital, etc., along the east wall. The window arrangement, as will be seen from the pictures, provides for the utilization of the maximum of natural daylighting.

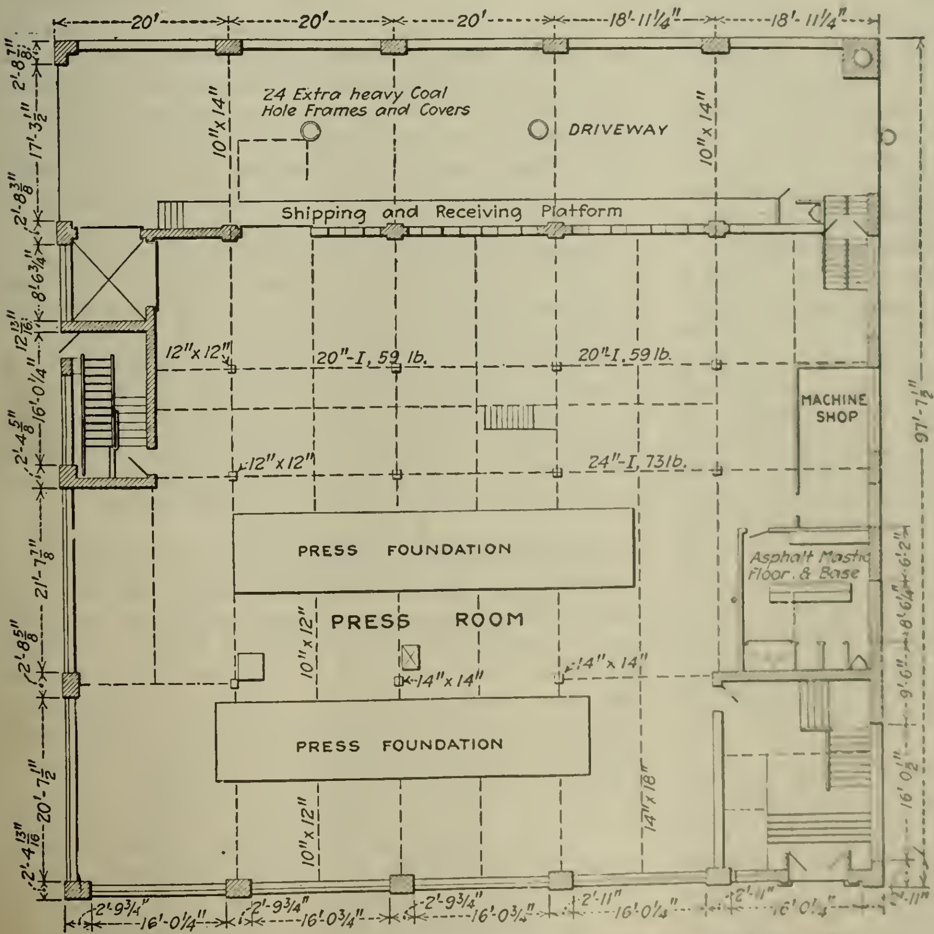
In the center of the hollow square formed by the offices is the reference library, located there to provide easy access for any of the staff who have use for it. It is lighted partly by a light shaft extending through the third story to a skylight in the roof and partly by borrowed light through the glass partitions which surround it.

Communication between the editorial departments and the composing room is by means of a spiral iron stairway at the head of which is the proof-readers' office. The third floor was chosen for the composing room because it was possible to provide, by four rows of sawtooth skylights in addition to the large side wall sash, for the maximum amount of daylighting in every part of the room.

INTERIOR VIEW SECOND FLOOR SHOWING COLUMN CAP DETAILS

Directly adjoining the composing room is the stereotyping room, which presented a peculiar problem aside from the fact that it is the portion of the building carrying the highest unit live floor load. The equipment of the room includes a gas fired melting pot and an auto-plate casting machine, the latter being equipped with water jets for cooling the plates.

This equipment made it necessary that the floor should be waterproofed and also protected against the high heat (about 700 deg. F.) under the melting pot. At first it was thought that it might be advisable to install a concrete slab floor in the section occupied by the stereotyping room but, inasmuch as the remainder of the building was of mill construction and the columns were of wood, this idea was abandoned and the plank were covered with ⅛-in. steel plates, having waterproofed joints, and a platform of ½-in. asbestos wood sheets was installed under the melting pot.

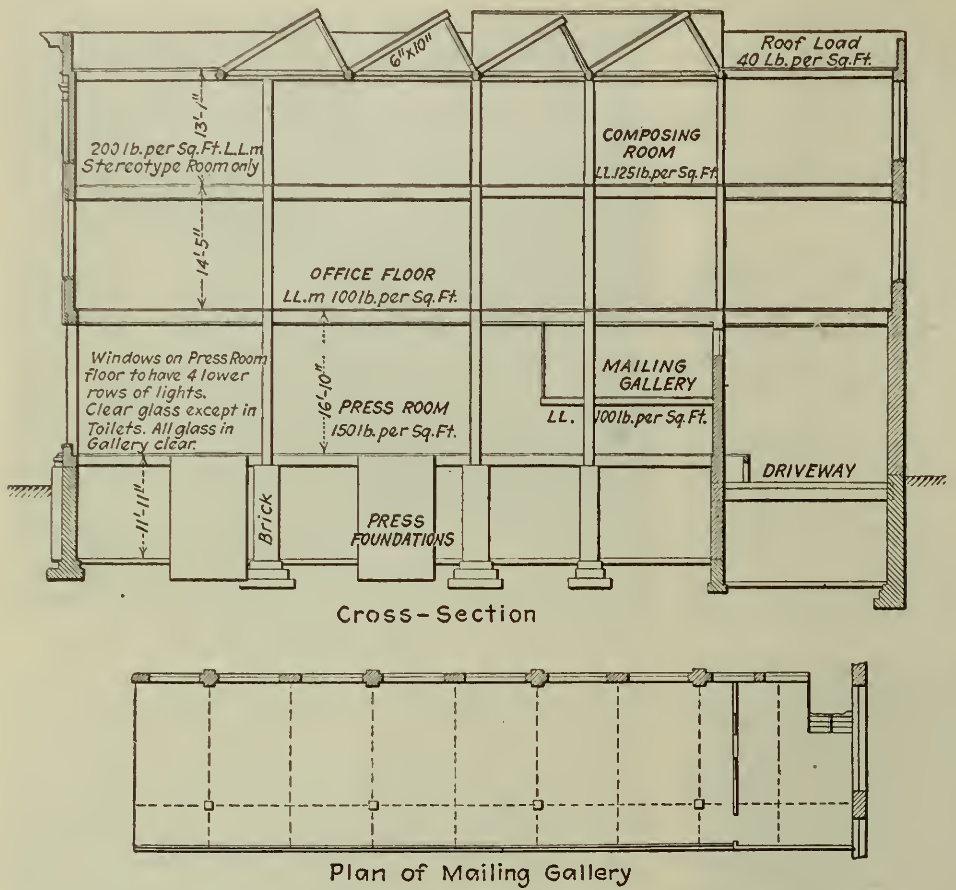


FLOOR LAYOUT OF FIRST FLOOR OF SPRINGFIELD *REPUBLICAN* NEWSPAPER PLANT

The stereotype plates are conveyed from the stereotyping room to the press room on the first floor by means of a Miles plate drop, which also returns them to the stereotyping room for remelting.

In designing the press room consideration was taken of the interest which printing presses in action always have for the public, so, even though the plant is not on the principal street, the sills on the front of the building were kept down close to the floor in order to permit people standing on the sidewalk to watch the presses.

The press room layout was really the dominant factor in determining the column spacing. In order to place the two presses, which are of the Hoe multiple web type having a combined capacity of 60,000 complete 32-pp. papers per hour, side by side and parallel to the front of the building, and at the same time provide necessary clearances for re-



(2) ELEVATION OF *REPUBLICAN* BUILDING

moving rollers and other work around the presses, it was necessary to make the two front bays each 23 ft. wide and the driveway at the rear necessitated a 20-ft. bay there, leaving only 28 ft., too much for one bay and too little for two full bays so, while the interior columns divide the span into two bays, a compromise was effected which resulted in the rather unusual pilaster spacing shown in the picture of the Boylston St. elevation.

This irregular spacing of the columns from front to back (they are evenly spaced in the other direction) resulted in having the horizontal members which meet at the columns of greatly varying depths. To have developed a satisfactory column cap with a bracket for each member would have been very difficult and certainly very expensive. Therefore, an ordinary cast-iron bracket cap is used to support the members whose soffits join the column at the lowest level and to serve as a base for the column above, no pintles being used. The other horizontal members are then carried on angles, the vertical leg of which is gained into the column and retained by lag screws, and the load is transmitted down to the column cap by pieces of steel channel which are fitted tightly between the underside of the angle and the top of the cap and held against the column by screws. Douglas fir timber and floor plank were used throughout.

The presses are supported on brick foundation walls resting on independent concrete footings below the cellar floor level and the pits formed by the press foundation walls contain steam radiation coils to maintain a temperature that will permit of satisfactory operation even in the coldest weather. The presses are electrically operated with Cutler-Hammer full automatic control, the control mechanism being located on a gallery adjoining the entrance to the press room.

As the finished papers come off the presses they are carried by automatic conveyors directly to the mailing room. This is located on a mezzanine gallery over the rear portion of the press room. Those papers which will be sold to local newsboys are passed to the east end of the mailing gallery where a carriers' room has been provided. Communication between the driveway and the carriers' room is by means of an iron stairway with a screen partition dividing it into two parts. The newsboys go up one side of the partition, pass the delivery window and receive their papers and thence down the other side and out without loss of time.

The other papers, which go out by mail or otherwise, are sorted and bundled and dropped on to sheet metal chutes which deliver them to the platform in the driveway below. This driveway, which is really a part of the building itself, extends through the rear section of the first floor and permits ten automobiles to receive their loads at one time and to pass on through without any turning around. There is no confusion in loading as the papers are sorted above and each truck simply backs up to the section of the platform assigned to it and receives its assignments through the chute.

This same driveway is used, outside of edition times, for receiving fuel and print paper, the coal hole openings being placed in the driveway directly over the bins so that no handling is required.

The mechanical layout of the plant is the work of Sherman H. Bowle, general manager of the Republican Co., while the building itself is the work of the Flynt Building and Construction Co. of Palmer, Mass., and New York City, the writer being the engineer in charge and B. L. Dow, superintendent of construction.

Small Warships Lengthened for Peace Service

Convoy and patrol boats built during the war by Great Britain have recently been lengthened to make them adaptable for use in merchant service. As built for the war they were 170 ft. long, and they have now been lengthened to 213½ ft. The work was done in some instances in dry dock, in others on launching ways, up which a vessel was hauled on a cradle. No special difficulties were met in the work. In addition to transforming the hull, the operation of change to merchant service involved reduction of the boiler capacity, rebuilding of the bow portion of the ship (originally shaped like the stern in profile, to deceive an approching enemy), and extensive changes in superstructure, etc. As rebuilt, the ships are of about 1,600 tons displacement and have a normal speed of 10 knots.

The Illinois State Waterway for Barge Navigation

First Contracts for 8-Ft. Channel from Chicago Drainage Canal to Illinois River—Large Locks for Boat Fleets—Flood, Ice and Water Power Plans

A NAVIGABLE connection between the Great Lakes and the Mississippi River, which has been the subject of several projects and considerable controversy during recent years, appears likely to become an accomplished fact within a few years, as the U. S. Government has approved the plans of the State of Illinois for an 8-ft. waterway and the State has awarded the contract for one lock and is inviting bids on other work. A plan and profile of the waterway are shown on pg. 1097.

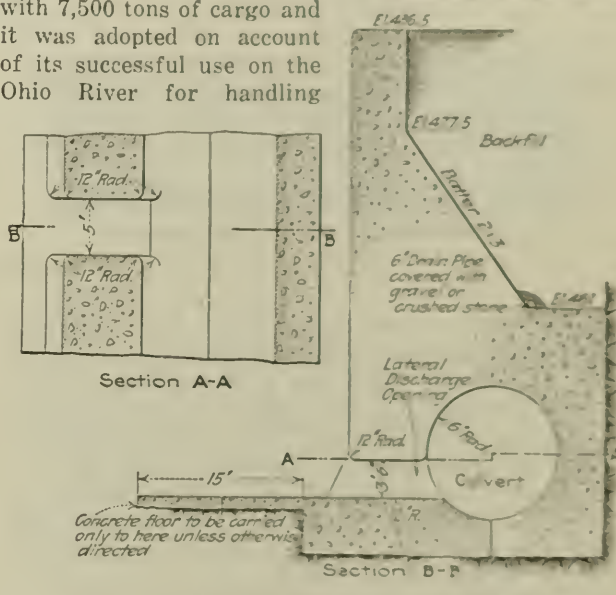
This State project includes canal construction and river improvement from Lockport, at the end of the Chicago drainage canal, to LaSalle on the Illinois River, beyond which point there is an 8-ft. channel in the river. The distance is about 60 miles, with a difference in water elevation of about 123 ft., this difference being provided for by five locks of 41 to 16 ft. lift.

History.—At this stage of development a brief historical review of the project is appropriate. A channel for navigation across the 7-ft. divide between the Chicago River and the Desplaines River has been proposed at various times since the first suggestion by Marquette, the explorer, in 1674. In 1829, the State of Illinois authorized the construction of the Illinois and Michigan canal from the Chicago River to the Illinois River at LaSalle. This was completed in 1848, giving a 6-ft. channel with fifteen locks 18 x 110 ft. Below LaSalle, the State built dams with locks at Henry and at Copperas Creek, in 1872 and 1877 respectively, to give a 7-ft. channel.

In 1883, surveys were made by the U. S. Engineers for extending the 7-ft. channel from LaSalle eastward to Joliet. In 1888, Congress ordered a survey for a 14-ft. waterway 160 ft. wide between Lake Michigan and the Mississippi River. Capt. W. L. Marshall, Corps of Engineers, U. S. Army, reported on alternative projects for 14-ft. and 8-ft. of water, recommending the latter as adequate and preferable. In 1899 and 1903, the U. S. Government built dams in the lower Illinois River at LaGrange and Kampsville, with locks 75 x 350-ft., thus extending the 7-ft. channel to the Mississippi River. In 1904, a board of engineers headed by Col. Ernst reported adversely on a project for a 14-ft. waterway from Lockport to the Mississippi with 80 x 600-ft. locks. Since that time nothing further has been done by the Federal Government. With the opening of the Chicago drainage canal in 1900, the lake-level channel was available as far as Lockport, at which point a lock connection was made later with the old 6-ft. canal.

The waterway project was taken up again by the State of Illinois in 1908, when the people authorized a bond issue of $20,000,000 for a navigable waterway from Lockport to the Illinois River at Utica, and passed an amendment to the State constitution permitting the expenditure of funds for water power purposes. Several plans were submitted, including one for a 24-ft. channel for lake and ocean steamers, but a State board of engineers reported adversely to both 24-ft. and 14-ft. channels. In 1915, the State legislature passed a waterway act and appropriated $5,000,000 for an 8-ft. waterway with 45 x 250-ft. locks, but the Federal government refused to grant the permit necessary for work in the Illinois River and nothing was done to carry the project into effect.

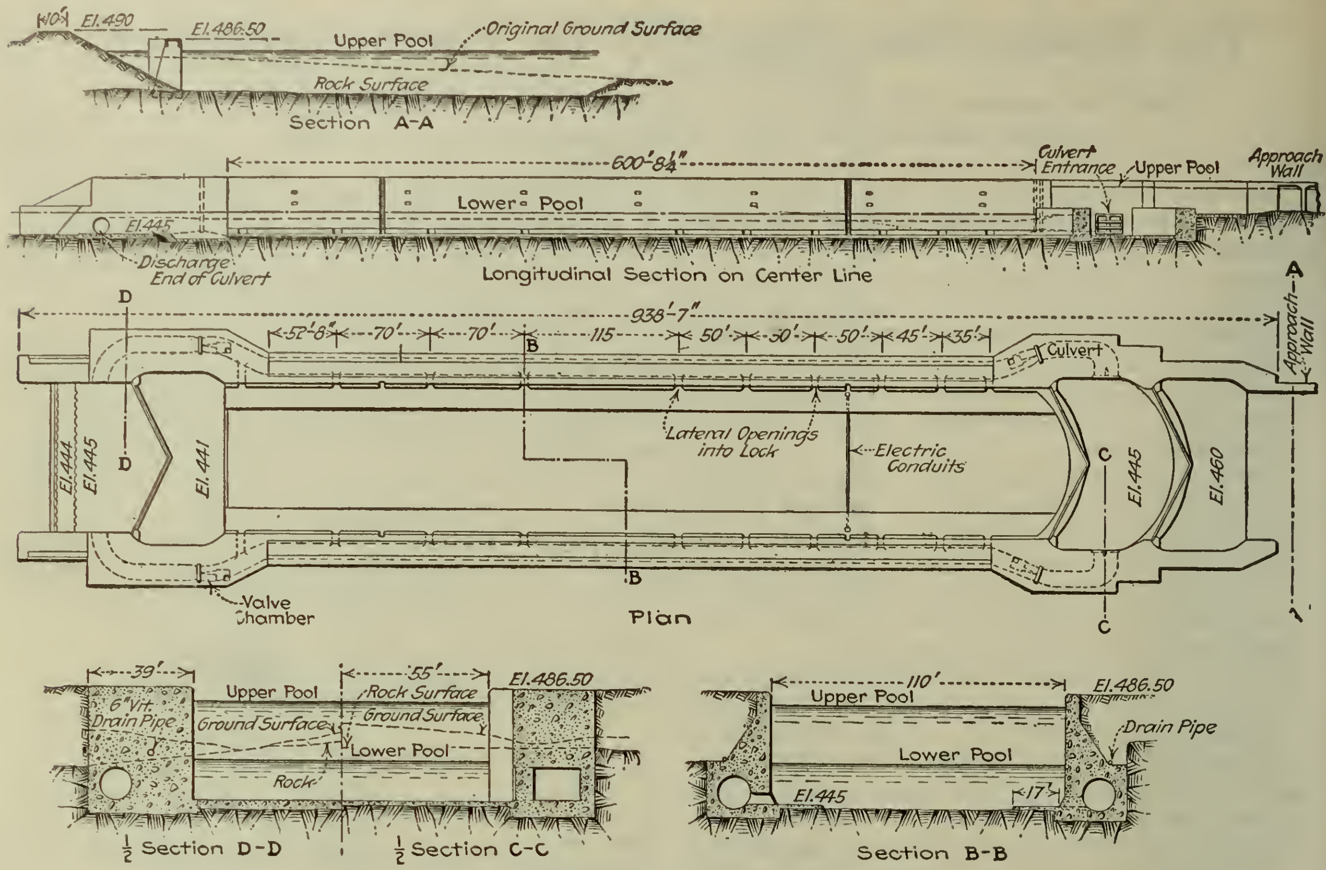
Present Project.—In 1919, the matter was taken up actively by the new Division of Waterways, which had been created in a reorganization of the State administration. Plans were made for a waterway from Lockport to LaSalle, having 8 ft. of water in earth and 10 ft. in rock sections, with a minimum bottom width of 150 ft. Locks are to be 110 x 600 ft., with 14 ft of water on the sills at low-water stages, so as to provide for the possibility of a future 14-ft. channel. This size of lock will permit of handling barge fleets with 7,500 tons of cargo and it was adopted on account of its successful use on the Ohio River for handling barges in fleets. With this project and with the present flow of water from the Chicago drainage canal it will be possible to remove the existing dams and locks in the lower part of the Illinois River and to maintain a 9-ft. open channel from LaSalle to the Mississippi River, as well as in parts of the present project. Water power development to the extent of 60,000 hp. is included.



MAIN CULVERTS FORMED IN LOCK WALLS

In 1919 the State legislature passed an act authorizing the construction of the work thus planned. This act repealed that of 1915, which had been nullified by the opposition of the Federal government. The law provides that the State may construct power plants and lease the output, or it may lease the water to a lessee who will build the plant. In either case, the leases are to be for terms not exceeding 30 years, and in the latter case the plant will become the property of the State on the expiration of the lease.

After the passage of the act of 1919 the general plans were submitted to the Federal government and were approved by the Secretary of War and the Chief of Engineers, U. S. A. An application for permission to develop the water power has been made under the



LOCK AT MARSEILLES, ILL., FOR BARGE FLEETS

provisions of the recent Water Power Act. Proposals have been invited for the construction of some of the locks. In October, 1920, the first contract, for the lock at Marseilles, Ill., was awarded to Green & Sons Co., Chicago, at $1,373,115. This contract does not include the gates, valves or operating machinery.

Excavation for the channel and locks will amount to about 2,500,000 cu.yd., of which 1,500,000 cu.yd. will be for the Marseilles diversion channel and will be mainly in shale. The remainder will be in the river channel and will be largely glacial drift.

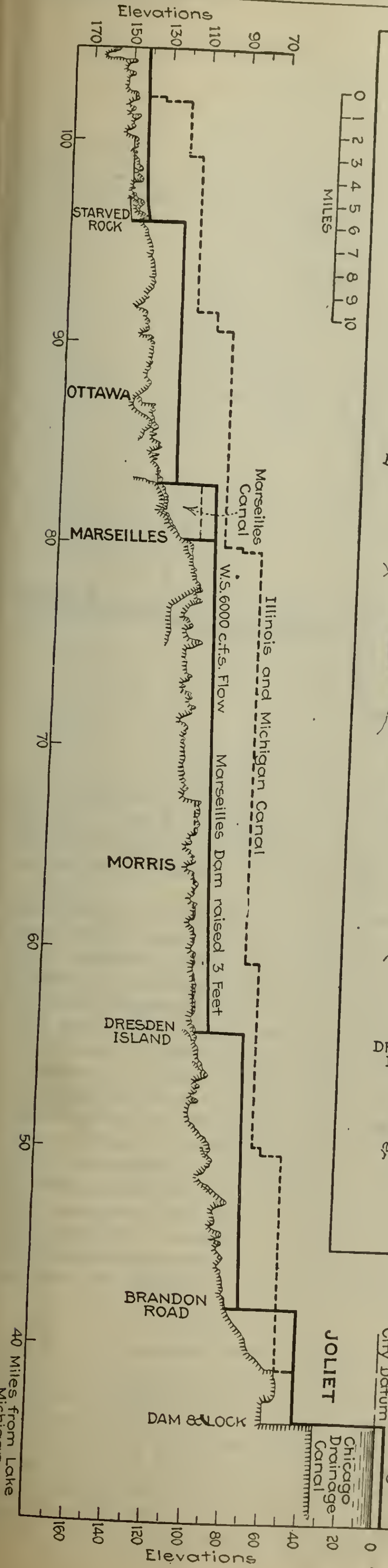
Locks, Dams and Bridges.—Five locks will be required, three with new dams and one in a diversion canal below an existing dam. All locks will be provided with power houses, except at Lockport, where the Sanitary District of Chicago has a hydro-electric plant. The new dams will be of concrete, of the gravity type, and both new and old dams will have movable crests formed by Taintor gates in order to provide ample capacity for the passage of floods.

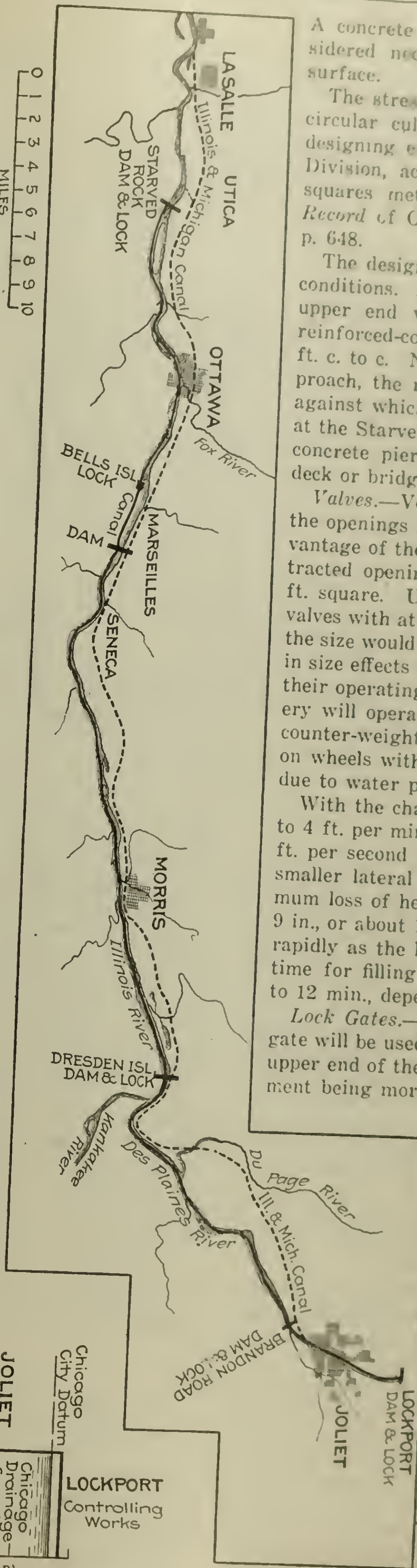
Lock 1, at Lockport, Ill., will overcome a difference of 41 ft. between the levels of the drainage canal and the Desplaines River. Lock 2, at Brandon road, south of Joliet, will have a 30-ft. lift and here will be a lock of 18 x 110 ft. connecting with the old Illinois and Michigan canal. Lock 3, with 16-ft. lift, will be at Dresden Island, half a mile below the junction of the Desplaines and Kankakee Rivers. The dam will raise the level of both streams and extend navigation on the Kankakee about five miles above its present limit.

Lock 4, at Marseilles, with a lift of 21 ft., will be at the lower end of a canal or diversion channel, 13,000 ft. long, 200 ft. wide and 10 ft. deep. This diversion is to avoid heavy work in the river, to prevent interruption to existing water-power plants during construction of the waterway, and to develop additional head for power development. The present dam at the upper end of the new channel will be utilized, but the pool level will be raised about 5 ft. by Taintor gates on the crest. Lock 5 at Starved Rock, with 16-ft. lift, will connect the waterway with the Illinois River. As this lock is below the mouth of the Fox River, the dam has to provide spillway capacity for floods up to 80,000 sec.-ft. For this purpose there will be eleven Taintor gates 60 ft. long, ten of these being 17 ft. high and the other only 5 ft. high in order to pass ice and floating debris.

New bridges will have to be built across the present channel in Joliet, as the first lock will raise the water level nearly to the present structures. As a width of 270 ft. is specified for this part of the work, it is proposed to employ one movable span and one fixed span. Several bridges on the lower part of the channel will have to be rebuilt. Bridge plans are not completed, however, and the headroom to be provided has not been determined.

Lock Design.—Culverts formed in the side walls and having lateral openings into the lock chamber, valve chamber openings designed on the Venturi principle, together with miter sills designed as horizontal arches, are distinctive features of the locks. Drawings of the Marseilles lock, which is a typical structure, are given above and on pg. 1098. For side walls a gravity retaining-wall section has been adopted, with the 12-ft. filling and emptying culverts formed in the walls instead of beneath the floor for reasons of economy. It is estimated that this arrangement will save $25,000 per lock as compared with that of floor culverts used in the locks of the Panama and Sault Ste. Marie canals.





A concrete floor will be used only where it is considered necessary to prevent erosion of the rock surface.

The stress analysis for these walls with the large circular culverts, was made by Walter M. Smith, designing engineer of the Illinois State Waterways Division, according to a modification of the least-squares method described by him in *Engineering Record* of Oct. 10, 1914, p. 407, and May 22, 1915, p. 648.

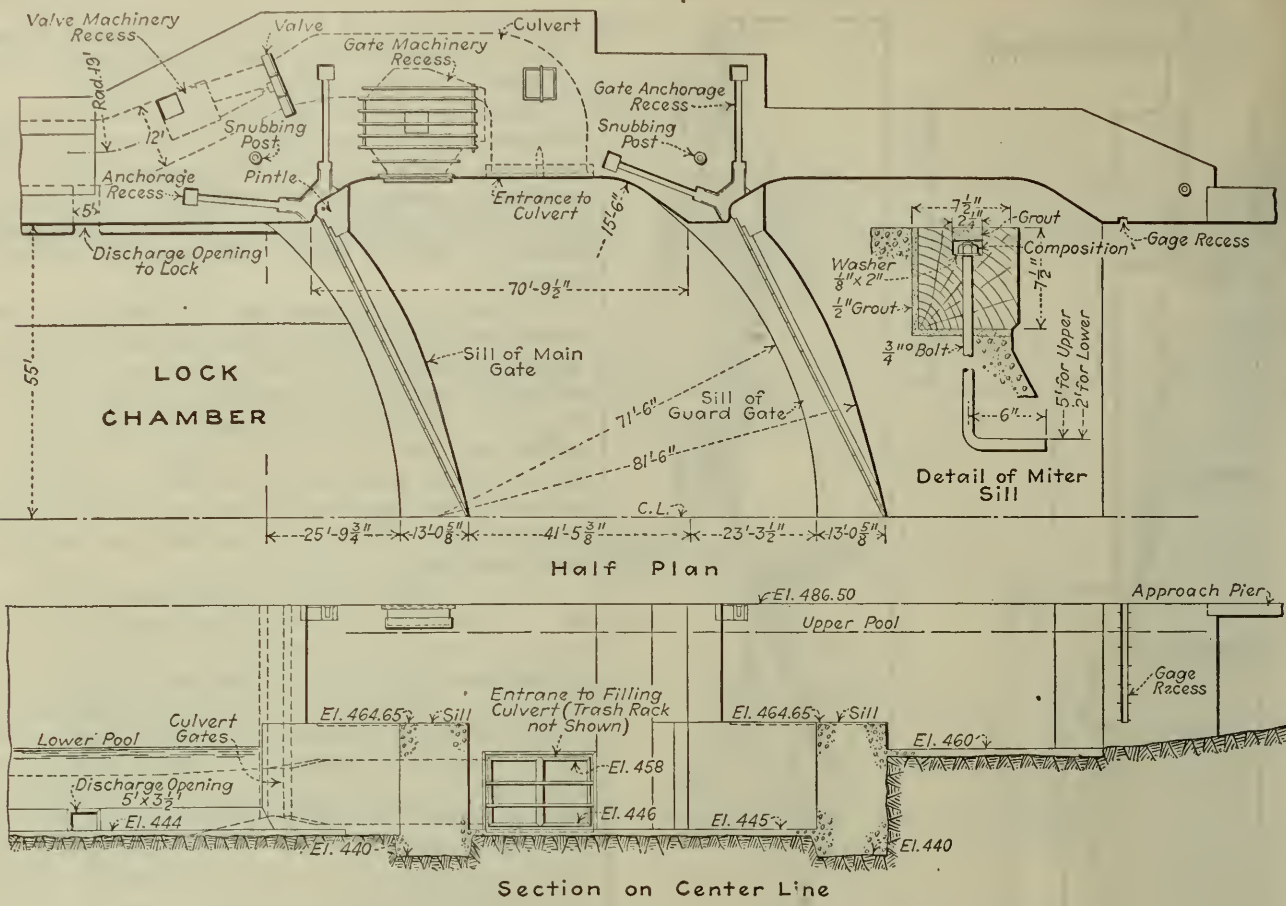
The design of approach walls will vary with local conditions. At Marseilles, the approach wall at the upper end will be of the bridge type, having a reinforced-concrete deck supported on piers spaced 20 ft. c. to c. No wall will be required at the lower approach, the rock being high enough to form a wall against which boats may be moored. Ice conditions at the Starved Rock lock will be met by placing large concrete piers 120 ft. c. to c., with no connecting deck or bridge.

Valves.—Vertical lift valves have been adopted for the openings for the filling system, but by taking advantage of the Venturi principle of flow through contracted openings, the size of valves is reduced to 9 ft. square. Under the usual method of making the valves with at least the same area as the main culvert the size would have been 12 ft. square. The reduction in size effects a saving in cost for both the valves and their operating machinery. Electric hoisting machinery will operate the valves by means of chains. No counter-weights will be used, but the valves will ride on wheels with roller bearings to reduce the friction due to water pressure.

With the change of water level in the lock limited to 4 ft. per minute, the maximum velocity will be 22 ft. per second in the main culvert and 30 ft. in the smaller lateral openings for the valves. The maximum loss of head due to the smaller opening will be 9 in., or about 10 per cent, but this loss will decrease rapidly as the lock fills. Under these conditions the time for filling or empltying a lock will be from 7 to 12 min., depending upon the lift or head.

Lock Gates.—The vertical lift or floating type of gate will be used for the main and guard gates at the upper end of the first lock, at Lockport, this arrangement being more economical than the provision of a moveable emergency dam to control the upper level in case of failure of the gates at the lower end of the lock. Each of these upper gates is designed to be raised readily against a full head of water should such an accident occur. A similar arrangement is employed for the lock in the Mississippi River dam at Keokuk, Iowa. (See *Engineering News*, Nov. 13, 1913, p. 964.)

All other lock gates will be of the mitering type, with horizontal framing. Each gate will have a single steel skin of plating on the downstream side, except that the lower gates of the first two locks will have a double skin for 15 ft. from the bottom in order to form a buoyancy chamber and



MITER SILLS AND CULVERT CONNECTIONS AT UPPER END OF MARSEILLES LOCK

thus reduce the bearing stress on the pintle and yoke pin.

A spring bearing of the gate against the miter sill so as to form the water seal is a novel construction used here for the first time and designed to simplify the design of both gate and sill. In the ordinary method, where leakage is prevented by the bearing of the gate leaves against the sill, this sill and its miter wall must be designed to withstand a possible pressure equal to 66 per cent of the total water pressure against the leaf. At the same time, the leaf has to be designed to take care of the deflection and stresses of vertical members with the leaf held at the bottom and having water pressure on its upper side. In the new design this uncertainty of stresses is eliminated, since the bearing spring can transmit to the sill only the pressure due to the water in contact with the spring. A material saving is thus effected in the cost of both the gate and the sill, the latter being designed as a horizontal arch instead of as a gravity wall.

Operating machinery for the miter gates will be of the bull-wheel type as used at the Panama canal, which arrangement permits of using a constant-speed motor to give a variable speed to the gate.

Ice conditions in the river will be improved by the new waterway, as explained by M. G. Barnes, chief engineer, in a paper read before the Western Society of Engineers. Much of the water is used at Chicago for domestic and manufacturing purposes and for sewage dilution, so that there is a flow of relatively warm water to be cooled by the air and by the water from tributary streams. This action leads to the formation of continuous fields of floating ice, which under present conditions cause great gorges, backing up the water and resulting in destructive floods. It is expected that when the waterway is in operation the discharge at the dams can be so regulated as to prevent serious ice gorges.

The traffic capacity of the waterway is estimated at 60,000,000 tons annually. In the paper noted above Mr. Barnes stated that the greatest usefulness cannot be reached until both the Illinois and the Mississippi rivers are improved to give a 9-ft. channel and until the various shipping centers provide adequate facilities for the handling and storage of freight.

This Illinois waterway project has been planned by and carried out under the direction of the waterways division of the State Department of Public Works and Buildings: F. I. Bennett, director of public works; W. L. Sackett, superintendent of waterways. M. G. Barnes is chief engineer of the Waterways Division and L. D. Cornish is assistant chief engineer. The cost of the work complete is estimated at $20,000,000, with $8,000,000 addition for water power development aggregating 60,000 hp. It is expected to have the waterway ready for operation by 1924.

A Wood Truss Flagpole

A timber-trussed flagpole 207 ft. high, built of native pine, has been erected at Corinda, Queensland, Australia. It is cigar-shaped in elevation and rectangular in section, with four curved chords united at the ends and giving a section 7 x 7 ft. at the middle of the pole. Horizontal members divide each side into panels, with diagonal bracing in each panel. The pole was built and erected by the Queensland Timbers Co.

Trend of Highway Development —a Survey

Arkansas Practice

THIS IS THE FOURTH *of a series of staff articles on the highway situation. It discusses work in Arkansas where 4,000 miles are completed or under contract and where improvement districts have been formed.*

The fifth article in the series will appear in next week's issue.—EDITOR.

ARKANSAS is the state of astounding facts in highway development. Within two years it has changed from one of the most backward to one of the most progressive states of the Union in the construction of improved roads. Beginning, practically, in 1919, the state has projected 9,000 mi. of roads of which 4,600 mi. have been completed or are under construction or contract. The remaining 4,400 mi. are in various preliminary stages of organization and it is probable, and, incidentally, desirable, that a considerable proportion of the projects may not complete their organization.

With 300 mi. completed and 4,300 mi under construction or contract, the state ranks extraordinarily high in the value and the mileage of improved road work in progress. This, moreover, is not the complete tale. Of the 4,300 mi. under construction all but 250 mi. is of a higher type of construction than permanently graded earth road. The types of construction are, as precisely as may be determined, as follows: One-course concrete, 192 mi., asphaltic concrete on stone or concrete base 629 mi., penetration macadam, 460 mi., waterbound macadam 560 mi., gravel surfaced, 2,209 mi., and earth road, 250 mi. Of completed mileage, the majority is of the two more permanent types.

Realization of the statistics quoted as applied to Arkansas is in one sense difficult. Despite its recognized natural wealth, the state has been conceived, and to a large degree rightly conceived, as one of bottom and overflow lands, cypress brakes, undeveloped hill lands and sequestered agricultural districts. Its roads outside of limited areas adjacent to centers of population have been visualized, and correctly so, as trails impassable during the wet months to heavy vehicles. The contrast, with this picture, of 4,500 mi. of high class highways under construction and nearly as great an additional mileage planned, requires a revision of thought which is not immediately accomplished. It is hastened, however, if it is kept in mind that the very conditions indicated are due to poor roads and that the only manner in which these conditions can be reversed is by improved roads.

The total estimated cost of the 4,300 mi. of highway under construction or contract is $56,000,000. The costs per mile range from $5,000 for the cheapest graded earth road to $58,000 per mile for a 20-ft. concrete surface on a 30 ft. road bed. These costs include permanent drainage structures. On present estimates the total possible aid funds in a five year period, 1917-1921, are: State aid $1,400,000 and Federal aid, $4,615,210, a total of about $6,000,000 or slightly over 10 per cent of the estimated cost of $56,000,000, assuming that all aid funds will have been expended on the 4,600 mi. completed and under construction, which quite certainly will not be the case. Over 90 per cent, therefore, of the cost of the construction completed and in progress is being financed by special assessment on the real property adjoining and benefitted by the improvements. Naturally the same fact will be true of that portion of the projected 4,400 mi. which may be actually constructed. Except, possibly, in Texas, where similar conditions exist, this practice has its parallel in magnitude nowhere in the United States.

Under its constitution, Arkansas cannot undertake works of public improvement. Neither the State nor the county can issue bonds. Highway construction is performed by the organization of improvement districts created under a general road law and by special acts. Under the general law the cost of the road is limited to 30 per cent of the assessed valuation of the land in the district. Where this sum is insufficient to build the road, the district seeks a special act of the Legislature empowering it to raise money exceeding the general law limitation as it may desire. In 1919 and 1920 there were created about 300 road districts by special acts. To illustrate the condition described in a more specific manner, 70 districts of which complete data are available, show the average cost per mile of road to be $14,500 and the averaged assessed valuation per mile of road to be $36,600. Under the general law limitation of 30 per cent, the permissible expenditure per mile is $10,980 which is not enough to build the roads. Therefore, the districts must secure power by special acts to increase expenditure.

Highway improvement districts, as usually formed, embrace an area extending about three miles on each side of the road to be improved. These districts have boards of commissioners which appoint the engineer and other employees and have charge of the work. If the district is granted aid, the plans, specifications and estimates have to be approved by the state highway department which also inspects and passes the improvements before aid is paid. Here is to be noted the complete independence, except where State or Federal aid is sought, of the district from any outside control. It can, as it sees fit, under the special act which governs it, finance the improvement, chose its route, select the type of construction, appoint its engineer and contractor and manage the construction. Generally, the districts seek aid from and work harmoniously with the state highway department but their independence is complete and at times has been asserted by waiving aid and conducting the improvements as desired.

RESULTS OF THE PAST

A number of circumstances have developed from the conditions: (1) Engineering direction has not been in all instances the most competent; (2) non-technical commissioners have on occasions over-ruled their engineers and adopted fancied types of construction not the most suitable; (3) districts have frequently over-reached themselves in expenditure undertaken; (4) districts have competed with each other for materials and labor with consequent inflation of costs; (5) anxiety to realize the improvement has caused unwise financing and particularly the marketing of bonds at high discounts; (6) roads have been located frequently without proper consideration of a coordinated system of main routes and not always without local favoritism.

Other criticisms are possible and while all are true they are far from being generally true. Indeed there is evident a surprising unity of purpose and quality in

the main highway system being produced by largely uncorellated interests. The local initiative and responsibility create an interest which hasten and disseminate education in highway development. Road improvement is more than commonly an expression of popular consciousness of a necessity. Stabilizing influences are: (1) the authority wielded by the State Highway Department in allotting state and federal aid and (2) the sound professional standards maintained by the leading engineers engaged in highway practice.

Structurally the types of road being built call for particular mention only in respect to the asphaltic concrete and gravel surfaced types. The asphaltic concrete construction is a 2-in. surface, usually Topeka mix, sheet asphalt or Warrenite on either a "broken stone" base or a concrete base. The term "broken-stone" base is really a misnomer; this base is a 5-in. waterbound macadam of the best construction frequently built between 6 x 10-in. concrete curbs. Choice between broken stone and concrete base is ordinarily determined by cost (roughly broken stone is $5,000 a mile cheaper) but structural considerations also enter. On fills and soft subgrade the concrete base gives needed strength and generally an asphalt on concrete is without a certain waviness almost impossible to eradicate with a macadam base. Preference for asphaltic concrete compared with cement concrete, as indicated by the respective mileages under construction, however, is almost wholly decided by relative costs.

In total mileage, gravel roads surpass all other types. They are particularly well constructed. A base of clay gravel 5 in. thick when consolidated is rolled to profile and on this a surfacing of finer gravel is consolidated to 2½ in. by rolling. Gravels suitable for road surfacing are generally plentiful except in the alluvial bottom lands in the eastern part of the state. Here long hauls are necessary. In other parts of the state chirt and novaculite rock are also plentiful. The state does not lack bulk materials for highway construction. In 1920, however, due to transportation shortage, highway contractors have not been able to secure on the job much more than 10 per cent of the material required for normal progress.

Construction Problems

Construction problems in Arkansas are peculiar in the respects (1) that wet weather, which is plentiful, because of the soil conditions practically shuts down operations, (2) that much of the location is through virgin territory and land clearing and grubbing are expensive operations, and (3) that work in the bottom lands subject to overflow necessitates raising the road on embankment with large drainage ditches. These conditions call for types of construction equipment such as dredges and clearing and grubbing tools, which are not ordinarily prominent in highway construction plant, and they also put out of commission many of the heavy hauling and grading units commonly employed. For many conditions nothing yet developed surpasses in effectiveness "the nigger and the mule" as a road-grading tool.

Because of the improvement district plan which disregards county boundary lines large mileage highway projects and also large mileage contracts exist in unusual numbers. Projects exceeding 50 miles are frequent. In the southern and eastern part of the state the Arkansas-Louisiana highway is 153 miles long in five counties. The improvement district embraces 675,000 acres and the work will cost upward of $3,500,000. Of the total mileage 111 mi. are asphalt on concrete base. An article analyzing and describing the construction methods employed on this project will be published in a future issue.

Commonly highway activity is measured by counties, for despite the improvement district plan the county remains the political unit and normally the improvement district manifests a tendency to keep within county lines. Some Arkansas counties have undertaken upward of 200 mi. of improved road. A noteworthy but not exceptional example is Phillips County in which the city of Helena is located. Because this county exemplifies the typical methods of the more progressive county, the development of its highway program is summarized as follows:

District	Date	Miles	Cost	Type
1	1915	2	$54,000	18 ft. concrete
2	1916	6	192,000	18 ft. Topeka top on 5-in. concrete
3	1919	14	443,000	14 ft. Warrenite top on 5-in. concrete
4	1919	34	992,000	14 ft. Warrenite on 6-in. stone
5	1919	73	1,700,000	14 ft. Concrete
6	1919	6½	190,000	18 ft. Topeka on 5-in. concrete
		135½	$3,641,000	

The costs given are contract prices. To them there is to be added about 10 per cent, made up of 2 per cent for legal fees, 5 per cent for engineering and about 3 per cent for general administration. Including street improvement districts in Helena the charge *per capita* for the highway improvements undertaken in Phillips County will exceed seventy-five dollars. This is typical of the financial obligations for highway work which many Arkansas counties have been ready to undertake. The great difference in sizes of districts—two miles to 73 miles—is typical, as are different engineering direction for each district, different contractors and different types of paving.

One comes from a survey of Arkansas highway practice with decidedly mixed impressions. Admiration is commanded by the energy of purely local initiative by which the highways of the state are being lifted out of their primitive sloughs of mud. Apprehension of trouble in prospect is created by the same popular tendency to assume burdensome financial obligations. Veritable alarm seizes one at the frequent willingness exhibited to drive ahead with improvements on money raised by selling bonds at enormous discounts. And finally the part which politics plays in all matters of highway development arouses unqualified condemnation. In noting these obvious shadows the disposition to regard the whole view as dark should be guarded against. This is not the true vision. There is much to admire in the manner in which highway improvement in Arkansas is being achieved. In particular one is encouraged by signs of reform.

Moderation is being shown in placing projects under contract. The State Highway Department is discouraging extravagant financing. There is a strong sentiment developing that the Legislature should review all projects on which no work has been done and repeal many of the special acts under which these projects exist. Growing out of this sentiment is a spirit of greater caution in projecting improvements. The day of wild-cat highway improvement projects has probably passed for Arkansas.

Water-Borne Outbreak of Typhoid at Schenectady, N. Y.

POLLUTION of a water-works well at Schenectady, N. Y., due to high water in the Mohawk River, caused 53 cases and 3 deaths from typoid in that city. The following summary of the outbreak, by Theodore Horton, chief engineer New York State Department of Health, is taken from *Health News* (the monthly bulletin of the department) for October, 1920:

The water supply of Schenectady is derived from three large wells on the south side of the Mohawk River, electrically-driven pumps sending the water into the mains of the city. Some years ago, however, steam pumps located in the same building that now houses the electric equipment were used to pump the water from the one well then in existence. These steam pumps, in addition to being connected to the well, had two 24-in. cast-iron suction pipes extending into the Mohawk River for use in case of emergency. Both of these suction lines passed through the well above the normal water line. Some time after the abandonment of the steam plant and the construction of the additional wells these pipes were disconnected, the part passing through the well removed, and the walls of the well sealed up with masonry. The suction pipes had been laid in brick tunnels with gravel bottoms for a short distance each side of the well, and the portions in these tunnels were also removed. From the end of the tunnel on the north side of the well to the river, however, the pipes were left in place, the ends projecting into the tunnel. One of these ends was carefully sealed with concrete, but through some oversight the other was left open. Under normal conditions this caused no trouble, for the open pipe was above ordinary high water.

On March 13, 1920, due to thaws and ice jams, the water in the river rose to about 7 ft. above the bottom of the open pipe to the river, and then slowly fell again until it was below the bottom of the pipe on March 20. Thus for seven days there was nothing to prevent the polluted water of the river from flowing through the pipe into the tunnel and thence down through the few feet of gravel into the well. The fresh deposits of river silt in the tunnel and the wash holes in the gravel bottom of the tunnel at the time of the inspection indicated plainly what had occurred. An extraordinary turbidity of the water was noticed.

On March 15, the second day after the extreme high water, and during the few following days, a large number of cases of gastroenteric disturbances were reported. During the latter part of March and the first part of April 53 cases of typhoid were reported, the greatest number of the onsets occurring between April 1 and 6, or from eighteen days to three weeks after the extreme high water in the river.

When the cause of the turbidity in the water and the unsatisfactory bacteriological quality was brought to the attention of the city authorities by the Engineering Division of the State Department of Health the city authorities immediately sealed the open end of the pipe and later removed a portion of both of the old suction lines between the well and the river, thus precluding any possibility of future pollution of the water supply from the same cause.

The issue of *Health News* from which the foregoing paragraphs were taken contains reviews by Mr. Horton of a number of other typhoid outbreaks in New York State. The Schenectady outbreak is described in much more detail by Mr. Horton in *Public Health Reports* (Washington, D. C.) for October 29, 1920.

Geologic Classification

Under the new mineral-leasing law it is incumbent upon the U. S. Geological Survey to determine the geologic structure of producing oil or gas fields and to divide the coal, phosphate, and oil-shale lands of the public domain into appropriate leasing units.

Letters to the Editor

What Will the American Society of Civil Engineers Do With Its "Proceedings"?

Sir—I have just read your editorial "What Will the American Society of Civil Engineers Do With Its *Proceedings?*" in the Oct. 21 issue of *Engineering News-Record*. Whatever changes are made in *Proceedings* or *Transactions*, whether or not *Proceedings* is expanded to magazine form, I hope that all members—speaking from a purely selfish point of view and arbitrarily assuming that others also desire what I consider an essential ingredient of *Proceedings* —will receive at intervals announcements of titles and publishers of new books and current engineering literature. While this has to do with "dissemination" it is of equal if not greater importance to the advancement of engineering or any other kind of knowledge or practice.

It is unnecessary to dwell upon the advantages of a technical library to a professional man. At the present rate of progress in engineering and other technical and scientific fields who can hope to keep abreast of the advancement even in his own particular field without the possession of or easy access to an up-to-date library? If, then, this is necessary to keep pace with the advancement of knowledge is it not more essential to one who hopes, by however small a contribution, to add something to the advancement of the knowledge or practice of his art?

The "Engineering Literature" and "Publications Received" sections of *Engineering News-Record* are an excellent example of an easy access to an engineering library. Those who favor "the cutting of the garment to the cloth" idea in your editorial will say immediately that this answers the question; subscribe to *Engineering News-Record* and cut down the *Proceedings*. My argument for continuing such sections as these in the *Proceedings* is that such material does aid in advancing engineering knowledge and practice and is therefore in accordance with the aims and purposes of the society. Furthermore, I believe this will be of more permanent benefit to members most of whom I believe will have bound copies of *Transactions* on their book-shelf long after they have thrown away or sold bound volumes of *Enginering News-Record*, if indeed they ever preserved such volumes at all.

WILLIAM A. CALLAWAY,
First Lieutenant, Corps of Engineers, U. S. A.

Camp Grant, Illinois, Nov. 17.

Concrete Columns in the Galveston Fire

Sir—The description of the results of the two fires in the warehouse at Galveston, Tex., in your issue of Nov. 18, p. 980, gives food for much thought on the subject of reinforced-concrete design. To my mind the greatest lesson is the old lesson of practically every reinforced-concrete failure or fire, including the Edison fire and one in a tobacco warehouse at Norfolk, Va., recently told about by the fire underwriters. This is the utter unreliability of rodded columns in any structural emergency.

The Edison fire showed the weakness of square rodded columns by excessive spalling, even in rooms where the heat was not sufficient to melt the insulation off electric wires; and it also exhibited the futility of so-called reinforcing (upright) rods in the middle of the side of these square columns, for in many cases these rods spit the columns and burst out the sides.

In the Norfolk example the rodded columns acted in the usual way; the rods curled up in fantastic fashion, showing how they reinforce (?) a column. The columns failed, with practically total destruction of the building.

In the Galveston building the columns, while round, were of the usual rodded-column standard and were not reinforced with close-spaced hoops as real hooped columns must be. Their action in the fire was on a par with that of square rodded columns in other fires and wrecks.

W. J. Knight emphasizes the destruction of concrete where there were sharp corners, and cites the drops at column

heads which broke off. There is no doubt much in this, but there is another thing about the drop of the slabs contributing to this destruction, the absence of reinforcement in these drops. If they had had a mesh of steel tying the drop into the slab there is no doubt that they would have stood up immensely better under the fire.

The column capitals, Mr. Knight says, were greatly impaired by the damaging effects of the heat. This, too, can be explained by the absence of reinforcement in these capitals, for the shape is certainly not such as to invite destruction by reason of sharp corners.

It is to be noted in your photograph on page 980 that just where the column capitals were, and presumably where the columns were strongest, many of the columns are entirely gone. In a design which I reviewed some years ago I recommended that the column capitals be reinforced. It is certain that if these had been reinforced the capitals at least of the columns, which in a flat-slab building carry a large portion of the slab weight, would have held together very much longer and with proper columns would doubtless have needed only replastering instead of reconstruction. The weakness and failure of the columns is amply confirmed by the photographs. It is inconceivable that anything approaching this destruction could have occurred if the columns had been reinforced with close-spaced hooping.

Mr. Knight says that the columns in most cases were the initial cause of failure and Mr. Besselievre says that, even under intense heat, in the other fire the floor slab stood up very well.

I do not share Mr. Knight's apprehension regarding construction joints. In my judgment the destruction at construction joints was due to cumulative effect. The great expansive force of the floor slab had to have an outlet somewhere, and as the construction joints were the weakest portions of the slab the force was concentrated at these joints. If such a thing had been possible and the floor slab had been poured in one operation it is probable that the expansive force would have caused buckling of the slab in very irregular lines, and the difficulty of straightening up the floor level would have been greater.

In this case, as in practically all failures of construction, design is at fault; and the thing to blame is the standards of design that allow and recommend such things as rodded columns. EDWARD GODFREY.

Pittsburgh, Pa., Nov. 22.

Sir—Your articles on the effect of fire on the reinforced concrete warehouse at Galveston [*Engineering News-Record*, Nov. 18, p. 980] are exceedingly interesting. The fire resisting properties of reinforced concrete are of such vast importance to engineers that too much information on the subject cannot be collected. The difference in the effect of the two fires, causing complete destruction in the one instance and not in the other, seems peculiar, but the writer believes this can be readily explained in view of the facts stated.

To get down to fundamentals, the real cause of failure of reinforced concrete during fire is the steel, and it will be helpful to consider the behavior of this metal under rising temperatures. Tests made in Great Britain during the war indicated that the yield point and tensile strength of steel fall very rapidly as the temperature rises. There is a marked falling off at even 250 deg. C., while at 500 deg. C. the reduction in tensile strength is very great. In the case of the earlier fire, on May 29, this occurred on the second floor. The second story was packed nearly full with sisal, which would readily absorb water and become exceedingly heavy. It seems highly probable that the full design load of 375 lb. per sq.ft. came on the floor after the sisal had become thoroughly saturated.

With a fire of such intensity it seems reasonable to presume that the steel became heated well above 500 deg. C. Its tensile strength could easily have been reduced to one-quarter of its normal strength. With the full design load on the slab it can be readily seen that failure would result. In the later fire the seat of the conflagration was on the first floor. The upper story in this instance had but one-quarter of the maximum load, and as far as can be gathered by the articles this load would not be increased by water during the fire. Although the tensile strength of the steel must have been considerably reduced it was yet able to support the comparatively small load above. While the floor may still appear sound it seems difficult to imagine that the steel in the concrete has not been seriously impaired.

It would seem that to obtain better fire resisting properties of reinforced concrete lower working stresses together with a thicker protective coating on the steel would be advantageous, although it would add considerably to the cost and might not be deemed worth while.

High Point, N. C., Nov. 23. EDGAR A. CROSS.

Is Surveying a Trade?

Sir—I am interested in what A. L. Dabney says on "Is Surveying a Trade," in your issue of Nov. 11, p. 956. My practice is mainly land surveying, but I am now and then called in to do work which might be classed as minor engineering. In my experience, dating back to 1880, I have many times caught technical men in serious errors in land surveying. On the other hand, I have found excellent work done by men who had picked up surveying without education. A level head and a technical training make a strong combination. But who is the tradesman: the non-technical man who does careful and accurate work, or the technical man who blunders? My experience is that educated engineers, who should be the best, are careless land surveyors.

Hackettstown, N. J., Nov. 15. E. N. MILLEN.

The Writing of Engineering Reports

Sir—The valuable hints on the writing of engineering reports in your issue of Nov. 4, p. 891, by Prof. Mead, than whom there is no one better qualified to give advice, should be read with profit by every engineer. The subject would justify a volume, which few are qualified to write. This subject is touched but little, if at all, at the colleges and possibly cannot be treated adequately in a college curriculum, but instruction must be acquired in some way to enable an engineer to suitably present the subject matter and findings of a report which he may be called upon to make.

We have occasion to handle a great many reports of other engineers and have been so much surprised and disappointed in their character and form that we have come to expect that they will be inadequate and unsatisfactory, in which preconceived notion we are seldom mistaken. Much is said about the lack of proper instruction in writing good English in the technical colleges, but this does not wholly explain the fact as an author known to be well educated may prove unable to treat this subject in a comprehensive and lucid manner. The following notes may be considered relative to what a good report should be and should not be.

1. A good report must be brief and concise yet not too condensed. This implies a matter of careful judgment. Brevity is desirable, but when treatment is too much condensed it fails of its effectiveness. A more expanded treatment is effective, if logical and clear.

2. A good report must deduce the findings and not express merely guesses on the part of the author. Much can be accomplished by deducing results step by step from unquestionable facts, findings and data, expanding the subject as the discussion proceeds, making the steps plain and the manner of deduction evident.

3. A good report will employ approximations and averages with the utmost discretion. A vicious thing in many reports is the way approximations and general averages are used. Approximate figures must be employed at certain points and averages have their uses, but the approximating should be done on the unit figures where there is an opportunity to employ judgment, and not on "per mile," "per annum" and other such figures. The writer has a particular aversion to averages as employed by the average engineer. How many times we see in engineers' reports a statement like this: "The average revenue per mile of other

electric lines in Texas is ——— dollars. Taking this average, we have ——— dollars for the income per year for the proposed electric railway." No notice is taken of the fact that this proposed line may be unlike the existing roads, or of the further fact that there is no more reason to expect that it should be just in accord with the average than that it should be in keeping with the maximum or minimum.

4. A good report will treat not only the technical problems involved but the business aspect of the matter. Frequently reports are found to contain exhaustive discussions of problems of engineering design and bring forward fairly satisfactory estimates of cost of construction and there stop, without any reference whatever to cost of operation or income. Occasionally reports may be called for upon purely technical questions, but the great majority have for their objective the solution of financial or financing problems. That being the case, it is the duty of the engineer to treat income and expense with equal thoroughness. A good report, when dealing with capital requirements, will treat thoroughly of the following:

A. The need for the money, in general terms.

B. What is to be done with the money. This implies descriptive specifications of what is proposed to carry out the project as outlined. There should follow estimates based upon the specifications which must be submitted to constitute a basis for such estimates.

C. Determination of operating expense in detail as thoroughly as if the property was to be put in operation immediately.

D. Determination of net earnings. In other words, a scientific deduction must be made of the amount of money which the investment that is to be solicited will earn.

E. A good report will be as free as possible from personal opinions of the writer. His opinions will be expressed in the determination of unit figures and fundamental estimates, but beyond that they had best be left to a final chapter in which the author may express himself freely and convey any suggestion that may be beneficial to the client.

If the engineer is to command respect and consideration he must be able not merely to write good English but to formulate and compile and logically set forth information, statistics, data and findings in a manner which will be not only clear but convincing and impressive In passing, a quotation from an engineer's report on a proposed new railway may be given as an example of how not to write a report: "The grades and curves will be easy and the line will probably be operated by electricity and there won't be any rock so the line will not be expensive to build, and there will be plenty of travel because the country is well settled with a good class of people that raise cattle and hogs, and the dairy business is a great business in that region so there will be a lot of milk cans and butter and eggs that can be carried every day on the new road which will make the freight business good." This engineer had muddled in his own mind a number of subjects, each one of which should have separate and distinct treatment.

W. K. PALMER,
Consulting Engineer, National Engineering Service Corporation.

Kansas City, Mo., Nov. 11.

Sir—I have read with interest Mr. Mead's article on engineering reports. (See *Engineering News-Record*, Nov. 4, 1920, p. 891.) He has left little to be added.

The importance of the length of the report may be emphasized, for while it should be complete in information it should, at the same time, be concise. Confining the discussion to the points at issue and avoiding repetition will accomplish much. In fact, reiteration of subject matter seems to be a besetting fault of the novice at report writing. It arises from and also conveys a hazy conception of the subject. The preparation of an outline will assist in presenting the proper thing in the proper place.

Action on a project is sometimes delayed for many months following the completion of the investigation It is important then that there be available a full statement of the conditions at the time when the report was made so that the conclusions may be reviewed.

Finally it has been said innumerable times, but will bear repetition, that the first essential in report writing is that the author shall know what he is writing about, and know it thoroughly and definitely. Much of the struggle for expression, both in composition and use of words, arises from a lack of comprehension of the thing to be expressed. The most remarkable thing about this obvious requirement is the frequency with which it is disregarded. During the writer's experience great difficulty has been found in securing capable assistants who can make thorough investigations and write intelligent reports.

MORRIS KNOWLES,
Consulting Engineer.

Pittsburgh, Pa., Nov. 20.

Export and Import Statistics and the Industrial Trend

Sir—The statistics of our export and import trade since Jan. 1, 1919, given by O. M. Fox in *Engineering News-Record* of Oct. 28, p. 835, should have the greatest interest not only for those of your readers who are directly interested in foreign trade, but also for the much greater number who are chiefly concerned with domestic business. The graph (Fig. 1) presented the more important of these figures in such a way that they could be understood at a glance were it not for the fact that the author then proceeded to deduce from them a number of apparently incorrect conclusions.

These conclusions appear to be based on a fundamentally incorrect conception of foreign trade and especially of the relations existing between exports and imports. The exchange of merchandise with foreign nations, as is the case with domestic business, can only be continued as long as both parties to the transaction are benefited. Under normal conditions almost the entire amount of exports must be paid for by imports of corresponding value, and by the so-called "invisible balance of trade," so that the actual balance to be settled by the shipment of gold will usually be so small as to constitute an almost negligible percentage of the total. Therefore it may be taken as inevitable that over a period of several years the exports and imports of any country will approximately balance each other.

For years prior to 1914 the United States annually reported a considerable excess of exports over imports, which was settled by an invisible balance of trade consisting principally of dividends and interest on European investments in our country, repayments on account of the principal of such investments, and the expenditures of American tourists abroad. To these must be added a gradually increasing volume of our own investments in foreign countries, which, during and since the war, have been of exceptional magnitude, whereas our payments on account of the interest and principal of the greatly reduced foreign investments in America have materially declined. In all probability our former adverse invisible balance of trade has been materially reduced and may soon be wiped out, or even replaced by a favorable balance, in which case our only important means for obtaining payment for our exports and for the interest and principal of our investments abroad will be through imports of merchandise.

It would, therefore, appear that the conclusions stated in the article are in error in the following particulars:

1. An excess of imports to settle a favorable invisible balance of trade will imply profits coming into the country, as contrasted with our former condition, in which excess of exports signified profits going out of the country to foreign investors in American enterprises. An excess of imports will hereafter be a sign of prosperity rather than otherwise, while an excess of exports may become a sign of bad business conditions, unless, unlike most other countries, we are able to invest safely abroad *all* the profits of our export trade.

2. When a nation is selling more than it is buying, exporting more than it is importing, it is not usually enjoying financial prosperity, nor experiencing relatively high prices in its home markets. On the contrary, when selling exceeds buying it is almost invariably a sign that prices in its home market are relatively low as compared with those of

the rest of the world, and that its fundamental prosperity is open to question. An exception occurs, as before mentioned, in the case of a country like the United States of pre-war days, when a high protective tariff preserved the home market for manufacturers for the domestic factories and the exports consisted largely of essential raw materials and food-stuffs. That this is really an unusual condition can readily be seen by comparison with the condition of the late European belligerents, which for a number of years to come will be obliged to put forth their utmost efforts to obtain an excess of exports over imports in order to pay off their foreign war indebtedness.

3. The present tendency of our exports and imports to balance each other by an increase of the latter rather than by a decrease of the former is, therefore, a most gratifying condition, implying a future improvement in the present prohibitive rates of foreign exchange which will enable our overseas customers to take more of our exports.

4. The author asserts that the coming change from an excess of exports to an excess of imports will imply a corresponding change from profit-taking selling to profit-paying buying, whereas it would really mean that from being engaged in selling on time, as at present, to foreign customers of more or less doubtful credit, we would become a nation of profit-taking importers. It would seem almost self-evident that under normal peace conditions no nation will have a considerable excess of imports unless it be in prosperous circumstances.

5. The conclusions of the author with reference to duty-free imports seem likewise to be based on erroneous premises. He admits that our importations of raw materials have increased 68½ per cent during the period, which would seem to indicate that our factories must be adequately supplied with all their requirements. As a matter of fact, owing to the recent severe declines in our domestic demands for such articles as raw wool, raw silk, India rubber, hides, etc., importers of these are now having the greatest difficulty in disposing of them to advantage in our markets. The increase in the imports of manufacture both actually and relatively as compared to raw materials is by no means alarming, but, on the contrary, is an indication of the return of normal conditions. It must be readily apparent that, as our principal foreign markets are the manufacturing nations of Europe, on the whole, less plentifully supplied with raw materials than ourselves, it follows that our imports from them must be manufactured articles.

6. It is even harder to agree that the present stagnation of domestic business is due primarily to the yet relatively insignificant imports of manufactures. On the contrary, the sharp shrinkage of values is a condition which is at present world-wide, and it seems safe to say that few, if any, countries have been less adversely affected by it than our own. It is to be attributed chiefly to the approaching end of war inflation, aggravated in our case by the fact that our export business has been sharply reduced by a tremendous decline in foreign exchange, which only a great increase in imports can restore to parity.

7. One of the most important questions to be decided by the next administration is that of the tariff. It must be admitted that in the past the principle of high protection has been of great value in preserving the domestic markets for our own factories, but there seems reason to doubt its value under our present conditions. As long as the total output of our factories was less than the requirements of the domestic markets and, therefore, while our interest in export trade was not vital, the high tariff was undoubtedly beneficial to the manufacturers of the country as a whole. However, if our total manufacturing capacity in the lines in which we excel is now greater than our domestic demand, leaving a considerable balance which should be exported, it follows that the tariff should be adjusted on a more moderate basis which will permit imports of manufactures which can be obtained to better advantage abroad sufficient in value to pay for increasing exports of our excess production.

ALBERT I. STILES,
Chief Engineer, Lindeteves, Inc.,
Engineers and Exporters.

New York,
Nov. 6.

[Copy of Mr. Stiles' letter in the preceding column was submitted to Mr. Fox, whose reply follows.—EDITOR.]

Sir—I regret that any one should have read into my article a brief for high tariff, as such was not intended. It was purposed purely to call industrial America's attention to the fact that a rapid and steady growth of imports had culminated in August in an amount which lessened our home markets for our home manufacturers by two and one-half billions a year. I agree with Mr. Stiles that under the circumstances this condition is inevitable and probably desirable, yet I see the situation fraught with danger for our manufacturers if they do not appreciate the extent of the shrinkage of their market and lay their plans in accord.

Who would care to be a stockholder in a concern whose managers measured their progress by their purchases rather than their sales? Such an enterprise would probably pay the same kind of dividends that the United States paid in 1893 when our imports were the largest in our history up to that time but our favorable trade balance, by a reduction in exports from \$1,030,000,000 in 1892 to \$847,000,000 in 1893 was reduced from \$202,000,000 to \$19,000,000; or the sort that were paid in 1873 when our favorable balance of \$119,000,000 became an unfavorable balance of \$19,000,000.

The fact is that American agriculture and industry, keyed up to a high pitch during the war and post-war periods, are capable of producing more than American needs of their output. We thought Europe would need this excess for years to come, owing to the destruction of her producing power. We now find this is wrong, and find Europe, the famished, meeting us on our own ground with goods in competition with ours. It is necessary that we face the situation and conduct our business accordingly.

Chicago, Nov. 22. O. M. FOX.

What Is Art?

Sir—Having read with great interest your editorial comment "What Is Art?" in the Sept. 16 issue, p. 531, the subsequent letters appearing in relation thereto, and Mr. Binckley's article entitled "Art in Structures" (Nov. 25 issue, p. 1024), I would like to take issue with Mr. Binckley in regard to some of the points touched upon by him, although I most heartily agree with some of the opinions he expresses.

Having had some opportunity of studying, in Europe and elsewhere, the relation of art to structures the writer feels that the degree of beauty from an architectural point of view is to some extent a matter of personal opinion founded upon good taste and the general fitness of things. Mr. Binckley speaks of the "wretched so-called architecture with which the modern world and especially the United States is encumbered"; as an answer to this, compare the modern architecture of Germany, Switzerland, Italy and France with that of the United States, and I venture to say that structures like St. Thomas' church on Fifth Avenue (New York), the Woolworth Building and the Lincoln Memorial in Washington, are, for pure architectural beauty and fitness, at least on a par with contemporary European architecture, and a great deal better than many oft-cited examples of ancient and early renaissance European architecture. As a whole, I think that the general run of European examples of later renaissance would be hard to equal or to beat for sheer vulgarity and ugliness; in this connection contemplate for a moment the Opera House in Berlin or even the Opera House in Paris.

Mr. Binckley goes on to say: "Our greatest modern engineering structures are bare mathematical skeletons of an idea . . . To a bridge engineer a great steel bridge is probably beautiful, but to an ordinary man of culture and taste it is merely large and very ugly." The writer happens to be a bridge engineer, and is somewhat curious to learn whether Mr. Binckley thinks the Manhattan Bridge and the Hell Gate Arch are intrinsically "bare mathematical skeletons of an idea." To the writer they are of high architectural merit, whereas he admits the Blackwell's Island Bridge and Williamsburg Bridge properly fall within Mr. Binckley's characterization. Why cannot Mr. Binckley's eulogy

of the Brooklyn Bridge (with which the writer agrees) apply equally to the Manhattan Bridge? As for the steel towers of the Manhattan Bridge as compared to the stone towers of the Brooklyn Bridge—is this matter really not one of relativity? We all know—even the layest kind of a layman—that steel can resist greater unit compression stress than stone, hence the greater need and fitness in the use of more massive towers if they are of stone, and even more massive towers if they consist of material less strong in compression than stone.

Some architects and even some engineers seem to think the element of decoration or ornamentation is absolutely essential in a structure before it can claim architectural distinction. How about the Campanile in Venice—a structure almost devoid of applied ornament, but to the writer's mind one of the most beautiful gems of architecture seen by him during his voyages to many parts of the world? True, the Campanile relies somewhat upon color for ornament, but the decoration is of such simple character, being one almost entirely of proportion of mass, that it is hard to reconcile the surpassing beauty of this structure with a condition which "will probably result in a cold and forbidding style."

As Mr. Binckley so well says, "of attempts at ornamentation, let him beware." In this connection consider what an unhealthy and neurotic mental condition must have been responsible for the nightmare of ornamentation seen in some of the later renaissance examples of architecture. To my mind, it is a matter of surprise that engineering structures are so often really sound from an architectural point of view.

There is no doubt in the writer's mind that the ability of Michael Angelo as an engineer (for he was undoubtedly one of the greatest of his time) was to some considerable extent responsible for his greatness as an architect. A study of St. Peter's at Rome and the Trinity arch bridge at Florence will reveal this. On the other hand it is the writer's opinion that the calling in of architects on the design of certain bridges in Paris over the Seine was a disaster, for an engineer could hardly have produced such architectural monstrosities. I most emphatically agree that architects should watch their step and beware of ornamentation, but I cannot for the life of me see why Mr. Binckley thinks "it may be irreverent to say so." It is all a matter of opinion, and the privilege and ability to entertain and express an opinion on this subject is not solely confined to architects. Surely they, as a class, do not possess a monopoly on good taste, a sense of fitness and of beauty.

F. H. FRANKLAND,
Consulting Engineer.

New York, Nov. 26.

Highway Costs and Traffic

Sir—In your issue of Oct. 21, p. 783, is a table, compiled by J. A. Johnston, containing some valuable data relating to the cost of maintaining several different types of highways in Massachusetts. Such information is always desirable, as maintenance is an important factor in the annual cost of highways, which cost is in turn a part of the total annual cost of transportation. However, in this case, as in many others, the information falls far short of its greatest possible utility because it fails to connect maintenance cost with the factors that produce it, that is, the amount of traffic passing over these highways and the climatic conditions and changes of weather.

Those who are in position to gather information along this line would render a very great service to the engineering profession if they would endeavor to ascertain by actual count, or by estimate, the annual tonnage passing over the roads and then correlate the cost of maintenance with the traffic. In fact it is high time that more attention and effort should be given to the systematic counting of traffic on all our main traveled roads. The observer should seek to determine what part of the wear and deterioration of the pavement is due to traffic and what part to weather and climatic changes.

It should be recognized that wear due to traffic is dependent upon the rate of wear (the amount of wear for one passage of the wheel load) and the number of passages of the wheel load per annum. The rate of wear at any instant is a function of the following factors:

1. Wheel load
2. Speed
3. The kind of tire
4. The amount of previous wear
5. Impact of the unsprung parts
6. The roughness and unevenness of the pavement
7. Resistance of pavement to wear.

Laboratory experiments are needed to determine these functions, but pending such research some advance can be made by frequently observing the roadway and by counting the traffic. On the principle that a half loaf is better than none, any information that can now be collected along the lines suggested will be a big improvement over the present published data. Approximate results are better than no results. For example, traffic counts can easily include, beside the number of vehicles, their size or capacity, which in turn gives a basis for estimating the wheel load. At the same time the kind of tires can be noted, whether solid rubber, penumatic, or steel. In a general way the condition of the pavement can be arrived at by noting the prevalence of holes and their depth, which would give a basis for estimating the amount of impact.

It is admitted that such results would be crude and would be of a provisional nature, but their publication would arouse more interest in the goal to be attained and hasten the time when adequate research work would be undertaken.

ROBERT C. BARNETT,
Economic Engineer.

Kansas City, Mo., Nov. 4.

Bearing-Plate Formulas Disagree

Sir—In general line with recent discussions in *Engineering News-Record* of stray points in structural design, the writer would like to mention one point that seems to need clearing up. It is the method of figuring the thickness of base plates and bearing plates. Recently the writer had occasion to go over the formulas given in handbooks for this purpose and was much surprised to find the difference in results given by the Carnegie "Pocket Companion" and such as Ketchum's "Structural Engineers' Handbook," Kidder's "Architects' and Builders' Pocketbook" and the Bethlehem "Handbook." Investigation showed that the formulas given in the three last named gave the same results, whereas that given in Carnegie gave a much larger result. It seems that the difference lies in the original assumption as to the proper method of figuring the maximum bending moment.

The following figures will show the difference referred to above. Take the case of a bearing plate 12 x 16 in. carrying the end of an I-beam whose flange is 6 in. wide, with end reaction 57,600 lb.; the 16-in. dimension is transverse to the beam, so that the plate projects 5 in. on either side. The Carnegie formula gives $M = \frac{57600 \times 10}{8} = 72{,}000$ in.-lb., requiring a section modulus of 0.375 per lineal inch at 16,000 lb. stress, and the thickness corresponding to this value is $1\frac{1}{2}$ in. The formulas of Ketchum, Kidder and Bethlehem all give a thickness of $1\frac{3}{16}$ in. The table in Carnegie gives $1\frac{1}{2}$ in., in agreement with the formula. It seems as though the Carnegie formula must be in error, and the writer would like to learn the opinions of others.

R. W. BOWMAN.

Alliance, Ohio.
Oct. 23.

[Analysis of the formulas shows that the first considers the bending at the middle of the plate, while the others use the stress in the plate under the edge of the beam flange. Assuming uniformly distributed pressure of the bearing area of beam flange on the plate as well as of the plate on its support, the bending moment in the middle of the plate is greater than that at the edge of the projecting width.—EDITOR.]

HINTS FOR THE CONTRACTOR

Winter Storage of Cement Practicable with Simple Precautions

BY BLAINE S. SMITH
General Sales Manager, Universal Portland Cement Co., Chicago

STORAGE of cement during winter in preparation for the needs of the next season is an effective insurance against delays to work. Unfortunately, many who made preparations for storage last winter could not get the desired shipments, even during the winter months, because the railroads could not furnish sufficient cars. Ordinarily, however, cement manufacturers are able to comply with winter shipping instructions, making it possible for users to stock cement. Storage helps to insure continuous operation during the construction season, when cement shipments may be interrupted by transportation or other conditions. It seems likely that improved transportation conditions this winter will permit manufacturers to ship cement in sufficient quantities for storing.

NEXT SEASON'S DEMAND FOR CEMENT

Despite the slackening in some lines of business, the demand for cement in the spring of 1921 promises to be such as to warrant the storage of cement this winter. With better labor and transportation conditions road building will probably increase. Appropriations are available for thousands of miles. Relief for the present housing shortage must come. Lessening of the restrictions that have deterred residential building should result in greater activity and an increased demand for materials. The program for public improvements is far behind schedule. The volume of railroad improvements needed is a matter of common knowledge. The demand for building materials in rural districts was not satisfied this year.

Will it pay a contractor to store cement? No one can answer that question as well as the contractor himself, since he is best able to compute what it will cost. By his experience of last year he can determine just what it may mean in dollars and cents to have cement when he needs it. He knows the possibilities for providing storage on his several jobs. He can best judge the necessity for an adequate cement supply and the premium he can afford to pay in the form of storage. Realizing the importance of having cement immediately available when required, several state highway departments have made financial inducements to contractors to store cement during winter months.

In *Engineering News-Record* of June 24, p. 1263, is a report of tests on the effect of storage of cement, made in the Structural Materials Research Laboratory at Chicago. The results confirm the conclusion that cement in storage should be protected not only from water but from free circulation of air. The conclusions drawn from these and other investigations will be of value to builders who contemplate storing cement this winter while the railroads can make shipments. The investigations show that dryness is one of the most essential of the conditions necessary to provide for. If cement is kept in an air-tight container it retains its strength indefinitely. Air always contains some moisture. Cement exposed to free circulation of air will take up moisture and show a loss in strength and slower setting properties according to the degree of exposure.

TIGHT WAREHOUSES ESSENTIAL

But cement can be stored so that it will be protected from contact with an amount of moisture appreciably affecting its quality. To secure this protection the warehouse should be made as tight as possible. Drain the vicinity of the warehouse to prevent any accumulation of water. Elevate the floor above ground. Pile cement directly on a dry floor, and stack it against the walls, laying the end bags alternately lengthwise and crosswise, to prevent pressure on the walls and to reduce air circulation.

For long-time storage take extra precautions of which the following are typical: Cover with tarpaulins, straw, burlap or other dry material to reduce air circulation. Leave the cement undisturbed, as "turning" exposes fresh cement to the air. Any "warehouse pack" that does occur can be loosened easily when the cement is removed from storage. After the cement has been stored, inspect the exterior of the warehouse to see that the cement has not caused bulging of the walls in such a manner as to produce cracks. Seal the windows and lock the doors. Then board up the cracks or cover them with tar paper.

A semi-permanent storage warehouse may be constructed as follows: Select a dry site. Dig a level trench for 2 x 8-in. mud-sills. Nail 2 x 4-in. studs on 20-in. spacing to the mud-sills. Nail 1 x 6-in. sheathing on the inside and outside of the studs from the mud-sill to the bottom of the floor joists. Fill the resulting space to the bottom of the joists with well compacted gravel, cinders or dry earth. Place 2 x 6-in. floor joists and complete the fill to the top of the joists. Place two layers of 1-in. rough flooring separated by heavy tar paper. Lap the tar paper 1 ft. on the walls. Sheath the outside of the studs from mud-sill to roof-plate with tight siding. Nail tar paper on the inside of the studs and cover with 1-in. boards and prepared roofing lapped over and under the eaves and nailed to the walls. Fit the doors and windows tight.

Brick Wall Torn Down With Dynamite

REMOVAL of a brick wall 150 ft. long, 22 ft. high and 18 in. thick, and resting upon a concrete foundation extending 18 in. below the ground level, was effected recently by a contractor in Gainesville, Fla., through the use of dynamite. It was desided to take down the wall only to the ground surface, and not to disturb the concrete foundation. In effecting the demolition twenty-six holes were cut into the wall just above the ground, and 2½ lb. of 30 per cent ammonia dynamite were placed in each hole. The charges were connected up in series and fired with electric blasting caps. The wall was cut down clean at the ground level, the work all being done by one man in less than a day, and the total cost, including labor, about $26.

NEWS OF THE WEEK

New York, December 2, 1920

Chief of Engineers Reports on Work of Corps

Large Sums Asked for River and Harbor Projects—For Muscle Shoals Job $10,000,000 Is Needed

An appropriation of $10,000,000 is asked by the Corps of Engineers, U. S. Army, for continuing its work on the Wilson dam at Muscle Shoals, Ala., on the Tennessee River, during the next fiscal year. The total of previous appropriations for this work is $20,351,336.92. Even with continuous and energetic work, it will not be possible to complete the Wilson dam before Jan. 1, 1922. These facts are revealed in the annual report of the Chief of Engineers, for the year ended June 30, 1920, made public last week. As usual, the report is voluminous; its text, exclusive of indices, occupies 2,088 printed pages.

Considerable attention is given in the report to the re-organization of the Corps of Engineers to meet post-war requirements. Both the civilian and military personnel have been reduced greatly. While the National Defense Act authorizes 12,000 enlisted men for the corps, its actual strength, at the end of the fiscal year, was 4,652 men.

The report shows that a large amount of topographic work was done by the Corps during the year, but that the maps of the territory surveyed have not been reproduced, due to lack of funds.

Since the armistice sales of surplus engineer material have netted over $110,000,000. The average return was 84 per cent of the cost price. On orders valued originally at $78,068,539.97, adjustments have been made by the Engineer Claims Board for $7,810,225.80. Included in the settlement was finished material valued at $5,786,641.35, making the cost of settlement $2,003,484.45.

River and Harbor Demands

The report reveals for the first time that the Chief of Engineers has asked Congress for $57,206,715 to be carried by the River and Harbor bill; $10,982,950 for works under continuing contracts, to be carried by the Sundry Civil bill. This is in addition to the $10,000,000 asked for the nitrate plant development at Muscle Shoals and $18,000,000 for the expenses of the California Debris Commission.

During the year the Corps expended $47,187,541.83 of government funds on river and harbor works, in addition to $2,255,321.95 contributed by local interests.

For the continuance of construction

(*Continued on p. 1108*)

Opposition Candidates for Am. Soc. C. E. Offices Named

A full ticket of candidates for office in the American Society of Civil Engineers, in opposition to the one selected by the Nominating Committee, has been established by "declaration," in accordance with Section 4 of Article 7 of the constitution, which authorizes additional nominations filed before Dec. 1, endorsed with the signatures of twenty-five corporate members and accompanied by signed acceptances from the nominees. The new slate is as follows:

President—J. Waldo Smith, chief engineer, Board of Water Supply of the City of New York.

Vice-Presidents—Allen Hazen, consulting engineer, New York City; and Frank G. Jonah, chief engineer, Frisco Lines, St. Louis, Mo.

Treasurer—Arthur S. Tuttle, deputy chief engineer, Board of Estimate and Apportionment, New York City.

Directors—District 1, John P. Hogan, chief of engineering staff, state waterpower investigations, New York City, and Robert S. Parsons, general manager, Erie R.R., New York. District 4, Harry A. Lane, chief engineer, Baltimore & Ohio R.R., Baltimore Md. District 9, Alexander Maitland, Jr., president, Kansas City Bridge Co., Kansas City, Mo. District 10, F. T. Darrow, assistant chief engineer, C. B. & Q. R.R., Lincoln, Neb. District 11, Richard D. Parker, chief engineer, State Railroad Commission, Austin, Tex.

The Nominating Committee's selection of candidates, as published in *Engineering News-Record*, Oct. 7, p. 723, was as follows:

President—George S. Webster, Philadelphia.

Vice-Presidents—Andrew M. Hunt, New York, and Edward E. Wall, St. Louis.

Treasurer—Otis E. Hovey, New York.

Directors—John P. Hogan and Ira W. McConnell, New York (District 1); Richard L. Humphrey, Philadelphia (District 4); Baxter L. Brown, St. Louis (District 9); Frank T. Darrow, Lincoln, Neb. (District 10); George G. Anderson, Los Angeles (District 11).

City Debt Limit Raised in Larger Cities of Missouri

The constitutional amendment permitting Missouri cities of 100,000 and over to increase their bond limit from 5 to 10 per cent of their assessed valuation, noted in our issue of Nov. 11, p. 961, as publicly carried was actually adopted by a vote of 368,651 to 329,938.

McCormick Drafts New Public Works Bill

Measure Does Not Conflict With Jones-Reavis Bill, Says M. O. Leighton, of Engineering Council

A preliminary draft of Senator Medill McCormick's bill for the re-organization of the government departments was made public last week. Senator McCormick has had in mind the preparation of this measure ever since he introduced his original budget measure in 1917. The latter, amended to meet the President's objections as expressed in his veto, is pending on the Senate calendar now, having been passed by the House last June.

The McCormick reorganization bill abolishes the Interior Department, creates in its stead the two new department's of Public Works and Public Welfare, divests the War and Treasury departments of functions not germane to the national defense or the national finances, and in general is designed to co-ordinate existing agencies which now are scattered irrelevantly and wastefully throughout the whole government organization. The bill will be introduced on the opening day of the approaching session of Congress, although action on it probably will be deferred until after Senator Harding's inauguration.

The McCormick bill as drawn brings together in the Department of Public Works all important engineering and building services of the government, now scattered among various departments, and authorizes the Secretary of Public Works to make such changes in the organization of these existing agencies as will increase their efficiency and lead to economy in expenditures. Army officers now detailed on engineering works would continue to hold their present assignments for three months after the measure goes into operation in order to give the Secretary of Public Works sufficient time to make an appropriate consolidation or rearrangement of these agencies without interrupting important work.

After receiving from Senator McCormick's office the summary of his proposed bill, *Engineering News-Record* requested from Marshall O. Leighton, Engineering Council's representative at Washington, a statement covering the relation of that measure to the Jones-Reavis bill. The McCormick bill, says Mr. Leighton, is not in conflict with the Jones-Reavis bill. The provision in the McCormick bill for a public welfare department may possibly delay the national department of public work, but Mr. Leighton believes that all supporters of the Jones-Reavis bill may

cordially support the McCormick bill.

The bureaus, offices and branches of service included in the Department of Public Works, as proposed by Senator McCormick, are:

(a) From Department of the Interior—
 General Land Office
 Geological Survey
 Bureau of Mines
 Reclamation Service
 National Park Service
 Division of Capitol Buildings and Grounds
 Alaskan Engineering Commission
(b) From Department of the Treasury—
 Office of Supervising Architect
(c) From Department of Agriculture—
 Bureau of Public Roads
 Forest Service
(d) Office of Superintendent of State, War, and Navy Department Buildings
(e) Rock Creek and Potomac Parkway Commission (abolished and its functions transferred to Department of Public Works)
(f) Commission of Fine Arts
(g) From the Department of War—
 Board of Engineers for Rivers and Harbors
 Board of Engineers of New York City
 Office of Supervisor of the Harbor of New York
 United States Engineer Offices
 Mississippi River Commission
 California Debris Commission
 Board of Road Commissioners for Alaska
 Office of Public Buildings and Grounds and Washington Monument
(h) Federal Power Commission (abolished and its functions transferred to Department of Public Works)

I. C. C. Clears Up Definition of Technical Engineer

Last month the Interstate Commerce Commission issued regulations placing engineers in the subordinate official class as engineers of mechanics. The American Association of Engineers, through a committee headed by George W. Hand, assistant to the president, Chicago & Northwestern Ry., protested Nov. 1 that the term was not clear as to whether it included mechanical and electrical engineers. The I. C. C. has now issued new regulations designating professional engineers as technical engineers to include civil, mechanical, electrical and other technical engineers inferior in rank to engineers of maintenance of way, chief engineers, division engineers and other technical engineers. The opinion is expressed that instrumentmen, rodmen, chainmen, designers, draftsmen, computers, tracers, chemists and others in similar engineering or technical work are not "officials of the carriers."

Chief of Engineers' Report

(*Continued from p. 1107*)

and maintenance of Alaskan roads, the Chief of Engineers asks for $955,000.

Expenditures smaller than those of former years will be made by the Corps on Panama fortifications, due to the fact that most of the defensive works on the Isthmus have been completed. During the next fiscal year, however, the chief of Engineers asks for $425,000 for the construction of seacoast batteries and $405,000 for the construction of sea walls. The remaining expenditures are mainly for maintenance work and for supplies.

Philadelphia-Camden Bridge Study Makes Progress

Organization of a technical staff for the engineering investigation of the proposed bridge over the Delaware River between Philadelphia and Camden was advanced at a meeting of the board held last week with the appointment of the following: Leon S. Moisseiff, consulting designing engineer, at $1,000 per month; Clement E. Chase, principal assistant engineer, at $500 per month; Ralph B. Liggett, chief clerk, at $200 per month; John Briggs, surveyor and draftsman, at $225 per month. These appointments were approved by the Interstate Bridge Commission on Nov. 19, and at the same time the commission approved the budget proposed by the board, which contemplates the expenditure of not more than $100,000 on the study of site type and estimated cost of the bridge, of which some $50,000 is the compensation of the three members of the board of engineers and $50,000 is to be devoted to fees of architectural and engineering consultants, salaries of staff, cost of test borings and other expenses.

Mr. Moisseiff was designing engineer for the New York Department of Bridges during the construction of the Williamsburg, Manhattan and Queensborough bridges, and has been in private practice as consulting engineer since 1915. Mr. Chase has been with R. Modjeski for the past ten years, being now in charge of the latter's New York office.

Specifications and contract forms for the test borings at the three bridge sites to be studied were submitted by the board of engineers and approved by the commission; the work will probably be advertised shortly. It is contemplated to put down but one test hole at the location of each pier and anchorage; this is considered to be sufficient as the foundation conditions are not expected to be a controlling factor in determining the site, being far outweighed by considerations of traffic needs and possibilities and the cost of land. The borings are to be extended into rock, however, so that the results obtained will be wholly dependable. They believe this to be particularly important because present knowledge of subsoil conditions under the Delaware River is meager, aside from the negative testimony afforded by artesian wells drilled on land near the river without striking rock.

The board of engineers is composed of Ralph Modjeski, George S. Webster, and Laurence A. Ball. The joint Delaware River Bridge Commission (of the States of Pennsylvania and New Jersey) is under the chairmanship of Governor Sproul, of Pennsylvania.

Reserve Needs Engineer Officers

The examining board for the engineer section of the Officers' Reserve Corps is now functioning and is anxious to receive applications of former engineer officers.

All Except Harbor Bonds Carried At Houston, Tex.

Bond issues totalling $875,000 for city work at Houston, Tex., were carried Nov. 2 as follows: bridges, $425,000; street improvements, $200,000; sewers, $100,000; schools, $150,000. A bond issue for harbor improvements was defeated, largely because a proposition for the purchase of 600 acres of land for wharf and industrial sites proved unpopular and had its effect in defeating all items for harbor work.

Boards of Engineering Examiners Form Council

Seven state boards of engineering examiners were represented at an organization meeting Nov. 8 and 9 in Chicago at which the National Council of State Boards of Engineering Examiners was formed. The purpose stated in the constitution is "to examine the state laws providing for registration of engineers and the custom and rule of procedure of the different boards in the examination of applicants with suggestions and recommendations for uniformity of practice so far as the same can legally be done by the different state boards, and to provide for reciprocal relations between the state boards for granting registration licenses to applicants from other states on equal terms of examination."

K. C. Kastberg, secretary of the Iowa board and city engineer of Des Moines, sent out a call for the meeting. He explained that there should be an organized and systematized method of procedure to be followed in the interstate registration and a plan for facilitating the procurement of license or registration. Informally under Seth Dean (Iowa) as chairman and Mr. Kastberg as secretary these matters and the administration of the various laws were discussed in detail by representatives from Iowa, Illinois, Florida, Louisiana, South Dakota and Michigan.

The following resolutions indicate the unanimity of opinion on reciprocity; (1) That where a qualified engineer obtains a contract he be permitted to proceed after filing an application and pledging himself to appear for examination at the next board meeting; (2) that efforts be made by the several states to standardize the examinations; (3) that members of the various boards be granted reciprocity license or registration without examination.

Much of the time was taken up in an explanation and discussion by T. L. Condron of the provisions in the proposed draft of a uniform law recently approved by Engineering Council.

The officers elected were: President, Marcel Garsaud, New Orleans; vice-president, C. S. Hammatt, Jacksonville, Fla., and secretary-treasurer, Alvin Le Van, Des Moines, Iowa. The next meeting will be held Oct. 3, 1921, in St. Louis.

Highway Estimates To Be Made Known After Receipt of Bids

The state highway commission of Indiana has adopted the policy of not making public its engineering department's cost estimates on jobs until after it has opened bids on the jobs. The motion to adopt such a policy was unanimously agreed on by the commission at a recent meeting. Heretofore the estimates have been accessible to the public before bids were opened. The theory back of the new policy is said to be that if contractors do not know the estimates before they bid, they will be unable to bid so closely to the estimates, and that by bidding "in the dark" the contractors may bid further below the estimates than they would if they knew the estimates in advance.

City Managers' Association Meets at Cincinnati

The seventh annual meeting of the City Managers' Association, held at Cincinnati, Ohio, Nov. 15-17, was by far the largest and most enthusiaistic meeting yet held. Approximately 100 delegates registered, half of the number being city managers. About half of the 200 city managers in the country have had engineering training.

"A Model Paving Program for a City of Twenty Thousand," was discussed by technical experts of the Portland Cement Association, the National Paving Brick Manufacturers Association, the Barber Asphalt Paving Co., and the Barrett Co. Each speaker presented his version of the program in a 15-min. paper. General discussion followed. Other topics were: "Practical Budget Procedure," a paper by C. E. Rightor, of the Detroit Bureau of Governmental Research; "Setting Up a City Plan Program," by Morris Knowles, of Pittsburgh; "Building a Fundamental First Step in City Planning," by W. J. Donald, director American City Consultants, New York; "City Planning Achievements in the United States," by George B. Ford, city planning consultant, New York City; "Making City-Owned Utilities Pay," by J. W. Greer, city manager of Tallahassee, Fla., and H. L. Woolhiser, village manager, Winnetka, Ill.; "The Relation of Motor Trucks to City Business," by Raymond W. Parlin, International Motor Co., New York.

The proceedings of the convention will be published in the Seventh Year Book of the City Managers' Association.

The new officers elected at the meeting were: President, A. W. D. Hall, city manager, Jackson, Mich.; first vice-president, George M. Zimmerman, city manager, Sandusky, Ohio; second vice-president, Edwin J. Fort, city manager, Niagara Falls, N. Y.; third vice-president, Wilder M. Rich, city manager, Goldsboro, N. C. Harrison G. Otis, Tribune Building, New York City, was re-elected executive secretary.

$25,000,000 Teredo Damage Studied by Committee

Interests Participating in Work at San Francisco Include Railroads, Ship Owners, Army and Navy

A survey of the damage caused by marine borers in the San Francisco bay region and an investigation to determine the best means of combating them have been undertaken by the Forest Products Laboratory of the U. S. Forest Service in co-operation with the San Francisco Bay marine piling committee of the American Wood Preservers Association. This work was begun after the rapid and very great increase in borer damage to waterfront structures during the past two or three years in the upper bay, as described in *Engineering News-Record*, May 20, p. 1000.

In the upper bay, by reason of past immunity, most of the waterfront structures had been built of untreated piling. This afforded a clear field for the teredos, whose attack was so rapid and severe that structures valued at many millions of dollars were destroyed. According to a recent statement by the marine piling committee above referred to, "Docks have been failing and frequently dropping into the bay with accompanying menace to the other structures, during the entire year past. The damage, which has been estimated by the committee at $25,000,000 up to the present time, bids fair to greatly exceed that sum in the near future."

Many Interests Represented

This committee consists of engineering representatives of the state board of harbor commissioners, the principal railroads, oil companies and shipping interests having waterfront structures in the bay, who are financing the investigation, and representatives of the Army, Navy, U. S. Engineer Corps, immigration commission and lighthouse board, and the University of California.

F. D. Mattos, superintendent of creosoting plants for the Southern Pacific Co., is chairman of the committee. Prof. C. A. Kofoid, marine biologist, is studying the biological aspects of the problem as representative of the University of California. The Forest Products Laboratory is represented by Geo. M. Hunt, chief of the section of wood preservation, and T. G. Townsend, engineer in forest products, who are conducting the survey. The executive officer of the committee, to whom communications may be addressed, is C. L. Hill, chief of the office of forest products, U. S. Forest Service, Ferry Bldg., San Francisco.

This study, it is announced, will be the first unit of a nationwide investigation under the auspices of the United States Forest Service and co-operating associations of wood preservers, lumbermen, railroads and many other industries having interests at stake, which will cover the entire coastal waters of the continental United States. Its ultimate object will be to find the best means of combating these attacks.

Chicago Conference on Education and Employment

That personal work is necessary in engineering schools and that the best teachers should be placed in charge of the more elementary work were definite opinions expressed in two resolutions adopted at a conference on employment and education, held in Chicago on Nov. 12, under the direction of the American Association of Engineers. Both resolutions were introduced by Dean E. J. McCaustland, University of Missouri. Courses in management at technical schools were advocated by R. O. Kramer, manager of the mechanical department of Montgomery, Ward & Co., his idea being to prepare engineers for executive positions. On the other hand, Dean A. A. Potter, Purdue University, held that although to a certain extent there is a demand for a specialized product the aim of the schools is to give a broad fundamental training which will serve to adapt the graduate engineer to any field of work.

A student entering college should be interviewed by a vocational adviser in order to give him the right start, according to J. H. Libberton, manager of the service bureau of the Universal Portland Cement Co., who also advised that men of the best talent should be secured as teachers and encouraged to engage in private practice. Methods of helping the undergraduate engineer to decide what line of work to undertake were explained by A. B. Crawford, director of the bureau of appointments at Yale University. In regard to the army schools, A. B. McDaniel, development specialist for the U. S. Army, explained the methods of training the soldier student to plan and execute work in some one of about a hundred vocations.

The Chicago conference showed, on the whole, greater unanimity of opinion as to employment than as to education, but it showed also the importance of joint consideration of the two subjects.

General Contractors Indorse Lockwood Inquiry

At a meeting of the executive board of the Associated General Contractors of America held recently in Washington, D. C., resolutions were adopted unanimously endorsing the action of the Lockwood Joint Legislative Committee which is investigating housing conditions in New York City. Plans were also laid for securing the co-operation of the United States Chamber of Commerce and other employers' associations in urging the Lockwood Committee to "pursue its investigations without fear or favor to the end that all guilty may be exposed and punished and that justice thereby be done to those who are condemning the purchase of immunity from labor troubles by the corruption of labor officials, desire an honorable settlement of the labor problems based on fair dealings."

Architects' Examining Boards Have Council

A copyright for the word "architect," a standard examination, and a feeling that joint registration laws for engineers and architects is undesirable, were points of interest to engineers in the meeting at St. Louis, Nov. 18 and 19, of the National Council of Architectural Registration Boards. The conference was called to consider the present status of registration and the experience obtained in giving the various laws effect, and to bring about co-operation.

The trend of the meeting was toward a copyright of the word "architect" on the principle that the passing on an individual by a board is a notice to the public that the holder is competent to practice architecture, but that competency must then educate the public. There was a strong tendency, led by Illinois and New Jersey, not to support Article 18 of the proposed model law of the American Institute of Architects which, while fully protecting the word "architect," would not protect engineers and other from doing similar work providing they use the correct appellation. A motion to the effect that Article 18 reflects the sense of the meeting was laid on the table.

By resolution the issuance of certificates to alien engineers was approved and so was another resolution "that a joint registration law for architects and engineers is undesirable."

Reciprocity between states has been found difficult under existing laws because of the lack of uniformity in requirements but a way out seemed likely in the latitude most of the laws gave the examining boards in conducting examinations. It was the general opinion that a standard examination could be devised by the Council.

Fail To Agree on Waterfront Viaduct at Toronto

A recent conference on the plans for a railway viaduct along the waterfront at Toronto, Ont., failed to arrive at any conclusion owing to the opposing views of the city officials, the railways and the harbor commission. Before the war the railways had agreed to build a six-track elevated line, as required by the Railway Board, but now they wish to have the work postponed for ten years, laying tracks at the present level into the new union station and providing subways and temporary bridges at important streets intersected by the railway line. The new station building is practically finished, and two floors are occupied for railway offices. The city is insistent that the viaduct should be commenced at once. A postponement was granted to enable the railway engineers to consider the alternative plans of procedure, after which there will be another conference of representatives of all interests concerned.

Railway Fire Protection Meeting

So much interest was shown in a report on fire hazards and fire protection in railway shops and roundhouses, presented at the recent annual meeting of the Railway Fire Protection Association, that the matter was again submitted to a committee for further elaboration. A brief report on the use of small gasoline tractors in freight houses and piers gave some rules for care and handling, but this report was incomplete and was referred back to the committee. These tractors do not appear to be a serious risk and although a proposition was made to exclude them from freight houses this was defeated after an explanation that shippers' motor trucks must be admitted. The fire risks incidental to industries served by railways were reviewed in a paper by W. F. Hickey, who outlined various chances of fire in plants entered by steam and electric locomotives. Carelessness in handling and storing refuse is a large cause of fire, and may be reduced by persistent instruction and inspection, but this should be by personal methods rather than by merely issuing circulars and bulletins. In regard to oil fires, a resolution was passed approving any extinguishers approved for this purpose by the Underwriters Association. W. F. Hickey was elected president; secretary, R. R. Hackett, Baltimore & Ohio R.R., Baltimore, Md.

Lime Association Appoints Department Managers

Laurance H. Hart, the newly appointed manager of the construction department of the National Lime Association, and Dr. E. Holmes, newly appointed manager of the chemistry department, are to act as consultants on any phase of the use of lime. Mr. Hart will handle the use of lime in building operations from lime used in brick work to stucco and concrete, and Dr. Holmes' services are available to anyone interested in the chemical use of lime.

Mr. Hart went to the National Lime Association from the Lakewood Engineering Co., in which organization he was employed as construction sales engineer in Michigan. Previous to that time, he was with the Hunkin-Conkey Construction Co., of Cleveland, as manager of the western New York office; and the Lupfer & Remick consulting and contracting engineering firm at Buffalo.

Dr. Holmes was at one time research engineer for the National Carbon Co., Cleveland. His industrial experience covered practically all the departments of a manufacturing establishment, but particularly has he been engaged in technical control of factory production, development of new products and improvement of old products, the building and operation of semi-factory plants, consulting work with departmental heads, technical research and the preparation of technical literature.

New California Road Contracts Ready by February First

The earliest date on which California highway contracts will be awarded under the new flexible interest plan will probably be Feb. 1, according to a recent announcement by the California Highway Commission. This plan, which was approved at the recent election and described in *Engineering News-Record* Nov. 11, 1920, p. 962, will be acted upon at once, but the legal requirements are such that some delay is unavoidable.

The amendment does not become operative until five days after certification by the secretary of state who will not be able to effect a complete and official canvass of the Nov. 2 vote much before Dec. 1. Thereafter the new state highway finance board must meet, fix a prevailing interest rate and offer for sale such an amount of bonds as is needed to meet existing obligations and provide for new work. This operation, according to the commission's announcement, will consume not less than sixty days as the bond sale advertisement will take thirty days and printing and signing bonds will take an equal amount of time.

Brindell Indicted for Attempted Extortion as Inquiry Result

Robert P. Brindell, head of the Building Trades Council of New York City, who has been under fire from the Lockwood Joint Legislative Committee investigating the housing situation, has been indicted by the November additional grand jury of the city and county of New York on three counts of attempted extortion. His arraignment before Judge Mulqueen, of General Sessions, resulted in a bail of $100,000 being fixed, a sum which was secured by Brindell. The specific charges against Brindell concern his alleged attempted extortion from Jacob Fradus, a wrecking contractor, as insurance against strikes. It is the assertion of the special assistant district attorney who made a plea for a bail of $100,000 being fixed, that Brindell's alleged extortions will aggregate $1,000,000.

New York Highway Transport Show in January

The first New York Highway Transportation Show will be held in that city Jan. 3-8, 1921, under the auspices of the Motor Truck Association of America, 144 West 65th St., New York City. The exhibit will occupy the 12th Regiment Armory, Columbus Ave. and 62d St. The exhibit will include trucks, trailers and accessories, educational exhibits, a model terminal, and model traffic control. It is planned to include in the program addresses on highway transport problems. The program has been divided into Army Day, Motor Accident Prevention Day, Highway Transportation Day, Farmers' Day and Motor Truck Association Day.

Wall of Store Slides Into Nearby Excavation

Collapse of the rear wall of a department store building in Topeka on Nov. 6, in which fortunately no one was injured though large property loss was caused to the store, was brought about by weakening of a lateral support of the wall foundation by excavation for an extension at the rear of the store. This excavation had approached within 8 or 10 ft. of the rear wall, a distance which the contractor regarded as safe. The wall foundation was rendered less stable than under ordinary circumstances, it is thought, by the existence of a former well, long ago filled with earth, close to the foot of the wall, about at the middle of its length. Some outward leakage of drainage water from the building may have contributed to the failure. Longitudinal girders supporting joists of floor and roof of the building rested on the rear wall near its middle, bringing a concentrated load to bear on the foundation at this point. With the failure of the wall these girders and the joists carried by them sagged, rendering part of the structure of the store unsafe.

Cracking noises suggesting movement of the wall were heard by a watchman during the night, but the wall did not fail until eight in the morning, after having given noticeable warnings of approaching failure half an hour earlier.

South Bend Postpones Water-Works for Lower Prices

Following the advice of W. A. Artingstall, city engineer of South Bend, Ind., the water-works department has decided not to award contracts for work recently advertised but to postpone all improvements until next spring, expecting a reduction of approximately 25 per cent in the cost of materials and labor. The present plans called for an expenditure of $150,000.

One Concrete Ship Sold; Three Wrecked

One of the 7,500-ton reinforced concrete tankers built for the United States Shipping Board has been sold and several of the smaller boats have been under lease and the larger ones are for sale. The vessel sold is the *Latham* which was built at Mobile and it has been bought by the American Fuel Oil Transportation Co. for $700,000. Of the other ships built the *Polias* was wrecked last winter off Penobscot Bay in Maine, and a contract has been entered into with Aëronautical Equipment, Inc., of New York City, on a "No cure, no pay" basis to salvage the ship. It is reported that the salvage operations are proceeding successfully. The *Selma*, a 7,500-ton ship, built at Mobile, ran on the breakwater at Tampico early this summer. It has been dragged off and towed up to Galveston for repairs, which are now under way. The *Cape Fear*, as reported on another page of this issue, was sunk on Oct. 29 in Narragansett Bay.

By the original contract for concrete ships by the Shipping Board there have been completed six 7,500-ton ships, three 3,500-ton ships, and two 3,000-ton ships. Contracts for three of the original nine 7,500-ton ships were canceled and the ships left half-completed on the ways.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Washington, D. C., Dec. 13-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City, Jan. 19, 1921.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. 25-27.

The Engineers' Club of Philadelphia, at its weekly luncheon meeting, Nov. 23, was addressed by E. J. Mehren, editor of *Engineering News-Record*, on "An Engineer's Observations in Europe."

The Philadelphia Post, Society of American Military Engineers, held a meeting at the Engineers' Club of Philadelphia recently at which time the constitution and by-laws of the local post were adopted. The following officers were elected to hold office until Jan., 1922: Col. W. B. Ladue, commander; Major Marshall R. Pugh, vice-commander; Major H. W. Goddard, adjutant; Capt. J. C. Hinton, finance officer. Staff officers elected for two years are: Lieut.-Col. Henry S. Spackman, Major Thos. W. Battin, and Capt. Clarence Roberts; and for one year, Capt. R. W. Robinson, Lieut. Robert L. Harding. Regular meetings are to be held the fourth Thursday of each month during the winter.

The Association of Chinese and American Engineers, formed with the sanction of the Chinese Government and supported by the highest officials of the Government of China, by the American Minister to China and prominent American engineers in that country, desires to exchange the English edition of its journal with the publications of other engineering societies throughout the world, and particularly with American engineering societies. The secretary of the association is P. Y. Tsai, assistant engineer, Chuchow-Chincow Ry., Peking, China. The chairman of the publication committee is Murray Sullivan, acting chief engineer of the railway named.

The Detroit Engineering Society was addressed Nov. 15 by Lieut.-Col. T. A. Leisen, civil engineer of the Board of Water Commissioners on "The Detroit Filtration Plant."

The Montana Irrigation and Drainage Institute, at its meeting held in Billings, Nov. 10-11, elected G. C. Sanford, Great Falls, president and F. H. Murdock, Bozeman, secretary-treasurer. The Institute approved a committee draft for a state irrigation code of 11,000 words to be submitted to the legislature in January.

The Iowa Section, American Waterworks Association at its sixth annual meeting Nov. 5 and 6, elected the following officers. Chairman, Francis D. H. Lawlor; vice-chairman, J. Chris Jensen; directors, R. C. McDonnell and H. V. Knouse; secretary-treasurer, Jack J. Hinman, Jr., Iowa City.

An Affiliation of nearly all the engineering societies of Baltimore with the Engineers' Club of that city, and the establishment of headquarters of the enlarged Engineers' Club on the fifth floor of the Merchants and Manufacturers' Association Building, was decided upon Nov. 4 at a meeting of Baltimore engineers in celebration of the fortieth anniversary of the founding of the American Society of Mechanical Engineers. The Baltimore branch of the American Society of Mechanical Engineers decided after the meeting to join with the Engineers' Club. The American Association of Engineers, at a meeting Nov. 5, also voted to co-operate with the other engineering bodies. In all, about ten engineering bodies have combined in the new organization.

The New England Waterworks Association, at its meeting Dec. 8, will be addressed by M. Bevant, engineer director of water supply service, City of Geneva, on "The Water Supply of Geneva, Switzerland." There will be a general discussion on the cleaning and painting of standpipes, opened by Charles W. Sherman of Metcalf & Eddy, consulting engineers, followed by Prof. Harold K. Barrows, consulting engineer.

Personal Notes

LEON S. MOISSEIFF has been appointed consulting designing engineer on the technical staff for the engineering investigation of the proposed bridge over the Delaware River, between Philadelphia and Camden. Mr. Moisseiff was designing engineer for the New York Department of Bridges during the construction of the Williamsburgh, Manhattan and Queensboro bridges and has been in private practice as consulting engineer since 1915.

P. G. BRUTON, formerly chief of the metal sales section, Material Disposal & Salvage Division, Air Service, at Buffalo, has accepted a commission in the Corps of Engineers, U. S. A., and is assigned to the 6th Engineers, Camp Pike, Ark.

EMILE G. PERROT, formerly of the firm of Ballinger & Perrot, architects and engineers, announces the opening of offices in the Woolworth Building, New York, and the Parkway Building, Philadelphia, Pa. Mr. Perrot has been associated as architect and engineer with the erection of industrial structures for twenty-five years and he announces the continuation of his professional activities under his personal direction in the designing and construction of industrial plants and institutions.

H. LEE WILSON, assistant city engineer, Johnstown, Pa., has been appointed city engineer to succeed Jackson R. Crissey, resigned.

BRUCE L. MELOY, formerly field engineer, Johnstown, Pa., has been appointed assistant city engineer.

DR. HERMANN M. BIGGS, health commissioner of New York State, has temporarily assumed the duties of general medical director, League of Red Cross Societies, Geneva, Switzerland, in place of Dr. Richard P. Strong, the latter having resigned to resume his position of professor of tropical medicine at Harvard University. Ad interim, Colonel F. F. Langley, who succeeds Prof. Geo. C. Whipple as chief of the league's department of sanitation, was medical director.

W. C. WEST, formerly resident engineer on work on the Dixie Highway north of Toledo, Ohio, is now assistant district engineer stationed at Saginaw, Mich.

JOSEPH T. KIERNAN has resigned his position as assistant engineer with Hill & Ferguson, consulting engineers, New York City, to take the position of office engineer in the chief engineer's office of the Interstate Railroad at Norton, Va.

J. B. DAWSON, recently division engineer in District 9, Kentucky State Highway Department, has been appointed maintenance engineer.

C. F. FOSTER, assistant district engineer of bridges, central and southeastern districts, Michigan State Highway Department, has been appointed district engineer for the west central portion of the state with headquarters at Grand Rapids.

G. N. PRENTISS, formerly chief chemist Chicago, Milwaukee & St. Paul R.R., has been promoted to engineer of tests with headquarters at Milwaukee.

W. H. WILSON, formerly assistant engineer Southern Ry., at Chattanooga, Tenn., has accepted a position as assistant engineer in the construction department, Southern Ry., Washington, D. C.

E. G. LANE, engineer maintenance of way, Western lines, Baltimore & Ohio R.R., with headquarters at Cincinnati, has been appointed engineer maintenance of way, Eastern lines, with headquarters at Baltimore, Md.

W. A. KENNON, division engineer, Missouri Pacific R.R. at St. Louis, Mo., has been transferred to a similar position with headquarters at Osawatomie, Kan.

L. WINSHIP, formerly assistant engineer, Missouri Pacific R.R. at St. Louis, Mo., has been appointed division engineer with headquarters at Nevada, Mo.

J. R. NAGLE, formerly division engineer, Missouri Pacific R.R. at Nevada, Mo., has been transferred to St. Louis, Mo., as division engineer.

E. P. GUTELIUS, vice-president and general manager, Delaware & Hudson Railway, has been appointed to act in an advisory capacity to the royal commission which is investigating the radial railway projects of the Ontario Hydro-Electric Power Commission, Toronto, Ont., Canada.

S. M. BAILEY, formerly resident engineer for the Department of Public Roads, Kentucky, has been appointed resident engineer, North Carolina Highway Commission in charge of gravel road construction on Federal-Aid Projects 69 and 115 and Federal-Aid Survey 78-D in western North Carolina.

OBITUARY

COL. THOMAS W. SYMONS, Corps of Engineers, U. S. A., retired, died Nov. 23, at Washington, D. C. He was born in 1849 and was graduated from the U. S. Military Academy, 1874. His first assignment was as an engineer on the Wheeler Survey under the War Department (1876-1879). From 1879 to 1882, engineer of the Military Department of the Columbia; 1882-1883, on Mississippi River improvement; 1883, in charge of reconnaissance of natural boundary line between United States and Mexico; 1883-1886, superintending engineer, Washington aqueduct and works for improving the water supply of the national capitol; 1886-1889, assistant to engineer commissioner and in charge of engineering work in the District of Columbia; 1889, in charge of various works of river and harbor improvements in Oregon, Washington and Idaho. In 1901 he was appointed by Governor Theodore Roosevelt as director and member of the executive committee of the Pan-American Exposition at Buffalo, N. Y. From 1903 to 1904 he was in charge of public buildings and grounds and military aid to President Roosevelt, Washington, D. C. He was a member of the advisory board of consulting en- gineers on New York State canal im- provements for which the state ap- priated \$101,000,000. In 1908 he was commissioned colonel of the Corps of Engineers, U. S. A. and, after th y years of service with the governm t, he retired July 28, 1908, at his n request.

HERBERT M. WILSON, gen l manager, Associated Insurance C panies, died Nov. 25, at Hartford, C n. He was born in Glasgow, Scotland, A g. 23, 1860. He was graduated with e degree C. E. from the Columbia U i- versity School of Mines, 1881. From 1 1 to 1882 he was on the U. S. Geolog al Survey as topographer; 1882-1888, r- rigation engineer; 1892-1906, chief n- gineer technologic branch; 1907-1 9, engineer in charge, U. S. Bureau of Mines; 1910-1914, director departm nt of inspection and safety, The Associ d Insurance Company, and from 191 he was general manager of this comp y. He has lectured extensively on irr i- tion, fuel testing, smoke abatem t, fireproof building construction, etc. le was the author of "Manual of Irr a- tion Engineering, Topographic Sur y- ing," and numerous magazine art es on the above subjects.

EDWARD F. LEIDL, chief engi er of sewers, Milwaukee, Wis., since 1 4, died Nov. 21. He was 46 years d He entered the employ of the city as a chainman in 1894, continuing in he municipal service until his death. le was appointed chief engineer, dep t ment of sewers, in 1914.

WALTER D. MOODY, mana ig director of the Chicago Plan Com s- sion, died at Chicago, Nov. 21. He as the author of the "Manual on ty Planning" and "What of the City

RICHARD J. GOODBODY, r merly superintendent of streets, an Diego, Cal., died in that city Nov. 0. He was 58 years old. He constru ed the irrigation distribution system or the Southern California Moun ir Water Co., San Diego. He was so for some years in the general cer nt contracting business and supervise a large amount of county highway n- struction.

ARTHUR S. GOODEVE, membe of the Board of Railway Commissio s. Ottawa, Canada, died Nov. 22 at T r- onto. He was born in Guelph, (t., Canada, Dec. 15, 1860. He was a gr u- ate of the Ontario College of P r- macy, Toronto. In 1903 he was p- pointed provincial secretary of the st Conservative Government—became a member of Federal House for Koote ay district in 1908. In 1912 he was p- pointed to the Board of Railway C n- missioners.

J. G. SCHILLINGER, chief e i- neer, Rutland R.R., died Nov. 12 at Burlington, Vt. He was graduated from Cornell University, 1892. He as at one time in the service of the ew York Central R.R. as division engi er

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
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E. J. Mehren, Editor

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International Road Congress

ATTENTION is called in a letter to the editor in this issue regarding the importance of having the United States represented in the International Association of Road Congresses. It should not be necessary to urge compliance with Professor Blanchard's suggestion that every engineer express to his representatives in Washington his approval of our membership in the International Association and our desire to see the next congress held in this country.

A Sound Principle

TAKING the gamble out of garbage disposal contracts was the way we characterized (Feb. 6, 1919, p. 265,) such contracts for garbage disposal by feeding to hogs as those made by Buffalo, Newark, and Baltimore in 1918 and 1919. The cities that entered into such contracts shared with the contractors the high prices for live hogs that prevailed on the Chicago market for some time, running as high as 23 cents a pound in July, 1919. And now that the price of hogs has fallen almost to pre-war level (announced as 10½ cents on Dec. 2, as compared with 8 cents in November, 1913) the prices the contractors must pay for the garbage of these cities will fall proportionately. The governing principle of these contracts might well be extended to other cities and to some other services than garbage disposal.

Highway Traffic Problem

ECONOMIC rather than structural problems trouble the highway departments of Connecticut, Rhode Island and Massachusetts. The intensity of the traffic and the presence of a comparatively small number of heavy trucks, for which expensive construction and renewals are necessary, have forced the traffic problem ahead of other highway considerations. In these three states, with an aggregate population of about 6,000,000, there are approximately 450,000 passenger automobiles and motor trucks. There is one car to each thirteen of the population and thirty cars to every square mile of territory. In addition, the highways carry a large number of foreign cars. The fact that these three states are almost entirely manufacturing communities means that they have well-developed systems of intermili and inter-city motor truck transport. Their reaction to the problem before them furnishes the theme for this week's article in the staff series upon the trend of highway development.

Safety in Rebuilding

SERIOUS accidents in the alteration of buildings are not frequent, in spite of the manifold risks inherent in such work. The collapse of a section of a nine-story building in New York City while in process of alteration is therefore a startling occurrence, but at the same time it serves as a remainder of the risks inseparable from reconstruction. Removing a carrying part of a building and replacing it by another implies a disturbance of many structural conditions, some of which it may be difficult to recognize. Minor elements of stability ordinarily neglected, but of more than negligible importance, may be involved. Skill and conscience do not always suffice to prevent accidents in such an undertaking. This is only the more reason, however, for placing fullest responsibility for safe results on competent engineering direction. Building departments, also, have a duty in the matter, while engineering societies may properly bear some of the responsibility, though their publications reveal but little discussion devoted to the subject in recent years. The Strathmore collapse may serve as a suggestion of the possibilities of fruitful work in this field.

Curves and Setbacks

IN THE residence district of cities a pleasing diversity of scene may often be introduced by the use of curved streets and by varying the setback distance of the fronts of houses or of groups of houses. This is well known to those who have given much attention to city and town planning, but would seem like a bad practice to many real estate developers, to layman city officials, and we fear also to many city engineers. Curving streets and unequal building setbacks might also be introduced at times and places in other than residence sections. In all cases such variation from the straight line for streets and the uniform setback line for the whole length of a street must be planned with careful regard to both appearance and convenience. Where municipal engineers and representatives of real estate owners lack the necessary training and taste for this sort of planning, as is often the case, the services of a landscape architect and city planner will be needed. Some of the books on city planning contain useful hints on the subject.

The Science Bond

THOSE who have had occasion to meet or correspond with engineers and scientists of the former "Central Empires" know that they have a conviction that it is through the contact of scientific men that an understanding between the former belligerent nations can most quickly be brought about. It is held that science is dispassionate and that admiration for each other's solid scientific achievements is a good basis for the establishment of relations. Judging by a recent occurrence in England, the desire for reconciliation extends to leaders in the arts and literature as well. In October a letter was addressed to the universities of Central Europe by many "doctors, professors, and other officers and teachers" of Oxford, inviting the restoration of amicable relations. The signers were men of

many pursuits. As was to be expected, there was controversy as to the advisability of such an approach, but the subsequent letter signed by sixty-five more teachers, most of them tutors, showed that the younger element —including many who had seen war service—agreed with the maturer men who had written the first letter. Great Britain, as in all things international, has again taken the leadership. Evidence is not lacking that in this country, within the last year, has come a similar feeling that international intellectual relationships should again include the central powers. Certainly we should not shut ourselves off from whatever of technical advance may be made by our former enemies.

The Personal Questionnaire

AS A MEANS of securing numerous opinions and data on a particular subject the questionnaire system is well established, but a newer and less frequent application is its use by an individual as a means of determining his own knowledge or lack of knowledge of a given subject. Two such applications of the personal questionnaire are suggested in *Engineering News-Record* of Oct. 14 and 28, pp. 727 and 823, for use by municipal and railway engineers respectively in considering the problems of snow removal and of electrification. For this purpose the engineer sets down more or less at random, questions and factors relative to the matter in hand, and then proceeds to fill in the data. That is, he first visualizes the various aspects of his problem and then arranges them in logical sequence; after which the can readily determine what information he possesses and what he needs to solve his problem. The personal questionnaire concentrates and clarifies opinion and knowledge, besides showing clearly where links are missing.

Fourteen Backward States

THIRTY-THREE states and the District of Columbia gather and record mortality statistics with sufficient accuracy and completeness to be included in the Census Bureau's registration area. Fourteen are so backward and so regardless of one of the very fundamental of public health protection as to be classed in the non-registration area. For the year 1919 the registration area showed the record-breaking low death rate of 12.9 per 1,000. What the death rate was in the fourteen backward non-registration states no one knows. The presumption is that in most of them it was relatively high, since states that neglect to record the birth and death of their citizens are likely to do less than they should to conserve their health in the intervening period. Since all the legislatures meet in 1921, an opportunity will be afforded to bring every state into the registration area and to pass needed sanitary legislation as well. The fourteen states in the non-registration area (shown in black, *Engineering News-Record*, April 8, 1920, p. 732) are as follows: Alabama, Arizona, Arkansas, Georgia, Idaho, Iowa, Nevada, New Mexico, North Dakota, South Dakota, West Virginia and Wyoming. Engineers in these states have a duty to perform. They should stir the people to insist that their legislators and administrative officers take immediate measures to place their states in the registration area. Some of the fourteen states outside that area are doing good work through their health departments, but lacking complete and reliable vital statistics those departments cannot work with full intelligence and efficiency.

Federal Intrastate Rate Control

WITH the Interstate Commerce Commission's order to railroad companies in three states to initiate and file rates within those states conforming to interstate rates already ordered, there is now the possibility of a Supreme Court decision greatly widening Federal powers of intrastate regulation of public utilities services which affect interstate commerce. The order of the commission appears generally to have been expected as conforming with the mandate of Congress in the Transportation Act directing the commission finally to adjudge and act in disputes with state bodies in equalizing intrastate with interstate rates. The opinion is widely held that the act is clear in this respect, and it would be difficult to sustain the charge that the commission has done otherwise than merely carry out the law. The State of New York has already announced its intention to take the case to the Supreme Court, and in its case the inviolability of a contract in the charters granted the railroad company is involved. Wisconsin and Illinois, it is understood, also propose to contest the commission's order.

In the New York case the contest is over passenger rather than freight rates, since the original state charters, and later state statutes, fixed only passenger fares, but the principle involved is so broad that the effect may be felt not only in intrastate passenger fare regulation but also in other public utilities services within states which affect interstate trade. "The Congress shall have Power . . . to regulate commerce with foreign Nations, and among the several states, and with Indian Tribes." This basic clause from the Constitution of the United States is the foundation and cornerstone upon which have been based all of the present sweeping powers of Federal regulation, and it is significant that the tendency of Supreme Court decisions has been to broaden rather than to restrict the powers of Congress in this respect.

One of the principal points at issue is the inviolability of state charters from the contract viewpoint. But from the viewpoint of expediency and the public good in regulating, rather than restricting, interstate commerce, we believe the principle sound that state commissions should not be permitted to exercise powers that tend to restrict commerce between the states. If intrastate rates are forced down, interstate rates will have to go up to bring the stipulated net return on aggregate value, which would act directly as discrimination against traffic across state lines. Thirty-one states have already acted to conform with rates prescribed by the Interstate Commerce Commission and eight states have opposed it—some on grounds of state charters and some on grounds of state statutes.

It needs to be recognized that charter provisions are arrived at as the result of bargaining between the state and the company involved. In return for certain privileges the company contracts to give certain service or to perform service at a stated rate. If the rate or the service be changed by Federal order, the whole contract should, in equity, be reconsidered.

Naturally some state commissioners are much exercised over the threat to their powers that is carried in the Transportation Act. This was strikingly brought out at the recent meeting at Washington of the National Association of Railway and Utility Commissioners, reported in *Engineering News-Record* of Nov. 18, 1920,

p. 1013. But, as we view the case, it is a question of national policy and national good as opposed to local policy and local benefits. True, the matter of abridging state charters, considered as contracts, is a serious step. Here, some of the states that still hold out against conformity with Interstate Commerce Commission rates have their strongest talking point. However, in 1912 the Supreme Court rendered a decision that state commissions "should" conform intrastate rates to those prescribed by the Interstate Commerce Commission, but denied the power of the commission to order such conformity. Here, the court made clear that, equitably, intrastate should conform to interstate rates, but that the commission could not enforce such rates legally, having no authority from Congress to do so. Now, by the Transportation Act, Congress has given this authority to the Interstate Commerce Commission and, if we may draw conclusions from the Supreme Court record of interpreting the Constitution with respect to Congressional powers over interstate commerce, the law is likely to be sustained.

Early Contract Letting Again

EMPHASIS has already been placed in these columns on the need for early letting of contracts for next season's work. The matter is of such grave importance, however, that frequent repetition is fully warranted. The argument applies to all classes of construction. It is to be understood, however, that it is not urged that all contemplated work should go ahead. There are good reasons for postponing unnecessary construction. But if work *is* to be done next season it should be let as early as possible.

Early letting has decided advantages. The early contractor gets the pick of labor forces; he can get his plant on the ground before the spring rush begins; he can get sidings laid, and, on highway work for example, can get his quarries opened and his plant under way for gravel-bank development. Where conditions are favorable he may even be able to stock-pile materials. So much for the contractor himself.

But the advantages extend farther back. With the business slackness that is upon us manufacturers of construction equipment and materials cannot be expected to manufacture for stock on a large scale unless figures are available as to the volume of the season's work. In the case of equipment manufacturers their raw stock inventories are already a serious burden. Good business judgment forbids increasing the inventories by turning the raw stock into finished product beyond a clearly evident demand. A general late letting of contracts, therefore, will find the equipment companies unable to meet the demands of their customers for spring shipment.

As against the advantages of early-spring letting we have heard of only one disadvantage—the likelihood that prices will drop in the spring and thus allow lower bids to be secured. It is probable, though, that the greater part of the drop will come within thirty days.

Offsetting, moreover, any financial gain that might accrue from late letting is the indisputable fact that late letting seriously endangers the completion of the work—which always results in heavy loss to both sides.

We are still in the early part of December, and, if measures be taken in hand now to let contracts early, can get next year's work started in the early spring.

Increasing the Efficiency of Bridges

EXPERIMENTAL verification of the theory of load-distortion stresses in steel structures is materially strengthened by the measurements on the Kenova bridge recorded in this issue. The numerical results prove that this secondary stressing occurs in precisely the way indicated by calculation. Those who still adhere to the view that such actions may safely be ignored in practical designing will find little comfort in the tests, for they plainly show that the bending stresses caused by truss distortion diminish the available strength of the steel by a significant fraction.

Because of the complicated, tedious character of the calculations required for determining secondary stresses, thought on the subject has not become entirely clarified, in spite of the fact that for thirty or forty years past these stresses have been known to exist and have been discussed more or less frequently. There is a general substratum of belief that a flat percentage allowance will take care of them, or in other words that it will do to let them go into the safety margin. The new figures supplied by Professors Parcel and Maney, however, indicate that this convenient method of dealing with the matter is not safe unless the allowance is made wastefully large.

The new specifications of the American Railway Engineering Association prescribe complete calculation of secondary stresses, in place of ignoring them or attempting to cover them by a flat allowance, but only when the members of the structure are unusually stiff or when sub-paneled construction is used. The practical obstacle in the way of applying this rule is that the time required for the calculation will limit its application to quite exceptional instances. As the importance of the actions in question depends essentially on the form or type of the structure rather than on its dimensions, considerable assistance might be given the working bridge engineer if a compilation of bridge forms and their respective calculated amounts of secondary stress were made available to him. The figures given by such stress sheets would naturally involve a certain small range of error when applied to any actual bridge of the same type, but they would be so much more correct than anything now obtainable (except by very tedious calculation) that they would undoubtedly increase the safety and efficiency of bridge construction.

In the future development of the art, as the distortion stresses in bridges come to be more familiar and their amounts more precisely known, it may be timely to consider what, if anything, can be done to reduce or eliminate the extra tax on the material which they represent. With respect to those stresses which arise during erection of a structure, being caused by its initial deflection under its own weight, expedients to eliminate some large local distortion effects have already been worked out and are more or less commonly applied in large structures; this is true particularly of the excessive constraints at the first lower-chord panel point and at the junction of end post and collision strut. In the matter of moving-load secondary stresses nothing of the kind has been attempted, and it is difficult to predict how much can be accomplished. But even if they amount to no more than five or ten per cent of the total tax on the material in a bridge, their elimination would mean a worth-while gain in carrying capacity, or in economy. Study of the subject will not be waste of time.

Secondary Stresses in Kenova Bridge Measured

Tests to Determine Secondaries at Four Joints Under Moving Coal Trains Give Satisfactory Check With Calculated Results—Effect of Load Variation and Floor Stiffness

By John I. Parcel and George A. Maney
Professor of Structural Engineering / Asst. Professor of Structural Engineering
University of Minnesota

IN SEPTEMBER, 1917, the writers made a series of measurements of secondary stresses on the 520-ft. span of the Norfolk & Western Ry. bridge over the Ohio River at Kenova, W. Va. (see Fig. 1.). The stresses were measured for regular train loading and the object of the investigation was to arrive at a comparison of computed and measured secondary stresses for these conditions.

Many other attempts* to determine secondary stresses experimentally have been made, but so far as is known

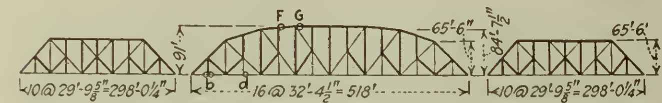


FIG. 1. KENOVA BRIDGE; STRESS MEASUREMENTS MADE ON MAIN SPAN

no test has been made on a structure of anything like the size of the Kenova bridge except that on the Hell Gate Arch, and in this case the measurements were for *dead-load* secondaries only.

Instruments and Methods.—The strain-gage used is shown in Figs. 2, and a typical attachment in Fig. 3. The multiplying device was so adjusted that one division on the dial corresponded to an elongation of 0.0001 in., which on a 50-in. gage length is equivalent to a stress of 60 lb. per sq.in., taking 30,000,000 lb. per sq.in. as modulus of elasticity of the bridge steel. A gage length of 50 in. was selected with a view to the elimination of purely local effects.

All members on which measurements were taken were of two-rib construction. In most cases a pair of instruments was placed on each rib, though for some cases, as later noted, the readings were confined to one rib.

The instruments on each rib were lined up vertically and each was at or near the plane of the extreme fiber. For symmetrical sections obviously the half sum of the readings (reduced to stress terms) of either pair of instruments should give the primary stress and the half difference the secondary stress in the plane of the instrument. With this arrangement of instruments and simultaneous readings, it is believed that temperature errors were largely eliminated.

Scope.—It has been said that the purpose of the investigation was to secure a comparison of computed and measured secondary stresses. There was no special reason, therefore, for examining a large number of joints. Two typical top-chord joints, *F* and *G*, and two bottom chord joints, *b* and *d*, were selected for investigation. At *b* and *d* the secondary stress is maximum at full load, at *F* and *G* for partial loading. The choice of joints was made as being representative of these two classes rather than because of especially large stresses developed. As a matter of fact the secondary stress at *F* and *G* for full loading is quite small.

Test Procedure.—For practically all the tests a heavy freight (usually coal) train of some 60 to 80 cars, drawn by a Mallet compound locomotive formed the loading. The trains all passed northward across the bridge, and due to the heavy grade of the south approach and local traffic conditions they rarely attained a speed of more than 15 miles per hour; usually they ran much slower. This fact eliminated all impact complications. In all cases the vibration of the needle of the Ames dial was so slight as to have no material effect on the accuracy of the readings.

In taking readings an observer was assigned to each instrument and an additional observer noted the approximate location of the train and also, usually, gave the signal on which the instruments were read. This method of timing readings proved quite satisfactory because of the very gradual variation of stress. Slight

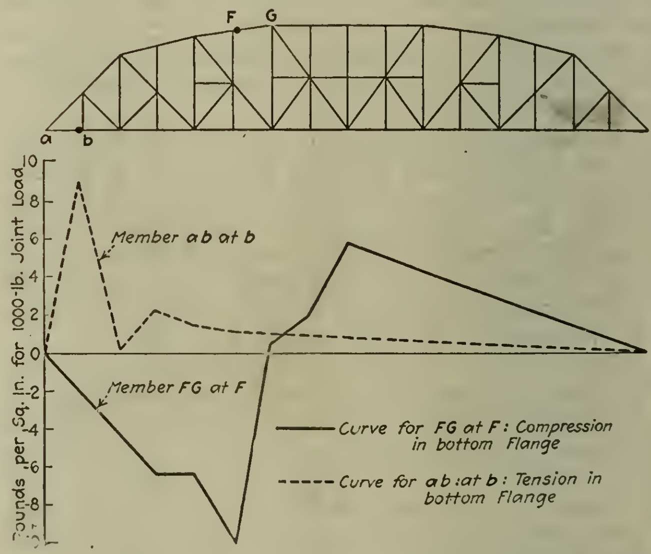


FIG. 1A. VARIATION OF SECONDARY STRESS SHOWN BY TWO INFLUENCE LINES FOR KENOVA MAIN SPAN

deviations from exactly simultaneous reading of the instruments could have but negligible effect on the results. No effort was made to space the readings at equal intervals. During the periods when the train was entering and leaving the span and the load was rapidly changing, readings were taken much more frequently than when the bridge was under a substantially uniform load. During the former period the interval was roughly from 3 to 6 seconds, during the latter from 20 to 30 seconds.

Data and Results—After all doubtful sets of readings had been discarded there remained 18 sets possessing all the marks of trustworthiness. Eight of these were taken at joint *b*, two at *d*, six at *F* and two at *G*.

In the reduction of the field data it was necessary,

*See, among others, W. Fraenkel, *Der Civilingenieur*, 1883; M. Rabut, *Annales des Ponts et Chaussées*, 1901, III; W. Gehler, "Nebenspannungen eiserner Fachwerkbrücken," Berlin, 1910; *Bulletin A. R. E. A.*, Nos. 125 and 163; D. B. Steinman, *Trans. A. S. C. E.*, Vol. LXXXII.

for comparison with computed values, to make some corrections for the location of the instruments. In general the strain gage could never be attached so that the plunger bar was in the exact plane of the extreme fiber, nor could it be attached at the very extremity of the members. In order to arrive at the maximum secondary stress (for only this could fairly be compared with the results of conventional computation) the method of linear interpolation was adopted. The adjustment to the extreme fiber requires no comment. The correction for longitudinal location of instrument was arrived at as follows: The inflection point for the member was located approximately. For all cases considered this could be taken as $\frac{2}{9}l$ from the joint in question. Then to transfer the stress reading at a given section to the stress at extremity of member it was only necessary to multiply the reading by the ratio of the distance between inflection point and panel point to the distance between inflection point and center of gage length.

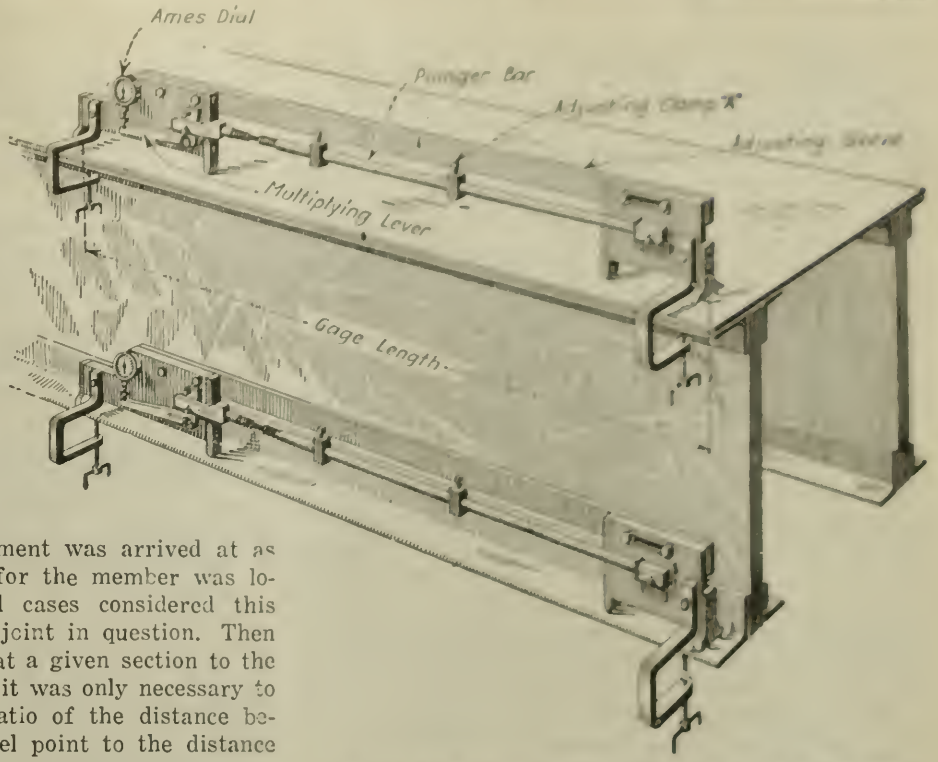


FIG. 3 POSITION OF STRAIN GAGES ON TOP CHORD

The corrected strain-gage readings, reduced to stress terms, were plotted up into the curves labeled "Measured Primary" and "Measured Secondary" in the accompanying Figs. 4 to 10. These graphs are believed to represent the history of the actual primary and secondary stress as a train passed over the bridge. For

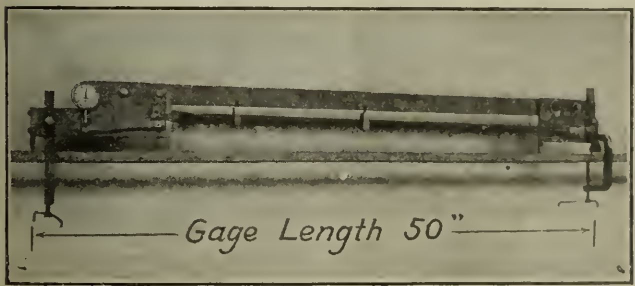


FIG. 2. STRAIN GAGE USED IN KENOVA WORK

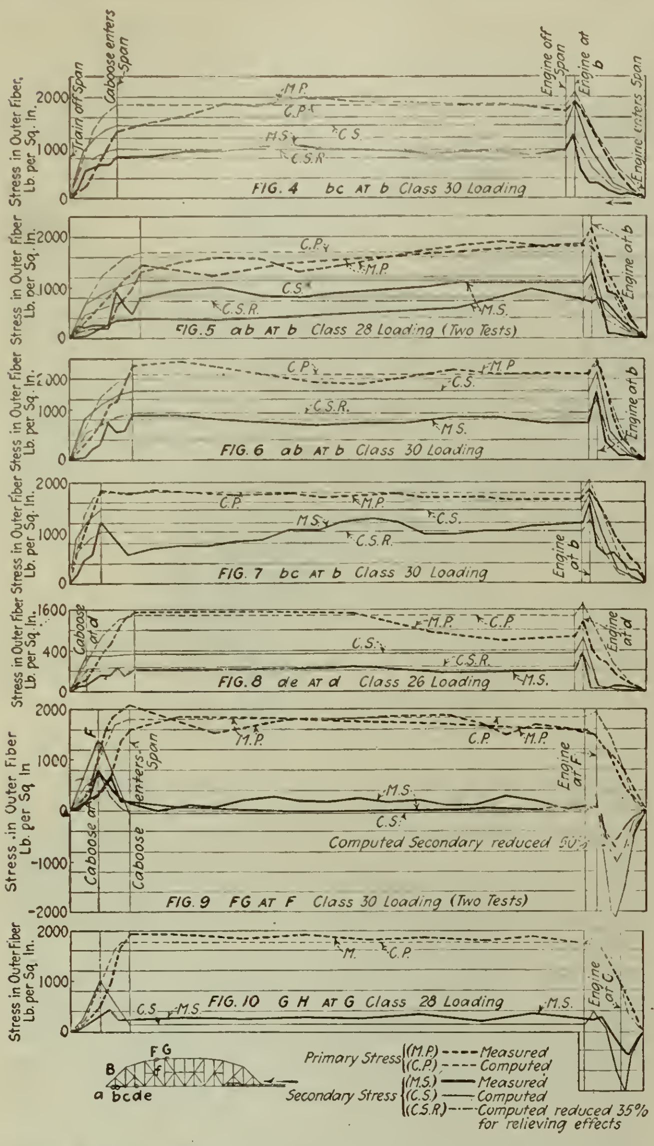
all measurements except those at F the plotted values are the average for the two ribs. Readings at F were taken on one rib only.

Exact determination of the train loading was impossible, but a very fair check on the average intensity could be obtained from the measured primary stresses. It was assumed that a load of 4,000 lb. per foot of track and an excess load of 2,000 lb. per ft. for the first 70 feet would approximate the form of the actual loading and would represent the maximum limit of the actual train loads. This loading was called arbitrarily Class 40. A curve of primary stress corresponding to the passage of this loading was constructed, and this was compared with the measured primary stress curve in each case and adjusted to agree with the average ordinate of the latter. If this adjustment required a 25 per cent reduction in a given case, it was assumed that the actual train loading for that case approximated Class 30, this being three-fourths of Class 40 loading.

Prior to the test a complete analysis for the secondary stresses in the Kenova truss had been made for unit joint loads, and secondary stress influence lines had been constructed. From these the "computed secondary stress" curves were obtained by using the train loadings derived as above.

A comparison of computed and measured secondary stresses on this basis of a conventionalized loading tacitly assumes that a given loading produces the same relative effect on both primary and secondary stress. This is never strictly true and in some cases far from the truth. It would be easy to devise two loadings of the same *average* intensity and producing approximately the same primary stress which would give secondary stresses varying by perhaps as much as 40 or 50 per cent, though such extreme variations are, of course, improbable. Therefore we are not strictly justified in assuming that, because the irregular loading of the actual train which traversed the bridge during a given test is fairly represented by a conventional "class 30" so far as *primary* stress is concerned, "class 30" will also produce the same secondary stresses as the actual train. In spite of these limitations in an individual test, however, the method should give a very useful comparison when applied to a large number of tests.

In Figs. 4 to 10 are plotted nine typical sets of readings. It is believed that these graphs are largely self explanatory. One or two points may be noted. A closer study of the local deformations in the panels investigated brought out the fact that for all subpanel points (b, d, F) a large relieving effect due to the stiffness of the floor system, induced stresses in auxiliary members and the like, might be anticipated. Such effects, of course, were not included in the calculation of the secondary stresses. Following certain assumptions as to the continuity and end condition of the members involved, a theoretical analysis of these relieving influences was made. This indicated, for lower-chord joints, a reduction of approximately 35 per



FIGS. 4 TO 10. MEASURED AND CALCULATED SECONDARY STRESSES IN KENOVA BRIDGE—TYPICAL CURVES

(Horizontal scale of stress curves approximate only. Loading for calculation of secondaries determined by adjusting curve of measured primaries to calculated primaries.)

cent from the conventionally computed values, and for upper-chord joints such as F approximately 50 per cent. Graphs of the computed secondary stresses so reduced are shown by light dash-and-dot lines in the figures for all sets of readings on joints b, d and F.

In studying the correspondence between the computed and measured secondary-stress curves it should be kept in mind that the only fair comparison is between the percentages, secondary to primary, of measured and computed values. The actual train loadings were never exactly uniform, consequently the computed primary curve could never be adjusted to more than approximate agreement with the measured curve. At some points the discrepancy was very considerable, and, though the effect of load variation on the secondary stress is not necessarily the same as on the primary —a point discussed in an earlier paragraph—we could hardly expect the former to show any better correspondence with computed values than the latter. In Fig. 8, for example, engine at "d", the measured secondary curve falls much below the computed values, yet the percentage of measured secondary to primary is almost the same as the percentage of calculated secondary to primary.

Summary and Conclusions—The results of the investigation may be briefly summarized as follows:

1. The eighteen sets of readings, taken as a whole, exhibit a remarkable degree of conformity to calculated values.

2. Where important discrepancies appear, they would seem to be fully explained by a more thoroughgoing analysis of all the factors contributing to the panel deformations.

From these results it would seem fair to conclude (in so far as it is justifiable to draw general conclusions from a single test) that *the actual live-load secondary stresses in a bridge of the Kenova type can be accurately calculated from the elastic theory*, though it may be necessary to include in the calculations certain factors ordinarily neglected in the conventional method of computation. This is the most important conclusion to be drawn from the test.

Attention may be called to one or two other points. In harmony with what has already been said on comparative stress actions of two different loadings, it is to be noted that sharp variations in intensity of loading over short distances will have a very much greater effect on secondary than on primary stresses. If the secondaries are computed for an equivalent uniform load suitable for the calculation of the primary stresses, the normal variations in actual service loading may be expected to result in very considerable fluctuations in the percentage of secondary stress, above and below the normal computed average. For all joints studied except F it seems probable that this variation may largely offset the relieving effects, so that the *conventionally computed value, without correction,* may fairly serve as an approximate extreme limit of the actual secondary stress.

For such joints as F the relieving effect is so great that the ordinary calculation, if made for maximum conditions, gives altogether excessive results. The test would appear to show clearly that the effect of such members as fF is far less serious in producing secondary stress than has been generally believed—a result of some practical importance.

The conventionally computed secondary stresses in trusses of the Kenova type will vary from practically zero in some members to 80 per cent of the maximum primary in others—even more in some extreme instances. The measured secondary stress at the joints examined in the present tests shows a corresponding variation. For member ab, at b, in one case the measured secondary was approximately 85 per cent of the measured primary, and this, too, when the primary was a maximum. Fig. 8, for end F of number FG, shows that the secondary co-existing with maximum primary is between 5 and 10 per cent of the latter. This emphasizes the point that any blanket percentage allowance applied alike to every member (a method commonly used in most offices) is an unscientific and inadequate method of providing for secondary stresses.

The writers feel that the results of the test are distinctly encouraging and are such as to justify further investigations, which if carried out comprehensively should give the profession valuable and much needed information regarding bridge action under service conditions.

The writers beg to acknowledge their indebtedness to the officials of the American Bridge Co. for data on the Kenova bridge and many valuable suggestions; to J. E. Crawford, chief engineer of the Norfolk & Western R.R., whose generous co-operation made the test possible, and to Franklin R. McMillan, now assistant engineer for the Turner Construction Co., at that time assistant professor of structural engineering at the University of Minnesota. Mr. McMillan was wholly responsible for the design of the strain gage used, and he also furnished invaluable aid in carrying out the test.

It is planned to publish soon a more detailed account of the investigation as a bulletin of the Engineering College of the University of Minnesota.

What Should Be the Dimensions of A Shipping Pier

An Engineering Inquiry Into the Size of Piers and Ships for Various Classes of Ports and Service

By H. McL. Harding
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Current controversies as to the dimensions proper for shipping piers are based largely on past practice or expected service. Little has been done to analyze the necessities of the case and to determine from an engineering standpoint the proper dimensions to be used. An attempt at such an engineering inquiry is made herewith.

It may be accepted that where possible the linear water frontage contiguous to a city, proportional to the size of the city, is limited, and must be conserved by designing for as many ship berths as possible, but without permitting unnecessary freight congestion on the piers or in the slips. To the deductions and conclusions as to the width of piers and slips for the transferring and handling miscellaneous cargoes there are many exceptions, but the general principles may be regarded as approximately correct for what are called public piers, for all kinds of freight, and not the continual use for special cargoes.

There is a ratio between the length of the pier and the width of the pier and the width of slip—if on the unit basis of length—the unit length being equal to the longest ship which it is judged will there be berthed for a number of future years, any extra length providing for the future to be utilized at present for holding harbor craft. A two-ship berthing length on each side of a pier would require a wider pier and a wider slip than if for the one ship's length. It will therefore be seen that the width of the pier and slip is a resultant of temporary holding capacity and longitudinal and transverse conveying space of the pier and similarly the width of the slip depends upon the berthing of ships and barges and the movement of ships and barges in and out the slips.

In general, as above for a one-unit length of pier of an ocean port, the width of the slip should accommodate, parallel to each other, a coal barge, a ship, another barge, another ship and a coal barge with ample clearances. For a two-unit length of pier there should be barge, ship, barge, space for an inner ship to pass in and out, barge, ship and barge, also with ample clearances all parallel to each other.

Piers may be divided into four classes, namely, inland river barge piers, 12 ft. draft (of those there will be very few), inland river ship piers, Great Lakes Piers and ocean port piers. The possible dimensions for piers in each of these classes for one-ship and for two-ship unit lengths are given in the accompanying table. The reasons for the selection of these dimensions are given below with the idea of stimulating discussion which may lead to the establishment of commercially practicable terminal rules or principles.

DIMENSIONS IN FEET OF SHIPPING PIERS FOR ONE-SHIP AND TWO-SHIP LENGTHS

Type	One Ship Length: Length	Width	Slip	Two Ship Length: Length	Width	Slip
Inland River Barge	300 350	130	150	[illegible] 700	[illegible]	[illegible]
Inland River Ship	500 550	140	2[illegible]	[illegible]	[illegible]	[illegible]
Great Lakes	700	140 160	2[illegible]	[illegible]	[illegible]	[illegible]
Ocean	600 700	150-160	3[illegible]	[illegible]	[illegible]	[illegible]

Inland River Barge Piers.—One unit slip width between two piers should provide for four barges, 35 ft. each, parallel to each other with clearances, or three barges of 45 ft. each. There should be pier capacity for four railway tracks, and one shed 200 x [illegible] x 30 ft. and 100 ft. open area.

On inland rivers and canals with not more than twelve feet depth 350 ft. may be taken as a unit length, possibly 300 ft.

It is expected that there will be constructed many inland river barge piers but rather quays, except at the confluence of two rivers where there may be bays scoured out and where diagonal piers might be possible. If by any possibility there are such piers, they would probably be one unit in length. They might be useful for a small tonnage capacity. To transfer any volume of freight quickly would require five units of 300 ft. each, and this would be only 3,000 ft., a little more than one-half mile.

Any conception of an inland river barge terminal should take into consideration not less than several hundred thousand tons to make a modern terminal a commercial success. It will therefore be seen that the widths of slips as given may be considered the minimum allowable, which would be small indeed for a large tonnage. In any such inland river terminal, all insistance should be made to provide for a large tonnage and to be able to add many units from time to time. There must be an interchangeability between barges and from one pier to another, and provision must be made for a comprehensive plan embracing many lengths of 300 ft. with the nearby warehouses supporting the sheds. In certain cases there may be ten units and all should be physically connected by car tracks and dray approaches. Too often a large tonnage requiring great cubical content has not been embraced in a comprehensive plan for the future.

A successful terminal is one which has facilities and can transfer a large tonnage in a short time easily and without congestion. The piers should be of sufficient width to provide for four tracks in addition to the shed.

Inland River Ship Piers.—Even here quays are preferable, and as the same principles apply as with the Great Lakes piers and ocean-port piers, reference will be made to these for suggestions.

Great Lakes Piers.—There are ships on the Great Lakes 625 ft. in length, and as the depth of the channel is fixed at 21 ft., there will probably be an increase in length, and also in breadth which is now over 60 ft. The unit length is therefore taken at 700 ft.

Ocean Ports.—At ocean ports, from a study of the

dimensions of freighters, not passenger ships, the unit length has been taken at from 600 to 700 ft.

For such piers of one-unit length there would be two sheds each 200 ft. long, in tandem with 100 ft. between them. A pier of two unit-lengths from 1,200 to 1,400 ft. would have four sheds. The width of the pier is closely connected with the shed capacity. One shed 200 ft. long, 80 ft. wide and 25 ft. tiering height would have a cubic foot capacity of 200 x 80 x 25 ft., or 400,000 cu.ft., and the two sheds 800,000 cu.ft., or the equivalent of two ships each of 4,000 tons. If of 200 x 1,008 x 25 ft. size, the cubical capacity for two sheds would be 1,000,000 cu.ft., or of two ships one on each side of the pier, each of 5,000 tons. This capacity at 100 cu.ft. per register ton includes the working area and is based upon careful estimates. On a 600 ft. pier, 400 ft. of the length is taken by the sheds, and there are 200 ft. additional for coarse freight.

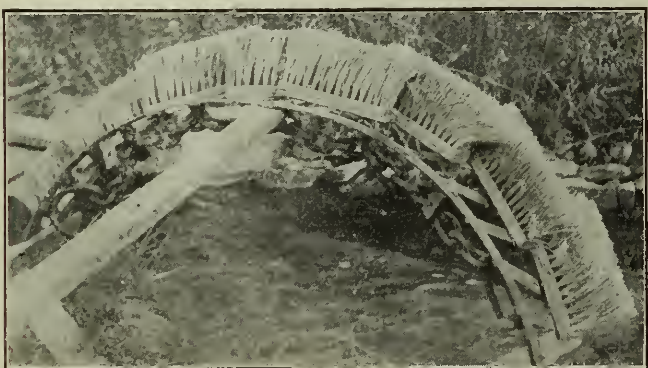
Of the 1,000,000 cu.ft. of cargo a portion will pass over the side of the vessel upon barges, some may be loaded directly on cars or taken away immediately by drays, other portions will be taken away from the shed as soon as it is assorted and distributed.

Of the width of 150 ft., 70 ft. is for railway tracks and dray ways. The 200 ft. in length not covered by sheds would be an area 200 x 80 ft. = 16,000 sq.ft., or 20,000 sq.ft. Tiering 25 ft. in height would give 400,000 to 500,000 cu.ft. additional capacity for coarse freight. With a 700 ft. pier, there would be an outside capacity of 600,000 cu.ft. for open freight.

If there are four ships berthing at a two-unit ocean-port pier, two on each side, there must not only be a holding capacity in the sheds opposite the two outer ships, but there must be space for the longitudinal freight movements from the outer half of the shed to the rear shore. There should be two railway tracks on each side of a pier, three tracks would be better.

Scrubbers for Semi-Circular Flumes

FOR clearing semi-circular flumes of moss and silt in the Yakima Valley, Washington, heavy bristle scrub brushes are secured to a semi-circle of wood which is supported at the base end of a triangular frame. As described in the *Highway Magazine*, a wheel on the apex end of the frame, which is directed downstream, guides and keeps the device from wedging. The illus-



tration shows the scrubber upside down. A heavy chain to add weight and hold the brushes against the sides of the flume may be noted under the brush support. The scrubber was devised by Charles B. Schmidt, manager of the Selah-Moxes Irrigation District.

Trend of Highway Development —a Survey

Practice in Connecticut, Rhode Island and Massachusetts

THIS IS THE FIFTH *of a series of articles on the highway situation. It discusses the trend of Connecticut, Rhode Island and Massachusetts toward first consideration of economic, rather than structural problems. The pioneers in roadbuilding work, they are confronted with traffic problems that far outweigh other highway considerations. Connecticut and Massachusetts present particularly serious situations.*

Other points of interest in the practice of these three states are: The "floating gang" maintenance of Connecticut; the success of penetration macadam roads in Rhode Island; and the authority given district engineers in Massachusetts in designing all but surface types.

The sixth article in the series will appear in next week's issue.—EDITOR.

Connecticut Practice

CONNECTICUT'S highway attention is focussed upon traffic. Insofar as is possible construction types are determined. Materials, transportation, labor—problems concerning these are only relatively troubling. The real disturbing factor is traffic: How far heavy units are to govern design; and how commercial vehicles are to be made to pay a proper share of highway construction and maintenance costs. As yet these questions have not advanced to the stage where solutions are possible. With a consideration of traffic problems should go some discussion of the organization set up to keep the roads in repair.

A large percentage of the traffic that passes over Connecticut's roads originates or terminates at points outside the state. Three of the main trunk-lines are in the routes from New York to Boston, New York to Providence and New York to Springfield, respectively. Traffic counts on the New York-Providence route show that, of 173,000 cars crossing the Saybrook-Lime toll-bridge in a year, 46,000 carry foreign licenses. It is estimated that at least the same proportion of total traffic using the New York-Boston road is foreign. The state, therefore, pays for construction and renewals for a heavy traffic, 25 per cent of which gives to the state not a cent of revenue.

TRAFFIC PROBLEM

Of 20,000 motor trucks registered in Connecticut about 16,000 are under two-tons capacity, and only 650 are over four-tons capacity. There are registered approximately 90,000 passenger cars rated at not over two tons. To provide a highway adequate for the needs of the 650 heavy trucks costs, it is estimated, twice the amount necessary for the 90,000 passenger cars and the 16,000 light trucks. Involved in the question as to the necessity or advisability of providing, by heavier construction, for such a very small proportion of the total traffic is the fact that money which otherwise would be utilized in extending the highway system, is used in expensive renewals and maintenance.

The highway commissioner of Connecticut believes that a highway department must do at least two things to be rated as progressive: Provide for existing traffic through renewals, repairs and maintenance; and, by

extension of the state system, provide for the normal increase in traffic resulting from quickened commercial activities as well as traffic resulting from haulage of materials over highways at no matter what cost, due to a temporary breakdown in other means of transportation. Construction types will be of secondary importance, then, at least until some approximation has been made of the probable weight and intensity of traffic.

Because of the amount of money that has had to be expended on heavier construction to accommodate the small percentage of heavy traffic, the money for the extension of the state system has not been adequate. The question then has arisen in Connecticut as to the advisability of making the heavy trucks pay for the improvement that they alone necessitate. How can these heavy units be made to pay? The commissioner's first answer, which is an admittedly impossible one, is to charge toll. The next one which he offers as a possible solution is to make every truck using the roads carry a Connecticut license. The added revenue would pay for the damage that the truck is alleged to do, and the development of the state system for the great majority of car owners who pay both car licenses and land taxes in the state, could be carried forward with greater speed.

Maintenance Organization

Maintenance work of the Connecticut Highway Commission is entirely divorced from construction, except for the accounting, which is done by a common organization. The maintenance department is in charge of a superintendent of repair. The system of maintenance closely resembles that employed by railroads. The state is divided into eleven districts and each district into a number of sections, the size varying with geographical character, intensity of traffic, availability of stone and other materials and type of road. It is essentially a "floating-gang" system, each section having a foreman and a gang of eight to ten men in summer and three or four in winter.

Almost the entire department of repair is motorized, each floating gang having its truck. Each section also has its own base or headquarters where are stored all the materials and equipment necessary for doing any sort of a repair job. Each district has its own pressure oil distributor, though mechanical hand spreaders are not used.

All of the men in the repair department are guaranteed yearly employment. If, during any season, the work slackens in one or a number of sections, the men are grouped to do such work as laying telford base, graveling, crushing rock, etc.

Equipment is furnished the various section foremen through the submission every February by them of a list of needed materials. These statements are received by the superintendent of repair and a blanket bid called for.

As a safeguard against running short of road oil, the department of repair has had constructed in strategic parts of the state and at railroad sidings oil-tank stations, seven of which are now in operation. The total capacity of these stations is approximately 200,000 gal. each containing, usually, four 6,000-gal. tanks with some barrel storage, or three 8,000-gal. tanks, together with barrel storage.

In reviewing Connecticut highway practice, it is hard to see beyond the big consideration—traffic. "Give us an idea of the intensity and weight of traffic we will have to design for and we will build the roads to carry it" is an oft-repeated phrase in Connecticut. The motor truck has become there a structural as well as an economic problem.

Rhode Island's Practice

TAKING the people into his confidence and showing them reasons for this or that improvement, or for other lack of improvement, is a cardinal principle with the chief engineer of the Rhode Island State Board of Public Roads. Add to that the personal attention that he gives every new project, whether new construction or reconstruction, and the painstaking care with which the subgrade is studied and drainage facilities are provided, and the result is found in the remarkable success Rhode Island has had in the construction of that type of road for which she has become well known—bituminous macadam. These features, together with the large reconstruction program—as against new construction—that is being carried forward, form a review of highway practice in Rhode Island.

Though the care given the subgrade has been set forth in detail in *Engineering News-Record*, Dec. 11-18, 1919, p. 976, a recapitulation of the main points stressed is not amiss. When any piece of work is contemplated, the subgrade, whether it be old waterbound macadam or virgin soil, is inspected during the winter and again in the spring when the frost is coming out of the ground. Necessary drainage structures, the needed foundation depths, etc., have as their bases these observations—invariably made by the chief engineer and his principal assistant.

Subgrade Studied

If the new surfacing is to be laid on waterbound macadam, the weak spots in the existing road are pretty well known. If the work is to be a re-location, greater study is evidently necessary. The division engineers must be able to see suspected subgrade troubles and tabulate them. During the winter road examinations, hydrographic properties of the soil are noted. In the spring, subsoil defects that would not appear in the winter are revealed. With these data as a background the design for the foundations is drawn and weak spots are corrected by the laying of deep courses of telford or broken stone, gravel filled. All of the design and the making of specifications for each new improvement emanate from the office of the chief engineer. Only minor matters of policy or of structural detail are left to the division engineers.

Contracts for such improvements are intentionally let late in the season so that the work cannot be completed in one season. When the foundation is in, it is rolled intensively, sometimes during a period of two weeks. The road is then opened to traffic and further consolidated. To the following practices is laid the success of bituminous macadam in Rhode Island:

1. The greatest care in the selection of stone.
2. The use of a hard asphalt, from 90-100 penetration.
3. The securing of the maximum mechanical bond before any application of bitumen.
4. The greatest attention to rolling.
5. The extensive backrolling after the seal coat has been applied.

The statement has been heard that Rhode Island can secure successful results in penetration work due to the uniformly good quality of the subsoil. Yet it is a fact

Rhode Island has a most variable subsoil, and the traffic upon its trunk line highways is as intensive as on most sections of the Lincoln Highway in Pennsylvania.

Out of 75 miles of such construction in the state system, as a result of the heavy winter of 1919-1920, only two blow-ups in the surface were found. One of these was so slight as hardly to be noticeable and the other required rebuilding. And in rebuilding it *the subgrade weakness was corrected by tearing up the entire road at the point of failure and putting in a heavier foundation.* The surface was not merely patched.

Reconstruction Program

Between the years 1912-1919 hardly a cent was spent in Rhode Island on new work. When the present board began to function it fell heir to a system of highways in a bad state of repair. Reconstruction was essential before any extension of the designated state system was undertaken. An elaborate plan for reconstruction was started in 1916 and has continued since that date. Money for new construction is supplied by direct legislative appropriation, and that for reconstruction and maintenance by automobile license fees, augmented by a small general tax. The 1918 session of the legislature made available for new work $250,000 for each of the years 1919, 1920 and 1921. A large part of the work based on that expenditure has already been done. In contrast to that amount for new work, the money available this present season for reconstruction and maintenance has been approximately $1,000,000.

Beginning with the year 1916 the state had enough money either to put in moderate repair most of the roads in the state system or to begin general reconstruction on a more permanent basis. The latter course was pursued. Most of the money available that year was used in putting in penetration roads with the result that road users were educated to the advantage of steadily building the modern-type surfaces.

Distribution of an intensive commercial motor vehicle traffic to avoid congestion particularly at centers of population, has given Rhode Island a serious problem. The state system as originally constructed gave rise to existence of numerous inter-village roads which were not always the most direct routes. The plan of highway extension now contemplates the construction of direct routes between points through which through-traffic goes. Reconstruction money might be used to put into shape these inter-village roads that are often circuitous and which, near towns, if used by through traffic, become congested. But, with the construction of new through routes, through traffic will avoid villages and enough money will remain to maintain inter-village roads for a greatly reduced traffic which is more or less local.

Original Plan

When the present chief engineer of the board began his program of reconstruction he contemplated first making the foundation permanent. Money was not available for general construction of the highest pavement types. Funds had to be expended most judiciously and some type of surfacing had to top the permanent grade. Bituminous types, particularly penetration macadam, were chosen with the belief that renewals would be necessary at least inside of ten years, and that the highways thus constructed would, after three to five years, become increasingly expensive to maintain. During the life of these pavements it was presumed that more would be known of the ultimate traffic highways would have to bear, and more adequate designs would have been created. However, so satisfactory have bituminous macadam roads proven, and so successfully have they withstood both climatic rigors and heavy traffic, that the experiment is becoming general practice.

As elastic a system of maintenance as possible obtains in Rhode Island. In general, truck patrol is used in work upon waterbound macadam, and the floating gang patrol, working out of the several division headquarters, operate in bituminous work. In addition there is a "flying squadron" which does hurry-up jobs. Due to the smallness of the state such elasticity of organization and control is possible.

Because so many of the highways are closely dotted with manufacturing communities, sub-surface installations and, consequently, pavement cutting are frequent. So far replacing such cuts have formed the major part of the maintenance work on bituminous roads.

If patching be necessary, when the weather will not admit of the application of a hot patch, a cold patch is applied. The instant a cold patch shows the least sign of deterioration or failure it is ripped up. In its place, and in general maintenance practice, the same materials as went into the original construction of the pavement are put into the patch, and in the same proportions.

Aside from the impression of co-operation, centralized control, and personal attention to each new piece of work, which makes the position of Rhode Island unique, two remarks of the chief engineer of the State Board of Public Roads embody the high lights in construction and maintenance practice:

"It is a public crime not to build roads right in the beginning"; and "maintain the integrity of the particular type of road built by putting in patches of exactly the same materials as went into the original construction."

Massachusetts Practice

HIGHWAY thinking in Massachusetts is centered about one problem to which all others are subordinated—motor-vehicle traffic intensity, with which goes the question of truck-weight determination. Perhaps in no other state has the traffic problem become more acute. Massachusetts presents some daring thought in the matter and is convinced of the early necessity of determining maximum loads that highways ultimately will have to bear. Important as this problem is, general consideration of design and construction, and special reference to organization and finance, must not be overlooked in reporting upon Massachusetts practice.

Massachusetts is about 200 miles from east to west and 50 miles from north to south. It has a population of approximately 4,000,000 centered mainly in 214 towns and 38 cities, the latter of more than 15,000 population. The state possesses a diversity of manufacturing industries that demand adequate transportation facilities. It has a state highway system of 1,500 miles of all types, a large proportion being waterbound macadam. It has registered this year 225,000 passenger cars and 50,000 trucks, in round numbers. Of the trucks 70 per cent are of one-ton capacity or less, 20 per cent one and one-half and two tons, and the remaining 10 per cent above two-ton capacity.

In Massachusetts, as in Connecticut, the small proportion of registered vehicles comprises those for whom expensive construction must be provided if no limitation is to be put upon the ultimate truck load. However, Massachusetts presents an accentuated case inasmuch as the ratio of heavy trucks to all other cars is so small.

Massachusetts a Pioneer

Massachusetts is the pioneer roadbuilding state. As early as 1894 a highway department began construction upon a definite system. Roads were then desired for a slow-moving traffic of rarely more than three tons. One lane of travel was usually provided. With the intensive development of the motor vehicle and the consequent crowding of the highways with heavy and light units, it has been found impossible to save much of the waterbound macadam. Particularly on trunk-line arteries have heavier bases been needed. A repetition of this loss through unreasonable demands made by a very small minority of highway users, particularly if increasingly heavier units are to be designed and built, is feared. It is to obviate this loss that Massachusetts is found among the leaders in that highway thought which demands utmost consideration and co-operation from the automotive industry in a speedy determination of the ultimate maximum loads to be carried by commercial vehicles.

With the problem of weights disposed of through universal limitation, traffic congestion must be relieved through widening existing highways and extensions of the state system. The state is seeing more and more the necessity of 20- and 22-ft. metalled widths for trunk-line routes. Prime considerations in construction are believed to be drainage, base, alignment and grade, in the order named. Experience has taught Massachusetts that a road, excluding the surfacing, must be made permanent in the beginning. The accommodation of traffic through good alignment, and grades not to exceed 7 per cent where economically possible, is sought.

When the first system of roads was constructed in Massachusetts, highways were built to interest the towns, therefore the work was done close to towns. The state system, until comparatively recently, presented no connecting system of highways. When the laying of modern types became imperative it was found many connecting links had to be constructed. The old highways, too, needed attention and as many of these were not on the new state system, maintenance of them became a problem, inasmuch as the villages and towns near were too poor to undertake their maintenance alone.

State Aid for Town Roads

To meet this emergency the legislature passed a law in 1918 setting aside a certain portion of the motor-vehicle tax for town-aid use. A small contribution toward the maintenance of roads near it was necessary before any town could apply for state aid. The aid is given to towns whose valuation is not in excess of \$3,000,000 and whose road mileage valuation is less than \$50,000. The state may either do the maintenance work or superintend it, but it is responsible for the economic expenditure of the aid funds. It is hoped the act will so stimulate maintenance among the towns that within a few years a large percent of the deteriorated highways will have been restored.

In all the New England states there seems to run a common belief: That, to make the subgrade uniform and adequate is much better than to vary surface thicknesses to meet varying subgrade conditions. In Massachusetts this thought is expressed: We will make the foundation as permanent as possible now, and when the ultimate weight of commercial units is no longer a variable, our engineers will design an adequate surface. Stone block on a concrete base underlaid by a foundation of field or quarry stone, is now considered the most permanent type. Its expense, coupled with the knowledge that concrete and penetration macadam roads will carry, for a reasonable period at least, 96 per cent of the traffic, has eliminated stone block. However, if the taxpayers agree that provision should be made for the heaviest truck unit, stone block on trunk-line highways costing from \$100,000 to \$150,000 per mile is not an impossibility.

In designing and carrying out new construction, Massachusetts pursues an unique course. Many of the men in the division of highways have been in state highway service for years. Three of the four district engineers have been with the department for 25 years and the fourth 20 years. The chief engineer has had more than 10 years service and many of those occupying subordinate positions are old in the employ of the department. This service has had a marked effect on the method in which construction projects are undertaken. The district engineers, who are acquainted with every foot of the highways within their respective territories, design drainage structures, foundation courses and bases. What surfacing is to be used is decided upon by the chief engineer in consultation with the highway board. The amount of traffic that any road will have to carry is approximated through the traffic counts that were taken upon practically all the highways in the state system in 1910, 1912 and 1915, and the count made at strategic points in 1918. Besides being responsible for foundation, base and drainage design, the district engineers superintend all maintenance within their districts.

The three states of Connecticut, Rhode Island and Massachusetts, small, densely populated, and housing manufacturing establishments of every description; where inter-mill truck hauls are general, and where traffic problems have become in a measure those of the thickly populated city, are confronted, perhaps more than any other section of the country, with the necessity of making determinate the ultimate maximum truck loading, so that the accommodation of all traffic may be secured through the construction of highways based upon known loads.

Large Bridge in China to Be Replaced

News of the calling of bids for a very large bridge reconstruction is given in *Commerce Reports* of Nov. 29, after a cablegram of Nov. 27 from Commercial Attache Julean Arnold at Peking. The Chinese Ministry of Communications is about to issue specifications for a new bridge over the Hwang-Lo or Yellow River on the Peking-Hankow Ry. The present bridge, regarded as inadequate, is 9,875 ft. long, partly of through truss and partly of deck girder construction, supported on screw piling, and is only 11 ft. above high water. It was fabricated in Belgium and France. The capacity of the old structure is stated to be little if any greater than Cooper's E-35. The new bridge is to be built for E-50. Its cost is expected to range from \$15,000,000 to \$20,000,000.

An Automatic Recording Apparatus for Stream Discharge

By George Holmes Moore
Hydrographer, City Engineer's Office, Seattle, Wash.

WHILE the machine containing the Moore stream-discharge plotting attachment is the first universally adaptable stream-discharge recorder, it is in the attachment itself that the essence of the invention lies. Those who are familiar with the standard types of stream gage-height plotters—the Gurley, Friez, Stevens and similar ones—know that previous standard practice has sought to secure a continuous record of gage heights rather than a record of actual stream discharge. The machine itself will differ very little in outward appearance from any of the standard forms of the well-known Stevens water-stage recorders, and in fact the attachment was developed for use with a Stevens Type A which has been operating on the Skagit River at Reflector Bar for some years past.

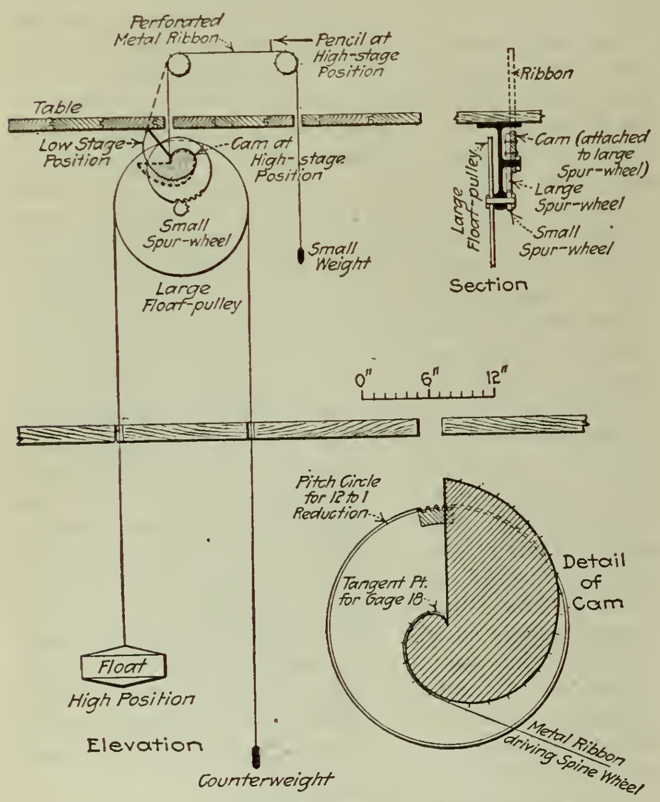


FIG. 1. MOORE STREAM-DISCHARGE ATTACHMENT TO WATER-STAGE RECORDER

The attachment (Fig. 1) consists primarily of a simple cam specially designed for each station, operated through a pair of reducing gears by the float-wheel of the standard water-stage recorder. This cam actuates the recording pencil directly by means of a perforated metal ribbon similar to the endless belt now used on the standard. Remembering that the sole function of the two spur-wheels is to secure a 12 to 1 reduction of the float-travel, the simplicity of the device becomes evident. It will be seen also that the pencil travel, at the high-stage position shown in the cut, will be much less than 1 in. per foot of float travel, a point which will be discussed more fully later on. It is clear that the recording pencil, as actuated by the metal ribbon attached to the cam, will produce a record widely different from that of simple gage heights.

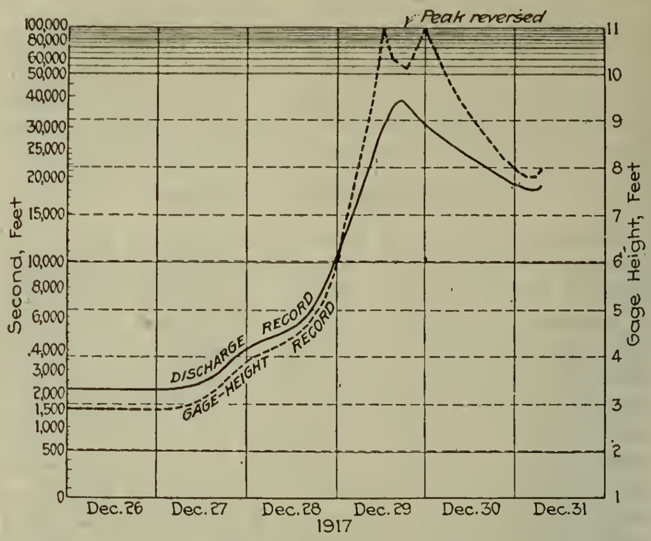


FIG. 2. FLOOD CONDITIONS OF SKAGIT RIVER AT REFLECTOR BAR, WASHINGTON, DEC. 26 TO 31, 1917

Two sheets here combined in one by superimposing the gage-height record on the discharge record. The peak load in the gage-height curve is inverted, due to one of the "dreaded reversals" mentioned in the text.

The particular cam shown was designed to fit the rating curve of the Reflector Bar station on the Skagit River; and it may be of interest to note that in its development, a new cross-section paper for hydrographic work was evolved, the characteristics of which will be presented further on. It should be pointed out, however, that experience already obtained indicates that no difficulty need be anticipated in the design of a similar cam to fit any rating curve whatever; since it is only necessary to so proportion the cam dimensions that the recording pencil will travel, on the new hydrographic paper, from the discharge value, as indicated by the rating curve for, let us say, gage height 9 to the discharge value as indicated by the same curve for gage height 10, while the float rises the distance of a foot, and the pitch circle of the large spur gear moves through the distance of one inch.

A cam-driven discharge record is shown in Fig. 2, contrasting strongly with the standard type of gage-height record shown in the same illustration. It will be noted that the gage-height record shows one pair of the dreaded reversals which, in actual practice, often mean a broken drive ribbon and the loss of the important flood record; and this in spite of the very ingenious design and workmanship found in the Stevens reversing mechanism. Furthermore, if the flood here recorded had found the machine operating on the smaller float wheel, as it usually is, there would have been two pairs of these reversal points instead of one.

In this connection it may be well to point out the four objects sought in the development of the discharge plotter: (1) A record of discharge instead of stage; (2) elimination of reversal points; (3) contracted scale for high-stage record; (4) expanded scale for low-stage record.

A comparison of the two curves in Fig. 2 shows that the first two objects are attained by the discharge recorder. However, the attainment of the very important object (4) is better shown in Fig. 3, which was designed for the duplex type of Stevens with a 20-in record. Here it is demonstrated that the pencil travel

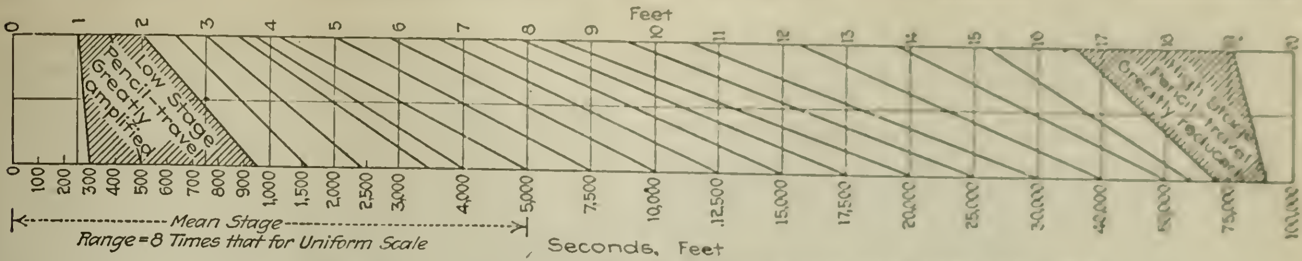


FIG. 3. DISCHARGE OF SKAGIT RIVER AT REFLECTOR BAR, FEBRUARY, 1920

for the plotting attachment is two and a half times as great as that for the standard water-stage recorder. Also, it is evident that pencil travel for high-stage conditions is correspondingly reduced, as specified in object (3).

Fig. 3 also shows the elimination of a serious obstacle met with in previous attempts at discharge plotting. Thus, if a discharge of 100,000 sec.-ft. is to be plotted on straight-line cross-section paper, all discharges up to 5,000 sec.-ft. would be recorded in a single inch of a 20-in. record. And, on this basis, the entire record at Reflector Bar for the seasonal year of 1915 would have been compressed into that inadequate space. With the Moore attachment and the new hydrographic paper this discharge record would be spread over no less than 8 in. on the 20-in. ribbon, or 4 in. on the 10-in. This would be approximately twice the size of the standard water-stage record for the Reflector Bar station, as will be apparent from further study of Fig. 3.

Since there will be some who feel lost without the familiar gage heights it may be noted that it is quite possible to have the same machine record both simultaneously. The Stevens duplex recorder is admirably adaptable to this purpose.

Before proceeding with a description of the new hydrographic paper it may be well to answer in advance some objections to installing a discharge recorder instead of the type previously standard. Thus, one engineer of eminence has urged that such a device should never be installed upon a new station, or indeed upon any station except those rare ones where the rating is not only perfectly established but also where it never "shifts." As a matter of fact, if the new cross-section is used for the record paper a new station is just the place where the discharge plotter should be used; for in that case the recording pencil can be set directly upon the proper discharge as soon as the first stream measurement has been computed. The accruing advantages which will result will become more intelligible from a more intensive study of the new paper.

In the search for this cross-section paper it was stipulated at the outset that the ordinates should correspond to a variation of 500 sec.-ft. for the first inch, of 5,000 sec.-ft. for the middle or fifth inch, and of 50,000 sec.-ft., for the last or tenth inch; and that the whole range of variation should follow some regular curve. It was not known that such conditions were possible of fulfillment, but the straight cross-section had been discarded, and the semi-logarithmic, while much better than any other known section, was unsatisfactory in that it never came down to zero.

It was found that the conditions were sufficiently complied with by the Spiral of Archimedes (American Civil Engineers' Pocket Book, 2d ed., p. 1162) and it was later discovered that when plotted on such a paper the Reflector Bar rating curve became a close approximation to a straight line at 45 deg., which is the ideal type for a rating curve. Upon later study it became gratifyingly evident that many other ratings would approximate the condition of a straight line at 45 deg., with only a little care in the choice of gage-height scale. Still later it became apparent that the entire discharge history of any river or stream could be plotted upon a single sheet of such cross-section paper without losing any of the advantages of accuracy and legibility in the low-stage portions of the record. With the possible exception of the semi-logarithmic paper previously mentioned this cannot be done with any paper which has thus far come to the writer's attention. A sample sheet of this new hydrographic cross-section paper is shown in Fig. 2, previously mentioned. The original of this sheet, however, is ruled to only 200 abscissa divisions while 400 are required for the annual studies

Large Activated-Sludge Installation at Reading, England

AN ACTIVATED-SLUDGE plant designed to deal in the future with 4,200,000 U. S. gal. of sewage per day has been designed for Reading, England, and the plans have been approved by the Ministry of Health. When the work is completed, we are informed by T. Midgley Taylor, Westminster, England, engineer for the plant, that this will be the largest activated-sludge installation in England, and Reading will be the only large town the whole sewage of which is treated by the activated-sludge process. The sewage of Reading is now dealt with on a sewage farm without any preliminary treatment, as it has been for many years past. (See editorial note, Nov. 25, p. 1018.) Since Reading is situated on the River Thames, above the London water-supply intake, Mr. Taylor states, a very high degree of purification is insisted on, and in consequence the farm is to be maintained for further treatment of the effluent from the activated-sludge plant in case that should be necessary.

The present dry-weather flow of sewage at Reading is about 3,300,000 U. S. gal. This comes from an absolutely separate sewerage system, into which practically no rain water is admitted and which receives only a small percentage of trade wastes. Consequently, there is very small variation in the rate of sewage flow.

The new plant will consist of screens and detritus chambers, four aëration tanks to be used in series, but each capable of being isolated, the four having a total capacity of 2,100,000 U. S. gal.; two settling tanks with a total capacity of 540,000 U. S. gal.; sludge storage tanks with a total capacity of 180,000 U. S. gal.; and a re-aëration tank with a capacity of 312,000 U. S. gal. Electrically-driven air compressors will be installed

Variable Speed Induction Motors for Centrifugal Pumps

THAT a large saving in the power required to drive centrifugal pumps might be made if designers and operators would employ variable speed drive to control pump discharge and not rely entirely on throttling is the conclusion to be drawn from a paper by Prof. Melvin L. Enger and William J. Putnam, University of Illinois, presented before the Illinois Section of the American Water Works Association. The authors first discuss the centrifugal pump as "inherently a variable speed machine" and outline conditions under which pumps operate, as follows:

Fig. 1 shows the relations between the quantity, head and speed in the case of a typical machine; when any two of the three variables are selected the third is determined. For example, if the speed and quantity are chosen the head is fixed. With the usual arrangement of an induction motor direct-connected to the pump, the speed is fixed. True, the speed of an induction motor is not quite constant, decreasing with increasing loads and affecting the relation of the head and quantity delivered by the pump somewhat as indicated by the dotted line in Fig. 1, but the variation in speed is so small, however, that this drive is usually considered to be a constant-speed machine.

There are four general conditions under which pumps operate: (1) constant discharge against a constant head, (2) constant discharge against a variable head, (3) variable discharge against a constant head, and, (4) variable discharge against a variable head. The first condition is the ideal one for centrifugal pumps driven by constant speed motors. Pumps delivering water to filter plants or to surface condensers often fall into the second class. The third condition is probably a rare one. In the fourth class would be included pumps used in water-works plants for delivering water into distribution systems, because in this case variations of the water level in reservoirs and elevated tanks cause the head to vary, while variations in demand cause the quantity delivered by the pump to vary. In the last three cases it is customary to select motor-driven centrifugal pumps operating at constant speed which will operate satisfactorily under the most adverse conditions, and to control the head and discharge by valves at all other times.

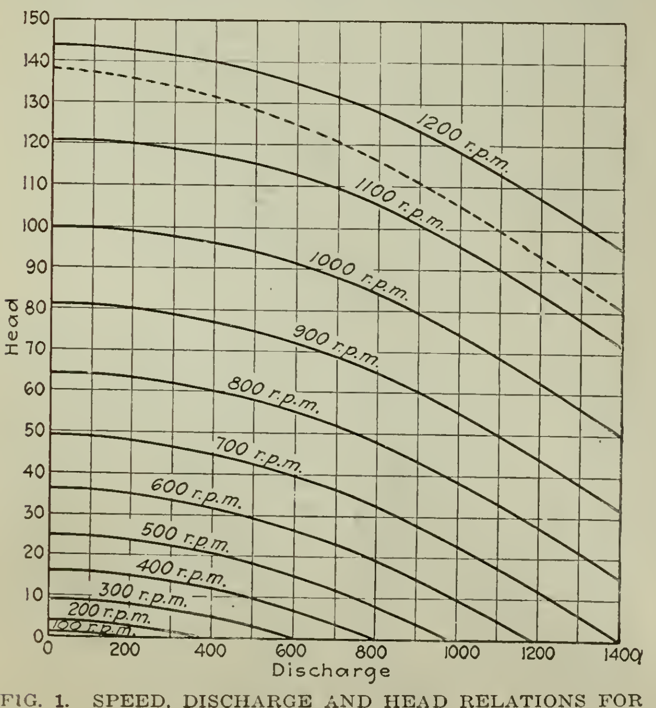


FIG. 1. SPEED, DISCHARGE AND HEAD RELATIONS FOR A TYPICAL CENTRIFGUAL PUMP

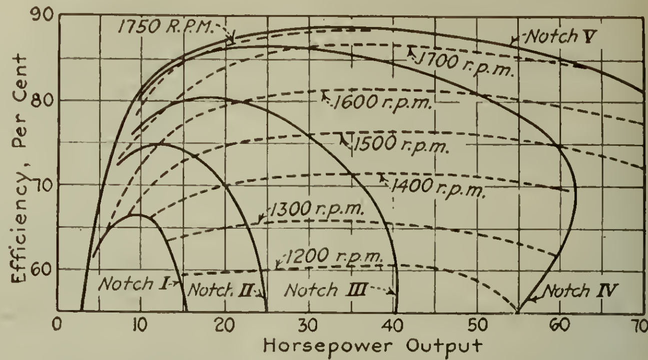


FIG. 2. EFFICIENCY AND SPEED RELATIONS FOR A VARIABLE-SPEED INDUCTION MOTOR

410-volt, 60-cycle, 2-phase, 50-hp.

The ordinary variable-speed induction motor has a wound rotor with its terminals connected to slip rings so that resistances may be introduced into the rotor circuit to change the speed. The action is somewhat analogous to slipping a clutch to secure lower speeds.

The authors next state that continuous running of a slip-ring motor with resistance in the rotor circuit is not widely advocated because it decreases motor efficiency and capacity, but in the special case of driving a centrifugal pump, the net efficiency of the unit is greater than running at normal speed with the pump throttled. The greater the resistance the more the speed falls under load; but at no load the speed is practically normal, or synchronous, whatever the amount of resistance in the rotor circuit. The energy lost in the resistance is proportional to the speed reduction—that is if speed is decreased 30 per cent below normal 30 per cent of the energy drawn from the line is lost. The remainder of the paper is given substantially as written:

Fig. 2 shows the relations between horsepower output, efficiency and speed of a 50-hp. Westinghouse variable-speed induction motor used for driving a DeLaval three-stage centrifugal pump in the Hydraulic Laboratory of the University of Illinois. The results of the test of this motor bear out the statements made above.

When the head developed by the pump is in excess of the head required under the given condition of speed and discharge, the excess head is usually wasted through a partly-closed valve. The power input to the pump remains unchanged because the pump continues to deliver the given quantity of water against the same head, no matter how much the valve is throttled. The power used in producing the excess head is wasted. If, however, the speed of the pump is reduced to the proper amount it will not be necessary to waste head through a valve. The head developed by a centrifugal pump varies as the square of the speed when the discharge is zero, and varies approximately as the square of the speed for any discharge within the usual range of operation. If the speed is reduced to 90 per cent of the original speed the head will be reduced to about 81 per cent of the original head. If this change of speed is accomplished by means of a variable speed induction motor, the efficiency of the motor will be reduced to 90 per cent of the original efficiency. The efficiency of the pump usually does not change materially within such a range of operation. If the head is reduced to 81 per cent of the original head by throttling a valve the over-all efficiency will be reduced to 81 per cent of the original over-all efficiency. That is, the use of the variable-speed motor to decrease the head to 81 per cent of the original value reduces the over-all efficiency by 10 per cent, as compared with a 19 per cent reduction in case a valve is throttled.

In the case of a motor-driven pump having an over-all efficiency of 55 per cent, delivering 1,000 gal. per minute against a maximum head of 100 ft., but operating against a head of 90 ft. half of the time, a saving of about $150

a year would be effected by the use of a variable-speed induction motor instead of a squirrel-cage motor, it being assumed that power costs 2c. per kw.-hr. Approximately the same saving per year would be effected by the use of a variable-speed motor with a pump of the above capacity and efficiency for any maximum head provided that the pump operates half of the time at a head of 10 ft. less than the maximum.

Fig. 3 gives the results of tests on a DeLaval three-stage centrifugal pump direct-connected to a Westinghouse variable-speed induction motor. The over-all efficiency of the unit when delivering various quantities of water against various heads is shown when the speed of the unit is varied

sitated the removal of the footings under the concrete

Total Head FOOTING AND IN FRONT OF COLUMN

FIG. 3. COMPARISON OF OVE... FICIENCIES FOR A CENTRIFUGAL ... IT

From tests on a motor-driven three stage pump run at normal speed throttled or variable speeds unthrottled.

and also when the unit is run at normal speed and the heads are obtained by throttling the discharge valve. It will be noted that the saving in power effected by the use of the variable-speed motor is large when considerable reductions of head are required. The motor driving the pump was arranged for only five running speeds. The smooth curves drawn through the points indicate the over-all efficiency if the resistances introduced into the rotor circuit could be made any desired amount. For the unit used in the tests it is necessary to throttle the discharge valve to obtain heads between those given by the five running speeds. The over-all efficiency for different heads is therefore as indicated by the dotted lines in the tests with the discharge of 150 gallons per minute.

In the selection of a variable-speed motor to drive a centrifugal pump great care should be taken that the several speed changes shall all be within the range required to produce the specified range of head, and the more speeds within this range the better. The electrical manufacturing companies might well turn their attention to developing an external resistant having a large number of steps.

The resistances consist of cast-iron grids compactly arranged, and are connected with the motor through a controller of the type used on street cars. Considerable heat is developed in the grids when the motor is operated at the lower speeds. The grids should therefore be located where the heat generated will not be objectionable. Unless the operator is instructed concerning the advantages of the use of variable speed he is liable to conclude from the heat developed in the grids that it is better to throttle the discharge by means of a valve, because the energy loss in this case is not so apparent, although it is in general about twice as great.

The variable-speed induction motor is more expensive than the ordinary squirrel-cage motor, but the saving in power resulting from its use, when the head varies considerably, will much more than pay the interest and depreciation on the additional investment.

Pipe Line System of Oil Transportation

A FEATURE in the development of the oil industry in this country has been the introduction of long pumping mains for conveying oil from the producing districts to the oil refineries, these lines dating back about 56 years and aggregating now about 45,500 miles, according to a paper by C. P. Bowie, petroleum engineer for the U. S. Bureau of Mines. Of this total, 34,000 miles are truck lines, usually of 8-in. pipe; the remaining 11,500 miles are gathering systems of 4 or 6-in. pipe from the tanks at the wells to those at the head of a trunk line. These gathering systems may be owned either by the producers or the trunk line companies. This method of transportation has largely superseded other methods owing to the low cost and has made it possible to establish refineries near the large consuming centers instead of in the remote producing districts. When most of the trunk lines were built the cost averaged $6,500 per mile of 8-in. line and $130,000 to $250,000 for each pumping station, the present fixed investment being estimated at $500,000,000.

Threaded steel pipe is used, the 8-in. pipe for trunk lines being designed to withstand a 2,000-lb. pressure and carrying a working pressure of 700 to 900 lb. In locating a pipe line, rough country and swamp land are avoided as far as posisble. For a private right of way, land may be purchased or a permanent easement may be secured to give the owners of the pipe line free access to their property. In some states the land may be obtained by condemnation. For communication with the various stations the companies usually erect telegraph and telephone lines along the right of way, so that the men who patrol the pipe lines can also note the condition of the wire lines.

In construction work the right-of-way gang first clears the site, placing culverts or casings at railway crossings and if necessary building roads to facilitate the hauling of the pipe. Then comes the stringing gang, which distributes the pipe; this work often involves hauling material for long distances and over difficult country. When a considerable stretch of pipe has been distributed the pipelaying gang connects the joints; 40 men with pipe tongs will connect up from 2,500 to 4,000 ft. of pipe in a 9-hour day. A more modern method is to use a pipe jointing machine and 28 men with such a machine have connected up 8,700 ft. of pipe in a day. Next comes the ditching gang to dig the trench and lay the pipe; in some cases the ditching being done first, the joints being then made with the pipe resting on skids or sleepers over the trench. Where the cost of trenching would be excessive or when the soil is strongly alkaline the pipe may be laid on the surface, resting either on the ground or on sleepers. If necessary to bury it in such soil the pipe is coated with asphalt and while this is wet a layer of roofing paper is applied and covered with a second coating of asphalt.

Pumping stations are spaced at distances ranging from 1½ to 90 miles, the distance depending upon the topography of the country and the viscosity of the oil. In the eastern and western states the average spacing is about 35 miles but in California it is only about 12 miles owing to the relatively thick and viscous character of the oil. The pumping equipment depends upon the quality and quantity of oil to be handled but also upon the fuel and water supply conditions, both steam and internal combustion engines being used. With 700 to 900 lb. pressure on the line the pumps can deliver through an 8-in. pipe about 30,000 barrels of oil in 24 hours.

Forest Depletion and Forestry Policy

CUMULATIVE depletion of the forests of the United States is the result of destruction rather than consumption and is the fundamental weakness in the supply and cost of wood products, according to a report prepared by the U. S. Forest Service to comply with a Senate resolution. To offset this, the problem is to increase the production of timber by stopping forest devastation. At the present time, 60 per cent of the original timber is gone, timber is being used four times as fast as it is grown, the forests remaining are so localized as to reduce their national utility, and the bulk of the population and manufacturing industries are dependent upon distant supplies of timber as the result of depletion of the principal forest areas east of the Great Plains. The above summarizes the main findings of the report, which are supported by a mass of detail and statistical matter. A shortage of lumber supply after the war was combined with a sudden demand for material for dwellings, industrial structures and manufacturing industries. But with labor difficulties, car shortage, bad weather and speculative conditions, the lumber industry was unable to respond to the demand. As a result the market has been unstable and prices have reached unprecedented heights.

Depletion of timber has been an important contributing cause of these excessive prices, and it has led to the migration of both the softwood and hardwood lumber industries from region to region, while the exhaustion of local resources has compelled many large lumber consuming centers to import their supplies from increasingly distant points. This last feature results in increased cost of transportation which is represented in increased price. Export of timber is not an important factor as to quantity, but has a direct bearing upon the duration of the limited supply of high-grade timber, especially hardwood.

Devastation of timber supplies and failure to utilize land for growing timber are the main causes of the depletion, actual use of the forests being but a small factor. A national policy of reforestation is urged by the report as the solution of the problem of insufficient timber supply. It is stated that if the enormous and increasing idle areas of forest growing land which are not required for other economic use, now aggregating 463,000,000 acres, can be restored to timber growth, they will assure a future supply of forest products adequate to the needs of the country. The forestry policy advocated in the report is based upon concerted action by the Federal government, the state governments and the landowners. It provides for protection and conservation of the remaining resources, public instruction, and recognition by the owners of forest lands of their responsibility in keeping these lands productive. This policy would aim at timber production as an established national practice, as in France and Scandinavia.

Houston Activated-Sludge Plant Results

CURRENT results of the operation of the Houston activated-sludge ... as given by J. C. McVea, city engineer ... of the ...

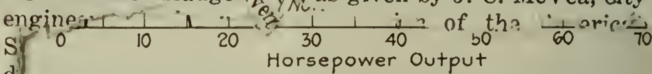


FIG. 2. EFFICIENCY AND SPEED RELATIONS FOR A VARIABLE-SPEED INDUCTION MOTOR
440-volt, 60-cycle, 2-phase, 50-hp.

The ordinary variable-speed induction motor has a wound rotor with its terminals connected to slip rings so that resistances may be introduced into the rotor circuit to change the speed. The action is somewhat analogous to slipping a clutch to secure lower speeds.

The authors next state that continuous running of a slip-ring motor with resistance in the rotor circuit is not widely advocated because it decreases motor efficiency and capacity, but in the special case of driving a centrifugal pump, the net efficiency of the unit is greater than running at normal speed with the pump throttled. The greater the resistance the more the speed falls under load; but at no load the speed is practically normal, or synchronous, whatever the amount of resistance in the rotor circuit. The energy lost in the resistance is proportional to the speed reduction—that is if speed is decreased 30 per cent below normal 30 per cent of the energy drawn from the line is lost. The remainder of the paper is given substantially as written:

Fig. 2 shows the relations between horsepower output, efficiency and speed of a 50-hp. Westinghouse variable-speed induction motor used for driving a De Laval three-stage ... the Hyd...

Rural Road and Bridge Expenditures

During the calendar year 1919, 46 States of the Union expended over $400,000,000 on their rural roads and bridges, the Bureau of Public Roads of the U. S. Department of Agriculture recently announced. This total is made up of the actual cash expenditures for such items as labor, materials, supervision and administration, amounting to $389,455,931, and convict labor and statute labor, the value of which, not definitely known, is estimated at about $132,000,000. So far as possible. all expenditures on city streets within incorporated towns and cities and all items of sinking-fund payments or the redemption and interest payments on road and bridge bonds have been excluded.

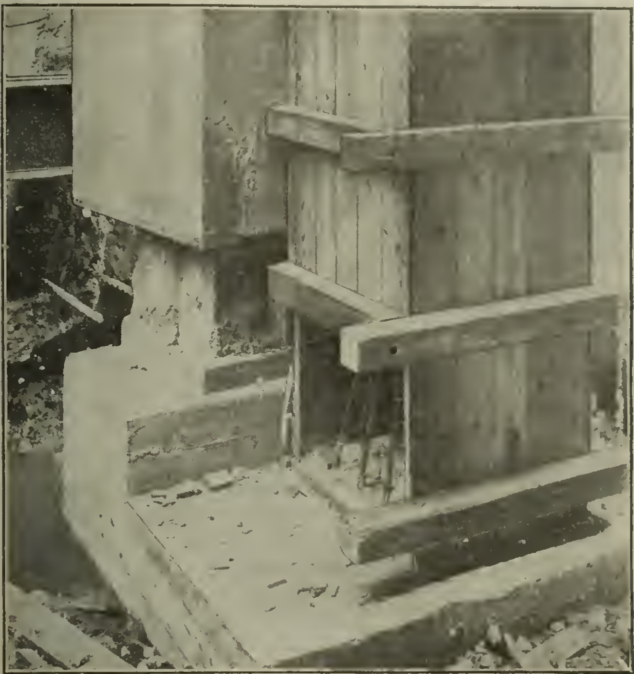
The road and bridge expenditures for 1919 show an increase of approximately 33⅓ per cent over those of 1918 and 70 per cent over those of 1914. More striking, however, is the increase in the proportion of the total funds supervised by the several State highway departments. In 1918 the expenditures by or under the supervision of the State highway departments amounted to $117,285,268, while the local road funds, over which they exercised no control whatever, amounted to $168,-812,925. In 1919, however, the State highway departments supervised the expenditure of $200,292,694 as against the total of $189,163,237 expended by the local road and bridge authorities.

Underpinning a Concrete Building by Jacketing Columns

Weak Footings Replaced and Made Continuous With New Footings for Adjacent Columns of New Building

By R. L. Bertin
Chief Engineer, White Construction Co., New York City

THE construction of a new building adjoining the existing building of the Gates Plant of the Yawman & Erbe Manufacturing Co., Rochester, N. Y., necessitated the removal of the footings under the concrete



IN REAR OLD COLUMN ON NEW FOOTING AND IN FRONT FORM FOR NEW COLUMN

columns of the old building and replacing them with new footings of sufficient capacity to carry the loading from the old columns as well as the new ones. The old building was built some years ago and no record could be found which gave accurate details of the construction.

The old building is a three-story and basement reinforced-concrete structure of the beam and girder type. A number of cracks are present throughout the structure and the footings under the old columns were found, upon examination, to be very thin in proportion to their spread and set eccentrically with the columns.

In view of the poor condition of the building it was essential that a method of shoring be adopted which would preclude any possibility of settlement and which would not cause undue stresses at the junction of the beams and columns. Taking into consideration the fact that the upper floors were occupied and could not be interfered with, that absolute safety was required at every step of the work and that the work had to be executed as economically as possible, the method finally adopted was to grip the basement columns with a reinforced-concrete jacket, to lift the jacket and with it the column, depending on the frictional resistance between the two to transfer the column load to the jacket.

The old basement columns were roughened and horizontal V-grooves about 1 in. deep, 2 in. wide and 12 in. apart cut into them. The corners were rounded to a radius of about 3 in. A spiral of steel wire was wound around each column and held in place by vertical rods; forms were set around the column thus treated and a concrete jacket 6 in. thick cast around it. The jacket was kept clear of the spandrel beams and girders of the floor above and the bottom of the jacket kept about 18 in. above the top of the old footing.

Temporary footings were cast between the columns and carried down to rock, which was found at a level 2 to 3 ft. below the bottom of the old footings. In order to get proper elevation for the I-beams which were to carry the columns during the underpinning the temporary footings had to be built higher than the basement floor but they were cast with a horizontal joint so that the upper part above the finished basement floor level could be removed by simply wedging the upper sections off the lower one. This was considered better practice and more economical than to attempt any other form of blocking. The holes for these footings were sheeetpiled and braced thoroughly to safeguard against undermining the old footings.

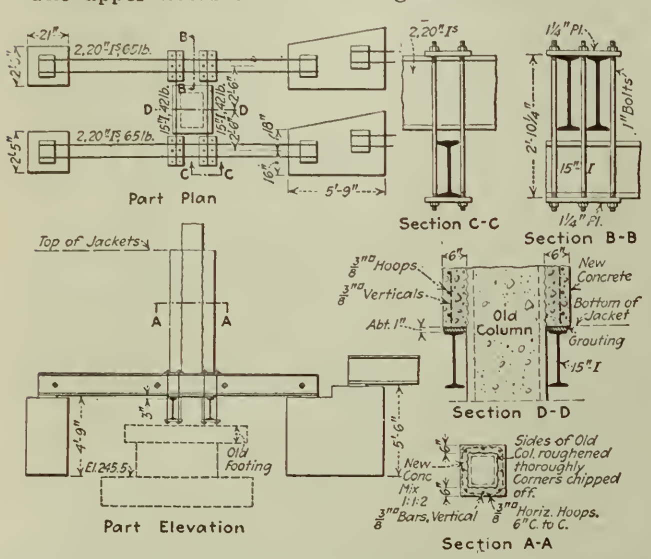
Two 20 in. I-beams were set on each side of each jacket, bearing on the temporary foundations, from which were hung two 15 in. I-beams, set and grouted under the bottom of the column jacket, using twenty-four 1-in. suspension rods. The cradle thus formed was raised by taking up gradually on the suspension rods until the weight of the column was transferred from the old footing to the steel beams, a condition which was accurately determined when the main steel beams ceased to deflect and the column started to raise.

The dirt under the old footings was then excavated, the old footings were broken up and removed and the bottom of the old columns was dressed to a true surface. The new footings were installed and the space of about 3 in. left between the bottom of the old columns and the top of the new footings was grouted under pres-

CONCRETE JACKETS DO NOT REACH TO UPPER BEAMS

sure with a 1:1 mix of cement and sand, thoroughly rammed in. Three weeks after the jackets were poured the cradles were lowered and the steel beams removed. Accurate readings taken while the cradles were being lowered and for some time after showed absolutely no settlement of the columns.

The upper floors of the building were used continuously while this work was going on and only a small part of the basement had to be vacated during the operation.



DETAILS OF UNDERPINNING OPERATIONS ON YAWMAN & ERBE BUILDING

The jackets were so designed that the shearing stress between the old columns and the jackets did not exceed 30 lb. per square inch and the bearing stress of the concrete jacket on the steel beams 500 lb. per square inch.

This building is being erected by the White Construction Co. of New York City, under the supervision of R. R. Tinkham, resident engineer for Smith, Hinchman & Gryllis, architects and engineers, of Detroit, Mich.

Quality of Electric Arc-Weld Steel Studied

Examination of a large number of specimens of the steel deposited in electrically arc-welded joints by the Bureau of Standards shows that this metal has mechanical properties like those of an inferior casting. In tension tests the metal showed low ductility, and all of the specimens examined, about 70, showed evidence of unsoundness in their structure, tiny inclosed cavities, oxide inclusions, and lack of intimate union. The investigators, Henry S. Rawdon, E. C. Groesbeck, and Louis Jordan, conclude that this unsoundness is a necessary consequence of the method of fusion as now practised, and that it is responsible for the deficiency in ductility of the joint metal. Microscopic plates found in the ferrite grains of the metal, which are not removed by prolonged heating, are believed to have relation to the nitrogen content of the metal. They are called nitride plates, but are considered unimportant as the breaks in tension testing were not affected by them. Both a "pure iron" electrode and a low-carbon steel electrode were used, with practically equal results. The composition of the material changed in fusion by elimination of carbon and other elements. The use of slight protective coatings on the electrodes did not appear to affect the mechanical properties of the arc-fused metal. The results are to be published in Technologic Paper 179.

Report on Richmond Borough Sewage Tests, New York City

Tank Treatment With Chlorination in Some Cases Indicated—Siphon Tank Favored—Sludge to Destructors

THE belated report on "Sewage Experimental Investigations at West New Brighton, Staten Island (Borough of Richmond), N. Y." recommends that tank treatment of the sewage of the borough be accepted under certain conditions as a satisfactory method of treatment, with chlorination in special cases. The "siphon tank" is recommended for localities where covered tanks will be necessary. For sludge disposal it is suggested that the waste steam and heat from the borough refuse destructors be used to dry the sludge and that thereafter the sludge be burned in the destructors.

Scope of Experiments

The report was made by Warren R. Borst, assistant engineer, under date of June 24, 1919 (printed but recently), and is approved by Theodor S. Oxholm, engineer in charge of the Bureau of Engineering of the Borough of Richmond. The investigations were authorized by the Board of Estimate and Apportionment of New York City in July, 1911. Most of the experiments seem to have been conducted in 1914-16.

The experiments were confined to (1) sedimentation in plain settling tanks, Imhoff tanks without and also with colloidors and a siphon tank; (2) disinfection of raw sewage with hypochlorite of lime and with chlorine gas; (3) sludge treatment by drying in vacuum and by digesting in separate tanks; (4) rate of reaëration of sewage when diluted with fresh water and when diluted with salt water. The plain sedimentation tanks were 11 ft. long, 6 ft. wide and 12 ft. deep. The Imhoff tanks were of steel, 11 ft. long, 6 ft. wide and 19 ft. deep. In order "to combine the principles embodied in the Imhoff tank with those of the Hampton tank" one of the Imhoff tanks was equipped with "furring strips, extending 4 ft. into the upper compartment," these strips being "spaced 6 in. c. to c. and so staggered that the sewage passing through the compartment would have opportunity to come in contact with the surface of the strips."

The reason for trying the "siphon tank" was, according to the report, that "many of the sewer outfalls in the borough are located in populated sections where it would not be desirable to have odors from a sewage-treatment plant." On this account it was decided to "study the action of a closed settling tank operated on the principle of a siphon for treatment by sedimentation alone." This tank is described and its operation summarized in the report as follows:

For this purpose a cylindrical steel tank, with a conical bottom (similar to the type described under the title of "The Kessel," Proc. Inst. Municipal and County Engineers, vol. XXXVI, p. 201, 1909) was constructed.

The tank at this experimental station was 12 ft. high and 4 ft. diameter, with 6-in. inlet and 2-in. outlet. Before entering the tank the sewage passed through a small grit chamber constructed of a 30-in. tile pipe set vertically, from which the 6-in. inlet, submerged about 14 in. in the grit chamber for a water seal, extended into the tank. This chamber also prevented floating materials, such as matches, corks, grease, etc., from entering the tank.

The outlet of the tank, located near the top, consisted

of an inverted conical funnel of sheet metal 2 ft. 6 in. in diameter at the base, to which was connected the 2-in. outlet pipe; this outlet extending into the outlet chamber the same distance as the inlet pipe of the grit chamber. A valve provided on this 2-in. outlet line permitted control of the sewage flow through the tanks. From the conical bottom of the settling tank a vertical 14-in. cast-iron pipe with a gate valve extended into a sludge receiving tank which was 2½ ft. deep and 2 ft. in diameter. The ends of the inlet, sludge and outlet pipes were all of the same elevation and therefore all had the same water seal. The difference in head was about 5 in.

To start the operation of the siphon tank all valves were closed and the tank filled with water. After filling, the valves of the inlet, outlet and sludge pipes were opened. The siphon action caused the sewage to flow. The "flow through velocity" in the siphon tank being very low, the solids settled through the sludge pipe into the sludge chamber under the tank.

This tank and its method of operation provided for immediate separation of the settled solids from the sewage and prevented septic action interfering with the sedimentation process. This tank was operated continuously for three months, November to February, treating approximately 12,000 gal. per day, with results as given in the following table:

	Storage	Corresponding Velocities Ft. per Sec. 6-in. Inlet	Tank	Per Cent Settling Solids	Reduction Suspended Solids
Maximpm	2¾ hr.	11.2	0.175	81	42
Minimum	50 min.	2.44	0.039	57	34
Average	1½ hr.	6.22	0.098	70	49

Conclusion

The conclusions and recommendations of the report, in view of local conditions in the Borough of Richmond, are given in the report as follows:

1. That the experimental results with respect to tank treatment may be summarized as follows:

(a) Tanks having a detention period of from 1 to 2 hours and velocities of flow of from 0.007 ft. to 0.015 ft. per second will remove from 50 to 60 per cent of suspended solids and from 30 to 40 per cent of oxidizable organic matter.

(b) Imhoff tanks provided with colloidors in the settling compartment with the sewage at this station gave a more stable effluent than the ordinary Imhoff tank.

(c) The siphon tank gave very satisfactory results and from our experience at this station it has shown considerable advantage over other sedimentation tanks, in that the settling solids are entirely separated from the flowing through chamber and can be treated or removed while in a fresh state and free from the disagreeable odors usually attending the disposal of sludge.

(2) That in the disinfection of sewage, chlorine gas is more efficacious than hypochlorite of lime, although either when applied in sufficient amount gives satisfactory bacterial purification.

(3) That the experiments in sludge drying, although not carried through to conclusive results, indicate that the sludge may be treated without creating a nuisance by separate digestion, by vacuum drying or may be made nonputrescible by aëration.

(4) Much work in the laboratories had been done on the effect of dilution of sewage in bottles. The investigations made in the large tanks at this experiment station gives the resulting effects of what may be expected from the minimum disturbance upon the surface of a body of fresh water, salt water and sewage dilutions in various proportions, as well as what may be expected when the surface is more violently agitated. These results show that the reaëration is decidedly rapid and uniform throughout the body of water.

The rate of which the reaëration of the foul liquid sewage (devoid of all oxygen) took place was very rapid and the results show what may be expected from the agitation of the sludge compartments of two-story tanks in assisting the digestion of the sludge and prevention of the accumulation of noxious gases.

Recommendations

(1) That tank treatment of the sewage of the Borough of Richmond be accepted as a means to produce effluents of such a character as to preclude the probability of local nuisances in the vicinity of the outfall sewers, but only on those outlets for which the flow of sewage is uniform throughout the year and which can be located at sufficient distance from any neighborhood so that any odor from the plant will not give cause for complaint.

(2) That all effluents should be discharged into the waters surrounding the Borough at such points as to avoid stagnation and where agitation by wind and other agencies will provide for rapid absorption of atmospheric oxygen.

(3) That in the vicinity of bathing beaches and shellfish beds, the tank effluent should be treated with liquid chlorine at the rate of approximately 10 p.p.m.

(4) That the siphon tank is thoroughly practicable and should be used in localities where covered tanks will be necessary. The sludge can be either removed from the lower sludge chambers before it has had an opportunity to become septic or they can be so arranged and equipped that the contents of the sludge chambers may alternately be thoroughly agitated for from four to six hours or such time that may be found sufficient to furnish oxygen to oxidize the organic matter. This tank is much more adaptable to locations where the population is not of a permanent character, such as summer resorts, where the variation of flow of sewage has a wide seasonable range.

(5) In the disposal of sludge in the Borough of Richmend, it would seem that by using the waste steam and heat from the destructors the sludge can be economically dried and burned with the garbage.

Submerged Tear in Ship's Side Repaired by Use of Caisson

Successful use of an outside caisson marked the repair of the tank steamer "Bradford," recently damaged below water line while passing through the Panama Canal. The shell plating and frames on the port side of the forepeak were badly distorted at about the 6-ft. mark and there was a vertical tear in the plate about 4 ft. long and 1 to 6 in. wide, as the case is reported in the *Panama Canal Record* of Nov. 3. The drydock was not available at the time, so that some method of making temporary repair had to be used. After removing all the cargo from the forward part of the vessel to bring the bow up as high as possible most of the injury was still below water level. A caisson was made to fit over the hull so as to inclose the injury and make it possible to work at it. The caisson was a strong wooden box with the top and one side open, the edges at the open side being shaped to the form of the vessel from a pattern made by a diver. The edges which were to rest against the hull were covered with a thick padding of canvas and oakum. The box was maneuvered so as to bring the padded edges against the side of the vessel and the open top a foot or so above water, and then the water within the box was pumped out. In this condition the outside water pressure held the caisson tight against the ship. Working inside the caisson a plate was applied directly over the break, extending for some distance either side so as to restore the strength of the hull. For further strengthening a box was built inside the hull over the damaged portion and filled with cement.

Observations on a Pacific Coast Trip—Spokane

By Frank C. Wight
Associate Editor, Engineering News-Record

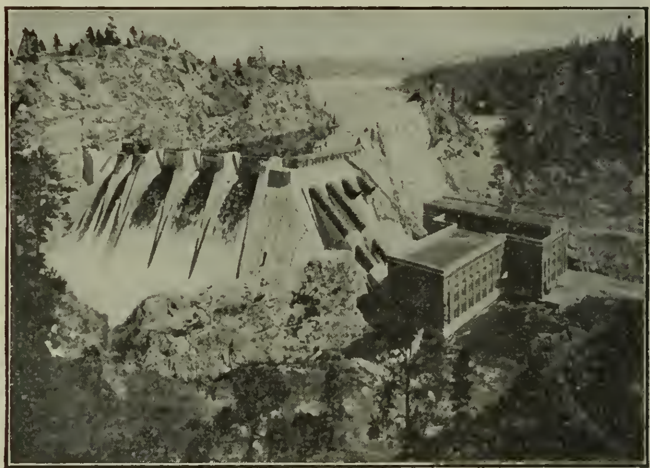
Mr. Wight is now on the Pacific Coast, studying engineering conditions. This is the first of a series of articles he will write recording his general impressions. Technical articles on outstanding developments will follow later.—Editor.

If HUMAN qualities can be ascribed to a whole country or section of a country, it is safe to say that the West is distinctly masculine or, perhaps better, virile. It has those qualities of independence, resolution and courage that are a part of man. And yet it has at the same time one characteristic we are wont to think of as feminine. It is temperamental; it seems to delight in being misunderstood. What the East or what the rest of the country thinks of this West is quite another thing from what the West thinks the East thinks, but no amount of argument will convince the Westerner of that. For him there is a typical Easterner—and that means any one living East of the Continental Divide—who believes that Indians still roam the plains of Washington and that red flannel shirts are the favorite dinner costume of San Francisco. To translate that into engineering terms he feels that the Easterner—and particularly the coast Easterner—has not a proper understanding or a full appreciation of the truly Western problems and that in consequence the East, controlling as it does so much money power and government action, is not giving the West all it is entitled to as a producer for the country's general good.

To give a true engineering impression of the West, therefore, is a ticklish job. The risks of misinterpretation are great. It could be done, of course, by a dry record of achievement and prospects, by data and statistics, by detailed descriptions of projects under way or contemplated, but those matters will be left for other pages. These letters will be merely the random observations of an Easterner traveling for the first time through western country and studying by conversation and inspection the state of engineering as found in the principal cities, where engineers center, and in such of the big construction areas as can be conveniently reached. It is frankly written by one to whom the country is new—though the men met are often old friends—for such engineers as have not yet been there. To many this will be old wheat threshed.

After Butte, the first stop was Spokane, about twelve hours away. Boosters for the Washington city should arrange that every new visitor come into town from Butte on the sleeper, for after the bareness and ruggedness of the mining center, Spokane seems like a garden. Its own quite evident beauty of surroundings and setting is all the more emphasized by the lack of adornment of its far-away neighbors. The hills behind it are not so very high, judged by Rocky Mountain standards, but they are close and heavily wooded and the rivers which join at its outer boundaries have cut valleys that require a succession of bridges, from the little concrete arch, dedicated to the soldiers of the World War on Armistice Day, to the high and delicately traced Hangman's Creek viaduct which carries the Milwaukee out of the city to the west. In fact the first engineering impression of Spokane comes from its bridges. There are so many that the city's bridge engineer couldn't say off-hand just what the number was but there are at least a dozen across the Spokane River in the city proper. And though individually they are of high merit the growth of the city's needs has resulted in an intricate maze of bridge work about the Falls which is far from pleasing and certainly not economical. The fine Monroe St. arch, for instance, named just recently by a board of disinterested artists as one of the ten best pieces of architecture in the city, is so placed that from one side it is quite impossible to take a photograph of it from end to end. And the Post St. arch, a 215-ft. concrete structure of surprising flatness, is squeezed in between two other old steel bridges—one of which it could easily have supplanted—at an absurd angle.

SITE OF LONG LAKE DAM OF WASHINGTON POWER CO. NEAR SEATTLE



COMPLETED DAM AND 67,500 HP. POWER HOUSE AT LONG LAKE

The presence of the rivers and the Falls right in the city has resulted in another possibility of which no large eastern city save Rochester can boast. That is a water-power in the heart of the business district. For many years the Washington Water Power Co. has

operated an old, inefficient plant here, diverting water through a natural channel by a low dam. It is now planning to go farther up the river—about 500 yd.—and bring the water through a 70-ft. drop to a new power house which will generate about 15,000 hp. This company has many water-powers under operation throughout Eastern Washington and by a tie-line is connected east to the Montana Power Co.'s lines and west to those of the Pacific Coast Co., so that interchange is possible clear from Butte to the coast. One of the Washington company's latest plants, that at Long Lake, has one of the big dams of the near West—a gravity concrete structure 208 ft. high, with an installation of three 22,500-hp. turbines. As the two views herewith show, the dam site was rather remarkable. The right hand branch of the river has been stopped upstream by another dam and the main dam turned at right angles over the penstocks to extend the promontory which jutted out between the two branches.

Water Supply from Underground River

In the Spokane districts there exists a curious underground river which is utilized for the city water supply. The source of this flow has never been definitely established, though probably it comes from the Coeur d'Alène lakes, but it is a never failing current of unknown amount which may be tapped anywhere in the valley at a depth of about 3 ft. below the Spokane river, which level it consistently maintains. Three large wells have been driven for the city supply alongside the pumping station which used to take water direct from the river and without purification—for it needs none—is pumped to the varying pressures of the city mains. So far Spokane has not experienced any of the current apprehension regarding its water system, which is ample and pure. The only source of worry is some old small wood-stave pipe put in mainly by real-estate developments which are in bad order and need replacing.

So much for material things. Spokane is in the Micawber-like attitude of the rest of the country of "waiting for something to turn up." It has not suffered any great slump because it did not share greatly in the increased production of the war. Its contributory industries are fruit growing and farming and it looks forward to the irrigation of its lands east for its greatest future. The ambitious Columbia Basin Development—with its millions of acres and hundreds of millions of dollars prospective cost—comes down almost to its eastern gate and it sees there another Yakima Valley which from the West is turning toward Spokane millions of dollars of produce each year. Every engineer in Spokane talks about the Columbia Basin. Not all are confident that it will go through but everyone thinks it ought to go through and that the state and the Federal government should back it to the limit. Certainly one would be optimistic in believing that $300,000,000, the ultimate cost of the project, could be obtained from private sources, even though the opening of the land would provide for settlers facilities for producing enough food for the entire country.

In connection with the government irrigation help another phase of government aid is much talked of in Spokane. That is what some engineers are pleased to call government "interference", not government aid, for roads. Complaint is made widely that Washington—D. C., not the state—is too far away to handle the Federal-aid situation, that the Federal road engineers are arbitrary and insistent on too high standards for pioneer conditions, that the full purpose of the Federal-aid measure would be achieved if there were a government engineer located in the state, acting independently of the capital, but in conjunction with the state highway engineer. Needless to say this is gossip and not the opinion of any state official, but it is set down for what it is worth as one of the straws in the growing western opposition to centralization and government control.

Spokane's engineers are well organized. They have a fine, sympathetic association of the various engineering interests and societies which meets weekly at luncheon and frequently in the evening. In a quiet but effective way they are having an influence on the government of the city, which after all is one of the best functions of an engineering association.

One final word of warning to other cities. In the 1920 census Spokane was shocked to find that its preliminary figures were lower than in 1910, though obvious crowding and housing shortage made such a thing highly improbable. Judicious and careful counting managed to bring in enough to pass the decade-old figures, so at least the city is saved the disgrace of a loss in numbers, but the citizens are now hunting for the enthusiastic enumerators of the year 1910!

Bank's Comment on Construction Status

The National City Bank of New York, in a review of economic conditions made public on December 1, makes the following comment on the status of construction work:

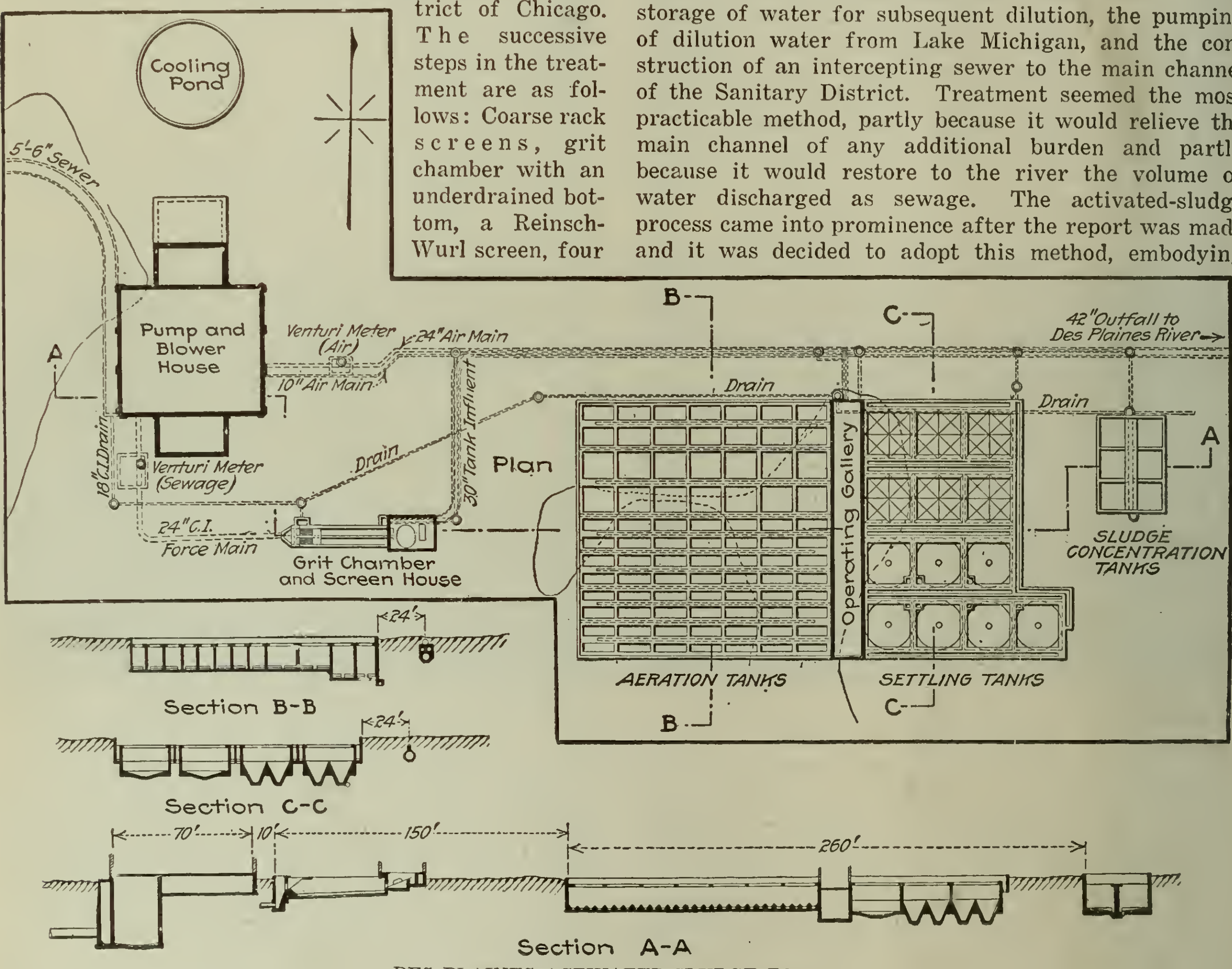
> Construction work has always led the way in recovery from business depression. The difference between good times is largely in the amount of construction work going on, and the strongest factor in the present situation is the amount of such work needing to be done. The country by all reports is underbuilt. None of the deficit of the war time has been made good, but last year and this year the country has fallen farther behind, because there is no confidence that present wage rates for mechanics or prices for material will be sustained in face of general business conditions. With great numbers of people out of employment, and the demand for office space and factory aditions falling off, investors are not wanting to put their money into building operations at costs which they believe can be very much lowered a year or so later. But if wages and prices come down so that building investments look to be safe against later competition there is a vast amount of work to go forward. There is no industry that holds such possibilities of help for the situation as house-building, for the materials required would give employment in a great variety of industries.
>
> The railroads have a great amount of work to be done, and only need the encouragement of lower interest rates, which undoubtedly are on the way.
>
> The manner in which the country has borne the great shrinkage in values, the comparatively few important failures, has shown that the business structure is essentially sound. The banks have carried the situation through the credit strain. There will be plenty of credit for a revival of business on a lower level of prices. The business organization is in working order and ready to resume normal operations when conditions are right, which, as we have indicated, will be when retail prices, wages and industrial costs generally have come down to the level reached by the basic raw products.

The Des Plaines River Activated-Sludge Plant

Chicago Sanitary District Is Building Model Plant With Wide Flexibility for Experiments on Moot Questions

By Langdon Pearse
Sanitary Engineer, Sanitary District of Chicago

An ACTIVATED-SLUDGE plant to treat the sewage of a number of villages on the Des Plaines River and thus prevent the present pollution of the water is being built at Riverside, Ill., by the Sanitary District of Chicago. The successive steps in the treatment are as follows: Coarse rack screens, grit chamber with an underdrained bottom, a Reinsch-Wurl screen, four



DES PLAINES ACTIVATED-SLUDGE PLANT

aëration tanks and settling tanks, some of them fitted with Dorr thickeners. Although located in the country, special provision is made to filter the air supply for activation so as to reduce to a minimum the clogging of the filtros plates. Sludge is to be stored in a battery of six 18,700-gal. concrete tanks. Two types of filter press, the Berrigan or platen press and the plate press, probably will be installed, as well as a centrifugal of the ter-Meer type, together with a direct-indirect dryer which will burn Illinois coal screenings. It is the intention to make this a complete experimental plant and also a model plant with surroundings attractive as a park.

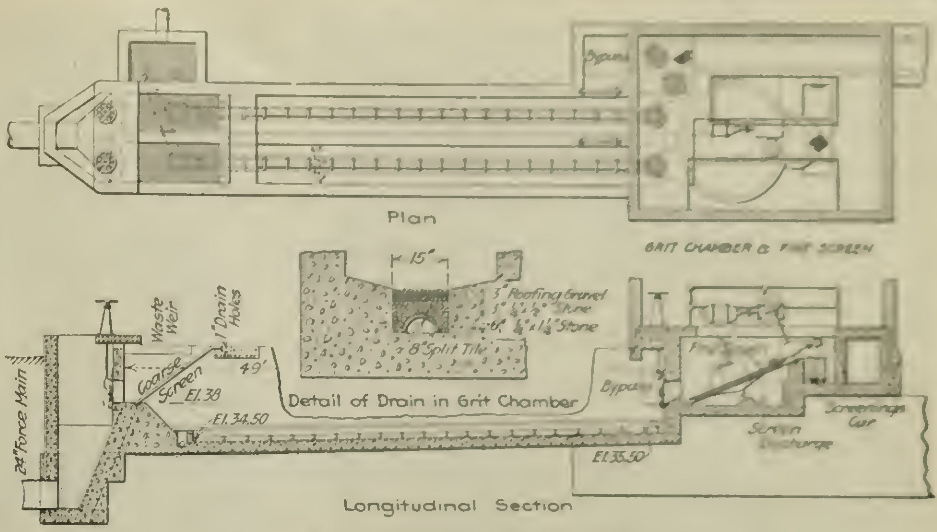
For many years the Des Plaines River at Riverside has annoyed residents within a mile of its banks. The major pollution comes from Melrose Park, River Forest, Forest Park and Maywood, with an estimated aggregate population of more than 30,000. The sewage is discharged at points four to five miles above the Riverside dam. Salt Creek, carrying the sewage of 16,200 people, also adds its burden to the river above Riverside. The pollution forms a sluggish flow or "piston" in the river, 10 to 15 days elapsing at times for the flow of five miles. Observations of the self-purification, as indicated by the dissolved oxygen, show that the piston moves up and down the river according to the flow.

After annexation of this territory to the Sanitary District in 1913, an exhaustive report, dated July, 1914, covered the following possibilities for relief: The storage of water for subsequent dilution, the pumping of dilution water from Lake Michigan, and the construction of an intercepting sewer to the main channel of the Sanitary District. Treatment seemed the most practicable method, partly because it would relieve the main channel of any additional burden and partly because it would restore to the river the volume of water discharged as sewage. The activated-sludge process came into prominence after the report was made and it was decided to adopt this method, embodying in it a number of experimental features to settle points of practice not yet determined upon. Construction started early in 1919 but progressed slowly owing to the strikes in the best working period of 1919 and to the hard winter following, but it is hoped to complete the work by the end of 1920.

The plant occupies a tract of 25 acres on the west bank of the Des Plaines River, 900 ft. south of Twelfth St., in open country near the Speedway Hospital, large cemeteries, an airplane field and the Riverside Golf Club. The sewage is collected from the various outlets of the villages by a 66-in. intercepting sewer, completed recently at a cost of $580,000. For the present flow, ranging from 4 to 10 sec.-ft. in dry weather, there are three 14-in. trash pumps with vertical shafts, working through a total lift of 32 ft., including friction.

The discharge is through a 24-in. cast-iron main and Venturi meter to the grit chamber. Space is left for two future pumps having capacities of 20 cu.ft. per second.

To care for the fluctuation in flow and to operate the pumps continuously, particularly on low flows, a by-pass is provided from the discharge of a small pump to the suction well, with float control connected to a hydraulic gate valve. This arrangement will automatically by-pass sufficient sewage from the discharge end to maintain a fairly uniform elevation in the suction chamber.



GRIT CHAMBER AND SCREENS

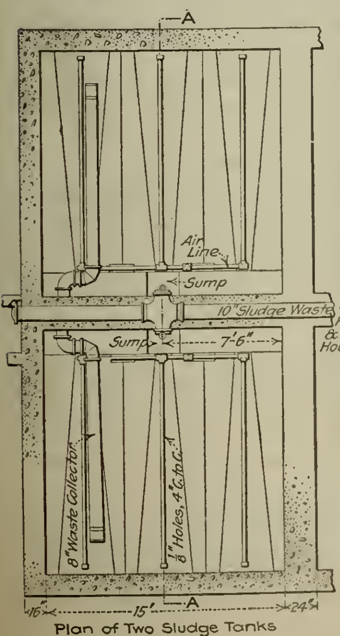
The pumps and blowers are arranged in one building, which also houses the air screens, transformers, switchboards, circulating pumps, heating plant and laboratory. The building has steel columns to support the roof trusses and the runway of a 10-ton hand-operated traveling crane. The walls are of brick and the roof is of gypsum tile covered with a weatherproof roofing. Current from the hydro-electric plant of the sanitary district at Lockport will enter the station at 12,000 volts and will be stepped down to 440 volts for the machinery and to 110 volts for lighting purposes.

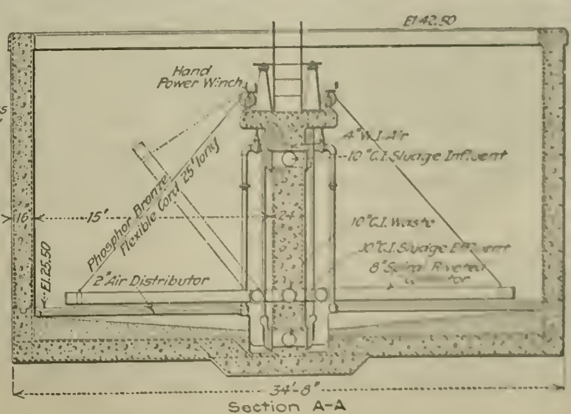
The incoming sewage will be measured by a Venturi meter and discharged into the grit chamber through a coarse rack screen of bars of $\frac{3}{8}$ x $3\frac{1}{2}$-in. section with 1-in. space in the clear. The grit chamber has two compartments, each 3.5 ft. wide by 3 ft. deep by 47 ft. long. Velocities will be controlled by sluice gates at the outlet end. Following the grit chamber will be a Riensch-Wurl screen, 14 ft. in diameter, inclined 15 deg. with the horizontal. It will have $\frac{1}{16}$ x 2-in. slots. A by-pass around the screen is provided.

The screened sewage passes to the aëration tanks. One is 15 ft. deep and the other three are 10 ft. deep. They have ridge-and-valley bottoms, with the ridges transverse to the direction of flow. At the bottom of the valleys will be set concrete boxes each containing four or five filtros plates. The ratio of filtros plate to tank area varies from 1 to 5.7 to 1 to 5.9.

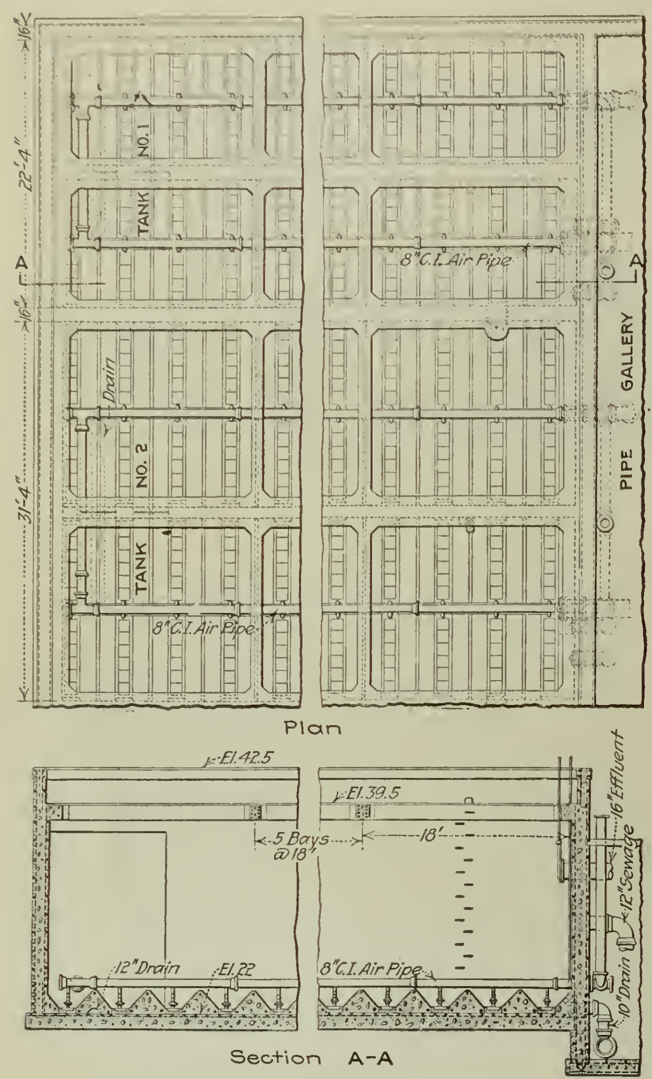
Aëration Tanks—The aëration tanks are arranged to compare various methods of operation. One 15 ft. and one 10 ft. deep will be run as straight-flow tanks. One 10 ft. deep will treat sludge re-aërated during its return. Another 10 ft. deep will be run with sludge reaërated during its return and resettled before introduction into the incoming sewage. All aëration tanks are 126 ft. long inside. Of those of the straight-flow type, the 15-ft. tank has a net width of 21 ft. and the 10-ft. tank, 30 ft. 4 in. Both tanks are baffled once longitudinally so that the total distance of travel is approximately 250 ft. The two units in which aëration of sewage and re-aëration of sludge will be attempted are divided by baffles into four longitudinal channels, each 7 ft. 7 in. wide, the sewage and sludge aëration compartments being separated by a removable transverse baffle of wood so that the relative detention periods may be changed. These tanks may be readily converted into the straight-flow type if this method of operation proves desirable.

The filtros plates will pass from 10 to 14 cu.ft. of free air per minute per square foot with a loss of head of 2 in. of water. Cast concrete boxes have proved satisfactory in the Milwaukee tests and at the tannery testing station of the Sanitary District. Channels feeding tanks in which aërated liquor will be settled are provided with filtros plates in the bottom so that air may be admitted to keep the sludge in suspension. To provide the greatest flexibility, each aëration tank is equipped with three unit settling tanks each 24 ft. square. One additional settling unit is also provided for re-settling the sludge in connection with the re-aëration and re-settling operation. Various methods of settling will be compared, since one-half of the tanks have hopper bottoms with four pyramidal hoppers to each unit with a slope of 2 vertical to 1 horizontal and the other half has a circular bottom with a





SLUDGE TANKS



AERATION TANKS

slope of 2 vertical to 12 horizontal. The latter are to be equipped with Dorr thickeners, a squegee cleaning device, which slowly collects the sludge to the center of the tank. An air-lift will raise the sludge to a measuring box, whence it will return either to the incoming sewage or to the re-aërating tank. Air-lifts are provided in each hopper of the pyramidal-bottom settling tanks to lift the sludge to measuring boxes that feed troughs of high velocity, which deliver the sludge to the re-aëration channel or to the return sludge channel. Aërated liquor will enter the settling tanks on two opposite sides through baffled openings. The settled effluent will flow over the effluent weirs forming the sides of troughs across the tank. The settled effluent passes to a 42-in. concrete outfall sewer extending 1,600 ft. to the Des Plaines River. At the upper end of the outfall is a connection to the overflow at the grit chamber and screen, so that the plant can be by-passed if necessary.

Blowers—The main pump and blower room is 60 x 70 ft. in plan. The pumps are located in the west end, and in the easterly portion are the motor-driven hydro-turbine blowers, with a total capacity of 11,500 cu.ft. of free air per minute. On recent tests of the blowers manufactured for the Sanitary District the following results were obtained.

Capacity Free Air, Cu.Ft. per Min.	Pressure, Lb. per Sq.In.	Brake, Horsepower
427	6.81	22.6
1,020	6.41	59.3
1,985	6.57	108.6
2,730	6.69	133.4
2,400	8.53	133.5

The incoming air will be screened through duck supported on wooden slats in a large room on the south side of the building, 2,870 sq.ft. of area being provided, or roughly 0.25 sq.ft. for each cubic foot of air per minute. The air will then pass into a large concrete supply duct extending around the blower-room basement. The compressed air passes through separators to remove the moisture, and through check valves into the main header, thence through a Venturi meter to the aëration tanks. The check valves will have aluminum disks to reduce the loss of pressure through them.

Because of the high cost of cooling water, a set of centrifugal pumps is provided, with a cooling pond and spray, so that the water can be re-used.

Owing to the use of two depths in the aëration tanks two air lines are planned from the blower house, the larger, a 24-in., carrying air at approximately 6 lb. pressure; the other, a 10-in., carrying air at approximately 8.5 lb. pressure. There is a cross connection with a reducing valve in the blower house so that an excess of high-pressure air can be put into the low-pressure line. Inside the blower house, spiral-riveted steel pipe will be used for the air lines. Outside pipes are of cast-iron.

For convenience in manipulation, an operating gallery covered with a concrete walk has been established between the aëration and the settling tanks. In this gallery are housed the Venturi meters for measuring the flow to each tank of screened sewage and of air, the devices for measuring the returned sludge and the operating stands for the gate valves on air, incoming and outgoing sewage, sludge removal and drains. The meters on sewage and air will be provided with recording devices. However, the meters on the auxiliary air lines for air-lifts will only have manometers.

Sludge Handling—For the storage of excess sludge, sludge concentration or acidification prior to dewatering, a battery of six concrete tanks is provided. Each tank is 11.5 ft. deep and 15 ft. square. An adjustable outlet pipe will remove the supernatent liquor which separates from the sludge.

The sludge will be handled in a press and dry house, in which the liquid sludge, removed from the system direct or from the storage tanks, will be dewatered.

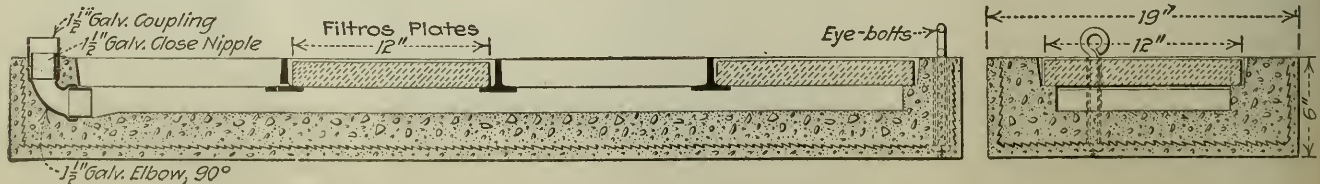
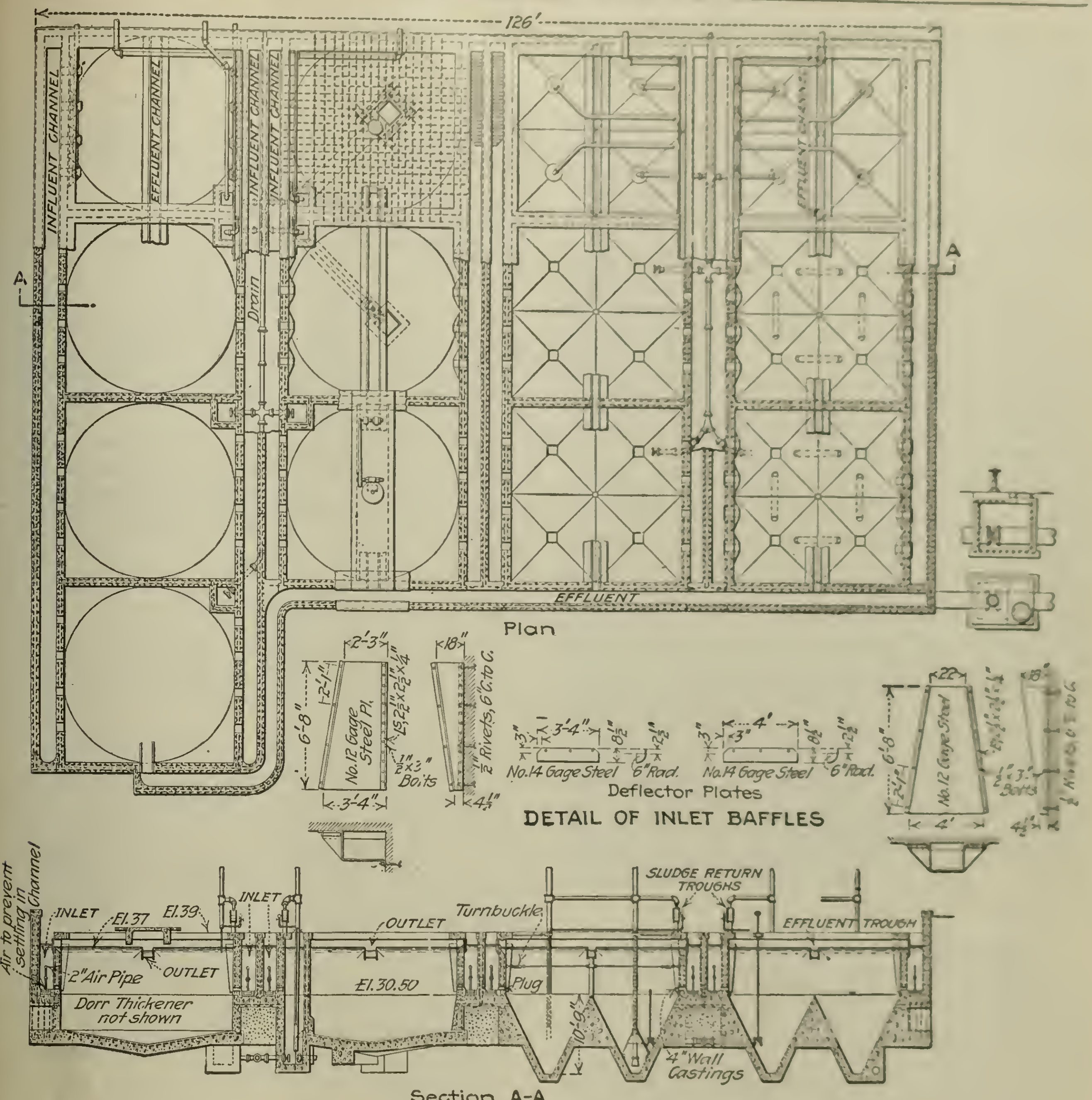


PLATE BOX FOR AERATION TANKS



SETTLING TANK

The water content of the sludge probably will be from 98 to 99.5 per cent of water. This will be reduced by filter pressing. The sludge cake from the press will be dropped into pans on wheels, rolled to a corner of the building and lifted to the second floor for storage and feed to the dryer. A centrifugal machine of the most recent ter-Meer type is also to be installed. This works continuously and discharges the cake automatically.

For drying the press cake, a direct-indirect dryer was selected after much investigation as the most likely to dry sludge without burning or scorching or causing the loss of nitrogen. A cyclone will retain the dust from the waste gases. The screenings from the Riensch-Wurl screen can be dried in the dryer, if suitable, and mixed with the sludge. Otherwise they may be burned or buried. About 3,300 lb. of dry sludge are expected per 24 hours, and about one ton of coal per day will be burned. Storage facilities as well as a screen and crusher for the dried sludge will be provided.

In the design of the plant advantage has been taken of the experience at Houston and at Milwaukee. Thanks are due to Messrs. Sands and Fugate and in particular to T. Chalkley Hatton for courtesies extended. Every effort has been made to prevent rust production, in order to reduce the likelihood of choking the filtros plates. Surfaces of all cast-iron or wrought-iron pipe have been coated. Traps are provided to remove all accumulated moisture and the inlet to the filtros boxes is trapped so that only a short length of galvanized wrought-iron pipe is directly tributary to it. Considerable care has been taken to make air lines drain and to provide blow-offs. A comparison is to be made on the durability and rusting qualities of dipped and galvanized cast-iron pipe, used in the air headers in the aëration tanks. Located in the outskirts of the

city beyond the industrial district, in the midst of farms, golf clubs and cemeteries, it is hoped that clean air can be secured by the cloth screens and the hydroturbine blower.

A laboratory on the second floor of the pump and blower house will contain the necessary apparatus for the essential determinations to control the plant and to learn what is happening. Measuring devices have been provided wherever helpful quantitative data can be secured.

The operation of the plant will be continuous, except at times of high water, when the incercepting sewer will be submerged. The pumping of sewage will then probably be discontinued and air blown simply to keep the sludge alive. This condition will occur when the river stage reaches El. 35, Chicago city datum, or 5 ft. below the maximum flood heights. Space has been provided for a plant of equivalent capacity which may be operated with the present installation.

Until his resignation in May, 1920, this work was carried on under the general direction of George M. Wisner, chief engineer of the Sanitary District of Chicago. E. J. Kelly, formerly assistant chief engineer, was made chief engineer when Mr. Wisner retired. The engineering staff working on the plant includes the writer, as sanitary engineer; George S. Brack, electrical engineer; C. R. Dart, bridge engineer; H. I. Steffa, mechanical engineer, and F. L. Barrett, architect. R. H. Burke, division engineer, is in charge of the construction of the intercepting sewer, pumping station and treatment plant. L. C. Whittemore, assistant sanitary engineer, has been in charge of the preparation of the contract plans for the treatment plant under the direction of the writer. A. B. Wood, New Orleans, was consulting engineer on the pumps and pump layout. The Leyden-Ortseifen Co. is the principal contractor but the contracts have been let to various trades in considerable detail, thereby securing vigorous competition.

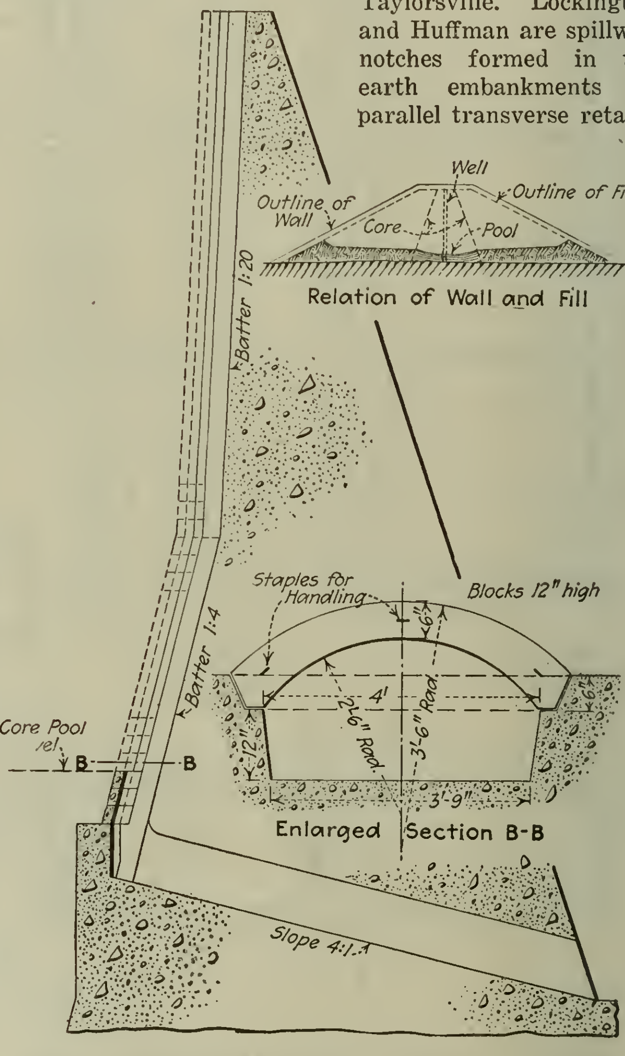
Water-Supply Improvements at Cleveland

The general program for water-supply improvements at Cleveland, Ohio, outlined in *Engineering News-Record*, Nov. 4, p. 886, in connection with the article by A. V. Ruggles, engineer of construction and surveys, Division of Water, is now being carried out. According to a letter from Mr. Ruggles excavation is in progress for the proposed Baldwin filtration plant with a capacity of 165,000,000 gal. a day and designs are being made for the plant and for the lining and covering of the Baldwin reservoir; the excavation for the latter having been finished. Plans are also being made for the reconstruction of the Fairmount pumping station and for various pipe lines or force mains from this station. It is expected that the contracts will be let in the spring for a 48-in. main connecting the Baldwin plant with the new East station to be built later on in the eastern end of the city. In accordance with the recommendation of the commission that reviewed the water-supply report abstracted by Mr. Ruggles in the article already mentioned, water rates in Cleveland were raised on Oct. 1 from 40c. to 60c. per 1,000 cu.ft. It is expected that the new rates will make it possible not only to pay interest and sinking fund charges on the cost of the improvements now being put under way, but also provide sufficient money, within ten years, to pay off a large bonded debt which has been refunded again and again.

Core-Pool Overflow Forms Core Inspection Well

TO PROVIDE overflows for the core pools in constructing three of the hydraulic fill dams for the Miami valley flood protection works, and also to provide a means for inspecting the process of core consolidation, wells designed as shown by the drawing are provided in the outlet works retaining walls.

As described in *Engineering News-Record*, June 10, 1920, p. 1143, the outlet structures of the dams at Taylorsville. Lockington and Huffman are spillway notches formed in the earth embankments by parallel transverse retaining walls. The ends of the embankments butt against the backs of these walls, which have a coping profile corresponding to the embankment slopes. The overflow and inspection wells, as indicated by the sketch inserted in the drawing, are located about on line with the vertical axes of the embankment cores.



WELL IN OUTLET WALL FOR CORE POOL OVERFLOW

In hydraulic filling the embankment the segmental blocks are laid up with each lift of the core pool and form the weir for the pool outlet. Every third block has a radial hole through it at the center of the arc. Plugs of wood close these holes, but when removed, at any time after the core has been raised above them, the holes are open for noting how the core has hardened and what its character is. Other methods of investigating the behavior of the core fill at the Miami Conservancy District dams were described in *Engineering*

News-Record, Dec. 25, 1919, p. 1040. Construction is under the direction of Arthur E. Morgan, chief engineer, Chas. H. Paul, assistant chief engineer, and C. H. Locher, construction manager.

Timbers of Tropical America and Railway Tie Supply

Hardwoods of Central and South America Little Known—Some Varieties Described—Life of Ties in Cuba

By Albert W. Buel,
Consulting Engineer, New York City

Vast timber resources exist in tropical America. Both the abundance of the supply and the remarkable quality of many of the woods make these resources of great importance for the future if not, indeed, for the present status of our timber supply for construction and industrial use. Hitherto practically all attempts to import timber or lumber from the countries to the south of us have been unsuccessful and unsatisfactory, except in so far as they relate to fancy and special woods, as those for the furniture and dye industries, involving values three to five times those of our native woods. In particular, attempts to develop a railway tie supply from the tropical and semi-tropical forests have failed. Yet there is good reason to believe that in this very field is to be found one of the most immediate and most significant possibilities in the use of tropical hardwoods.

In a special report of the committee on ties of the American Railway Engineering Association, made some months ago at the request of the Railroad Administration, the unsatisfactory condition of our tie supply and its probable future was fully discussed. At the present rate of consumption, the report says, the standing timber in the United States would be exhausted in thirty years, but due to increasing value and similar causes affecting consumption the present supply supplemented by new growths will last at least fifty years. During this period, however, the cost of ties will increase continually, quality will decrease, and more and more difficulty will be experienced in supplying the demand. For these reasons the development of additional sources of supply is of prime importance.

Why Previous Enterprises Failed

It is not hard to find reasons for the failure of previous attempts to organize a commercial supply of lumber, structural timber or ties from tropical forests. In all the cases known to the writer one or more of the following conditions brought the enterprise to failure:

1. Until the present time the market prices of domestic woods were so low that the products of tropical forests could not be sold here at a profit, or at least not at a margin commensurate with the risks and difficulties of the undertaking. This is now changed, according to the statements of men intimately acquainted with the market. The conclusion is well warranted that under existing conditions such enterprises, if handled with judgment and managed efficiently, offer excellent prospects of success. This conclusion applies to many, if not all, of the possible sources of timber supply from central and tropical South America.

2. Little is known in the United States about the various species of tropical woods available. Their qualities, in the way of durability and suitability for particular uses, have received practically no attention on the part of American timber users. Repeatedly timber cut from species of trees entirely unsuited to the use intended has been imported, with the result of creating an erroneous impression that tropical woods are quite unsuited to our requirements.

The difficulty arising from our lack of knowledge of the qualities of the woods is increased by the fact that tropical forests consist of mixed stands, with as many as twenty or thirty species grouped together. Further, the species are known by local names only, and the same species often have different local names in places only a few hundred miles apart. Sometimes, indeed, the same name is given to woods of different species in contiguous forest regions. No comprehensive botanical surveys have been made in any of the countries in question, so far as can be ascertained. These conditions quite obviously introduce confusion into the subject of tropical timber supply. Nothing would more effectively tend to conserve our North American forests by bringing the tropical and semi-tropical forests into the position of supplementary supply than a botanical survey of the standing timber of tropical America north of the equator. It would be desirable if means could be found to carry out such a survey at the earliest possible date. Such organizations as the Forest Service, the Smithsonian Institution, the American Museum of Natural History, should find this undertaking well within their abilities and their field of interest.

3. Most lumbering operations in tropical countries have been undertaken by inexperienced men, and these men have failed to employ capable advisers and managers. Under these circumstances insufficient consideration was given to the difficulties of the undertaking and adequate capital was not provided. Failure was but natural under such conditions.

Important Caribbean Woods

A noteworthy contribution to the subject of developing the Central American timber resources was made by T. W. Braddy, in charge of the lumber industry of the Panama Canal, in a paper presented before the Engineers' Club of the Canal Zone about a year ago. Mr. Braddy listed and described the principal Panaman woods, and discussed their availability for use in the United States. Engineers will be partciularly interested to know that the first four woods he mentions are of demonstrated high value for structural purposes and are among the strongest and most durable woods known, while seven or eight other species of his list are being used extensively for building construction, as interior trim and in cabinet work. Using his data, the following summarized account of the most important woods of the Isthmus (and in fact of the Caribbean region as a whole) has been prepared. The woods are listed in the order of their relative weight and strength.

Guayacan—The yellow guayacan grows 30 in. in diameter and 100 to 150 ft. high. It furnishes one of the hardest, densest and most durable woods known. It is of the same genus as lignum vitae *(Guaiacum Zygophyllaceae)*.

Almendra—No timber has given more satisfaction in ship and dredge work than almendra. It is similar in color to yellow guayacan, but occurs more abundantly. It grows up to 60 in. in diameter and 140 ft. high, but sometimes the trees branch as low as 30 ft. from the

ground. The wood is stronger, heavier and much more durable than white oak.

Alcareto—Alcareto has proved the most widely useful timber in Panama as a general substitute for oak, in work not requiring as heavy and strong a wood as guayacan and almendra. The tree grows to a height of 120 to 140 ft., without showing a branch. When green the wood is of a deep purple, the color changing to a light brown in seasoning. Alcareto does not check, has about the same weight and hardness as oak, and is more durable. It occurs abundantly, but the trees rarely attain a diameter as large as 30 or 36 inches.

Amargo—The lightest of the hardwoods used (except roble) is amargo, a wood of deep golden yellow color containing a resinous substance. It does not check and is a good substitute for oak, ash and maple. It is believed to be more lasting than alcareto, though lighter and less strong. The tree grows to 65 in. diameter and 150 ft. high, and is of symmetrical form and uniformly tapered, so that it is excellent from the lumbering standpoint.

Four woods of similar appearance but of very different botanical nature, *Batteo Marie, Caobo blanca,* and *Cedro amargo*, are being used for flooring, siding, interior trim and cabinet work, but have not been tried in structural work. Other trees available for interior trim that deserve mention are *Cedro espinosa, Coratu,* and *Espeve*. These woods are quite dissimilar in appearance. The trees are abundant and have a fair timber form.

Alcavu is a soft but long-lived wood and makes beautiful lumber. *Nispero* is a very hard wood, and incidentally yields a high grade rubber called "Balateo" and bears a very fine fruit. The wood season-checks very badly, however, and is useless for lumber or structural purposes unless means can be found to prevent its checking.

Among other Panama species some of which may be available for lumber or structual timber are *Mora, Mangle blanca, Mangle colorada, Soro, Quira, Amorilla, Marmocillo, Roble, Pilon, Tangari, Nogalon,* and others. They are, however, by no means of an importance commensurate with that of the woods mentioned before, and not much is known about their physical properties.

Points on Tropical Lumbering and Milling

As the governing factors of logging, milling and marketing in the tropical and semi-tropical countries differ materially from those in the United States special study must be given to the peculiar difficulties of the undertaking if success is to be assured and the necessary development capital attracted. Mr. Braddy in his discussion of the subject reviewed some of the points requiring attention. As he stated—and the writer is able to confirm this—little difficulty will be experienced from insufficient supply or excessive cost of labor. The difficulties center largely in providing a supply of logs to the mill, organizing the operating system of the mill, and organizing the marketing system with due regard to the variety of woods to be handled. Further, very careful technical study must be given to the problem of seasoning and kiln drying.

Discussing logging operations, Mr. Braddy suggests that modern logging machinery, properly applied to the local conditions, will prove entirely adequate to deal with the work. The ground skidder, the trolley skidder and the derrick barge have been supplemented with great success by the caterpillar tank, which has proved capable of bringing out timber from lands hitherto considered inaccessible to transportation.

Logging railroads will, however, prove an indispensable device in most of the tropical timber regions. In some instances these exploitation lines will require large investments of capital and the application of a high degree of engineering skill. A number of projects of this character have been studied by the writer and he feels on very certain ground in emphasizing the importance of considering transportation questions in addition to the problem of logging in the woods. Accessibility of supply is of prime importance, especially in the early years of such an enterprise.

Seasoning and Kiln-Drying

Reference to the formidable difficulties presented by the checking of some of the tropical woods should be sufficient to direct attention to the seasoning and kiln drying part of tropical lumbering. Cases have indeed occurred in which a promising enterprise to supply lumber from South or Central America to United States ports has been wrecked by disregard of the disastrous effects of checking. Logs, tie timber and finished lumber are all concerned in the seasoning problem. Both kiln drying and yard seasoning, therefore, must be studied, organized and administered with unusual care, not merely to reduce the losses of material, but, what in these enterprises will prove to be the critical consideration, to assure the supply to the purchaser of a satisfactory material, and thereby retain the confidence and good will of the market.

Organizing the mill operating system is intimately related to the character and size of enterprise suited to the South and Central American conditions. On this a paragraph from Mr. Braddy's paper is pertinent:

"Central America is not believed to be a country well suited to small mills scattered here and there over the land, for the small mill is usually backed by small capital and it is hardly possible with a small outlay of money to operate and maintain a logging equipment that it would require to stock even a small mill with logs for any length of time. Because the timber never occurs in pure stands a mill must engage in the manufacture of miscellaneous woods. This raises the most difficult feature of sawmilling to be met with, for it is necessary to make at least three grades of lumber from each species of timber handled. The Balboa plant is handling eight different kinds of timber; in the No. 3 grade all third-class material is placed regardless of species, while No. 1 and No. 2 are classified according to the species, thus making seventeen classifications. Assuming that a modern mill were operating here cutting from 40,000 to 60,000 ft. of bill stock per day and 20,000 ft. of boards, to say nothing of the miscuts, shorts and other scrap that would accumulate and could be worked up in slack and tight copperage stock, crate stock and basket material, it would be necessary to handle at least twelve different kinds of timber, and at least five grades of each species, thus requiring skid room, storage space and marketing facilities organized on a large scale."

An American engineer who during the past twenty years has spent considerable time in construction work in half a dozen of the countries bordering on the Caribbean Sea has made available to the writer some of the data which he has systematically collected on the subject of the semi-tropical hardwoods. These data,

together with perhaps equally extensive data collected by the writer through correspondence, interviews and information obtained in personal experience have been drawn upon for a table of the life of Cuban hardwood railroad cross-ties, representing actual service data. The figures of long life obtained are likely to prove surprising to railroad men of the United States, who deal with very much shorter periods of life even in the case of their best tie materials.

In connection with the general data on woods it should be said that particular attention has been given to securing data on the tendency of different woods to check, and on whether the checking is radial or tangential. The information on this point is necessarily rather incomplete and not altogether satisfactory. So far as it has been used in the table, however, it may be relied upon.

Briefly, stating the net showing of the table in a single conclusion, it may be asserted that, properly

LIFE OF CUBAN HARDWOOD TIES

Name of Timber (*Botanical Name*)	Life in Years Reported by — Cuban Central Ry.	Cuba R.R.	United Railways of H.	Esperanza Plantation Rys.	Ponupo Manganese Co. Rys.	Average
Caguairan †† (*Copaifera Hymeneofolia*)	30–40	25	* *	30–40	20+	28
Yaba† (*Andira Incrmis*)	.....	..	*	35	....	25
Majagua de Costa†	.....	25	...	.....	10	17
Guayacan Blanco† (*Guaiacum Oficinale Zigophyllaceae*)	.....		* *	.....	20	20+
Jiquí††† (*Romelia Horrida*)	20–30	25	* *	20–30	....	25
Jocuma††† (*Sideroxilon Salicifolio*)	20–30	..	*	20–30	.. .	20
Chicharron†† (*Terminalia Chicharronia*)	30–40	..	* *	30–40	.	27
Moruro†† (*Pithecobium Filicifolium*)	.	25	*	10–14	.	17
Sabicú†† (*Mimosa Odoratissima*)	.		*	10–14	8	14
Júcaro Negro††† (*Terminalia Augustifolia*)		25	*	10–14	10	15
Acana††† (*Bascia Albercens*)	...	25	*	10–14	10	15
Jaimiqui (*Mimusops Jaimiqui*)	...		*	.....		15

Average Life, in last column, is estimated from all available data, including experience of Cuban engineers in government service and independent practice.

*Most commonly used in Havana, (average life on dirt roadbed without ballast of any kind and very poor drainage, 10-12 years.

** Used, but not so easily obtained, average life on dirt roadbed without ballast of any kind and very poor drainage, 10-12 years.

† Does not check.

†† Seldom checks, or checks very little.

††† Checks badly or often.

selected, tropical hardwoods will prove gratifyingly serviceable and durable. Timber cannot be exported from Cuba at the present time in commercial quantities. But the timbers of the entire Caribbean region are closely related, and the species represented in the table as well as others are found also in the other Central American countries; and almost the same remark might be made concerning South America.

The Panama R.R. specified as acceptable for railway ties (in addition to guayacan), alcareto, amargo, almendra and nispero. On account of its tendency to check, it is doubtful whether nispero would be satisfactory in northern climates.

In Venezuela, ties of vera *(Guaiacum arborium)* and curarire *(Tacoma chrysantha)* last 25 to 30 years, and fail only by mechanical abrasion.

The greenheart of British Guiana *(Nectandra Rodioei lauraceae)* is rated first class by Lloyd's, as is also Mora *(Dimorphandra mora caesalpinoe leguminoseae)*, which is probably closely related to if not identical with the Cuban caguiran. These are two of the best tie and structural timbers, ranking with the guayacans.

It remains to identify species found in greater abundance in other and more accessible localities and now known only by various local names, with the six or seven best Cuban species, the four from Panama, and two each from Venezuela and British Guiana, as to which service records extending back 30 to 50 years are available. This work should be near the top of a botanical survey program.

There are several species each of the Guaiacum and Tacoma families that are said to have nearly equal value as tie timber, and it is probable that many if not the larger number of copaifera trees will prove serviceable. It is, however, important to bear in mind that 60 to 80 per cent of the stand in any subtropical forest is composed of species entirely unsuited to use as railway cross-ties, and, further, that some species which give fair service in their native climate may fail in northern regions, due to their tendency to develop radial season-checks extending from face to center of heart.

The opportunities for developing a satisfactory supply of ties to supplement our rapidly diminishing North American stock of tie timber therefore appear bright. If they are grasped, the time when wooden ties must pass out of use may be postponed indefinitely.

Prospects for Railway Tie Supply From South America

Tropical Timbers Now Offered — Little Knowledge of Behavior in United States — Indefinite Classification of Species

ALTHOUGH vast timber resources exist in the tropical forests of Central America and South America, there are technical and commercial difficulties attending the use of these timbers to supplement the supply of ties for railways in the United States, according to a recent paper by H. von Schrenk, consulting engineer, St. Louis, Mo. During the past thirty years there have been occasional shipments of ties from tropical countries but there is no adequate record of their species or service. Practically, however, this field has not been touched, but it is being given renewed attention and numerous offers are being made of various kinds of wood. The following notes are taken from the paper mentioned above.

Mexico has a large forest area, including both mountain and tropical regions. The mountain forests are composed largely of pines and are more or less inaccessible. The tropical forests contain a variety of hardwoods, there being, for example, some 85 species of oak in the territory tributary to Vera Cruz. In Central America there are large supplies of hardwood on the Pacific side, while the Gulf side has extensive pine forests, many of which are easily accessible. The chief tropical resources, however, are in South America, the largest area being in Brazil. Several years ago some ties imported from the Amazon region were laid on eastern railways, all of these being extremely hard and bearing no resemblance to woods found in the

United States. The Guianas are rich in forest resources and it is here that the valuable greenheart and mora are found. Venezuela and Colombia have smaller forests but can be counted upon for a large future supply. The mountainous parts of Chile and Peru are forested, but these countries at present import most of their timber from the United States.

Although these vast resources exist, Mr. von Schrenk points out that they are not available at this time and much development work will be necessary before they can furnish commercial supplies. Tropical timbers (with the exception of the mountain pines) grow in dense jungles and usually a large number of species grow close together. Thus if ties of lignum vitæ only were required they would have to be obtained from trees widely separated, while in any one acre where such a tree was found there would be 50 or 60 other species. For this reason, in order to make the cutting of ties commercially practicable it would be necessary to take a large number of different kinds.

In this connection, Mr. von Schrenk points out that the fitness of tropical woods for use as ties has yet to be determined. Hardwoods which have given excellent service in their native lands have failed when used as ties in the northern temperate regions, mainly by splitting and checking under the influence of the wide extremes of temperature to which they are subjected. Without further experience it would be risky to purchase any large number of ties of a particular species. During the past thirty years a number of species have been imported, but owing to incomplete records as to their names, origin and years of service it is in most cases impossible to determine their value as tie timbers.

Another difficulty is indefiniteness as to the nomenclature or classification of different species. Thus, samples submitted under various oak names have been found not even related to the oak family. A purchaser, therefore, must be careful to assure himself that the tropical wood offered has not only the local name by which it is known, but has also the botanical name by which alone it will be possible to specifically identify future shipments. Mr. von Schrenk is emphatic in stating that too much stress cannot be laid upon the absolute necessity of proper identification. Where tropical sources of tie supply are under consideration every possible care should be taken to have the proper botanical and other identification of all trees from which the ties are to be made.

Irrigation and Navigation Conflict

Interference with navigation in the Sacramento River caused by the diversion of water for irrigation is outlined by Lieut. Col. W. Kelly, Corps of Engineers, U. S. A., San Francisco, in a circular letter. The importance of irrigation, he says, is appreciated so fully that his office has been directing its activities "toward finding a solution that will permit maximum diversion and at the same time give permanent, reliable, all-year navigation." This will require movable dams with locks. A tentative plan for four dams has been made, but as the cost is beyond what Congress is likely to be willing to appropriate, Colonel Kelly has sent out the circular letter already mentioned to the irrigation interests to ascertain whether they would share with the government the expense of the dams.

Improve Small Water Power by Building Eight Dams

Primitive Construction Provides Storage for Modern Development in Nipissing Region of Northern Ontario

On account of the growing demands in the town of North Bay, in the Lake Nipissing region of Ontario, the Hydro-Electric Power Commission of Ontario is enlarging the capacity of the local electric power station, which has only recently been purchased from private interests. The most interesting feature of the revision is the construction of eight new small dams in

DOWNSTREAM FACE OF 12-FT. CRIB

the headwaters of the South River, which the plant utilizes, thus providing enough storage to dispense with the steam auxiliary which had been used when the river was low. The dams are in remote districts, where construction refinements would be expensive and so are being built in rather primitive fashion.

The old plant had a capacity of about 900 kw. with a low-water flow of only 75 sec.-ft. The steam auxiliary, therefore, was frequently called into service. The new plant will develop 1500 hp. continuous with a plant efficiency of 80 per cent, and on this basis 2200 hp. with an annual load factor of 70 per cent.

On the headwaters of the river are a series of small lakes now ranging in surface area from 100 to 1,000

UPSTREAM FACE OF SUPRISE LAKE DAM

acres each, the most remote being about 30 miles from the power house. The new dams are at the outlets of these lakes and increase their area and storage capacity. In all a total new storage of about 26,000 acre-feet will be created, heads at the dams varying from 2 to 14 ft. The dams themselves are of timber-crib, rockfill construction, sheeted on the face and puddled, with a single sluiceway containing stop logs, to permit

regulation of the outflow. They were built by local labor with such local material as could be obtained and with practically no machinery. The control will be in the hands of the Government park rangers who patrol this district.

In addition to providing additional storage the power house itself will be revamped, particularly to improve the rather antiquated turbines. New runners have been designed for the old casings which will develop 1400 bhp. each, in place of 1,000 bhp. developed by the old runners. New seal rings will be put in, and the connection between the guide vanes and the governor, which at present is very light, made more substantial. In addition to this, two new butterfly valves will be placed in the power house instead of the old gate valves, and sometime in the near future a new wood-stave pipe will be installed in place of the old one. New electrical equipment is also being installed, as well as a new shaft.

Concrete Towers at Railway Water Stations: C. & N. W. Ry.

Standard Design Adopted—Longer Life than Steel at Same Cost—Maintenance Cost Nominal—No Frost Box Required

RECTANGULAR TOWERS of reinforced-concrete to support elevated tanks at water stations, which are being introduced on the Chicago & Northwestern Ry., have about the same first cost as steel towers but have practically no subsequent expense for maintenance or painting. In the cost of a steel structure frost boxing around the pipes is included, but this is eliminated with the pipes enclosed in a concrete tower. The design for the concrete structure was made in 1918, on account of the shortage of steel resulting from war conditions, and it has been adopted as a standard design. Wood-stave tanks, 24 ft. in diameter and 16 ft. high, of 50,000 gal. capacity, are provided for in the typical design shown in the accompanying drawings, and several of these towers have been built. Larger towers are being designed for 77,000-gal. tanks 30 x 16 ft. In its essential features the monolithic structure consists of a tower 10 ft. square on a foundation slab 20 ft. square and carrying a circular top slab 23 ft. in diameter. In good ground the base is 6 ft. below rail level, but this depth is increased where necessary, the pipes being then supported at the normal level by concrete pedestals upon the floor. It will be seen that the top slab is formed with ribs or joists on which the tank bottom is placed, these taking the place of the wood joists ordinarily used and providing ample ventilation to prevent decay of the wood. Timber brackets, bolted to the wall of the tower, carry a frame supporting the hinged spout for supplying water to the locomotives. A concrete mix of 1:2:4 is used, made with stone not exceeding 1 in. in size. Exposed edges are beveled by 1 x 1-in. triangular strips placed in the forms. After 14 to 21 days, depending upon weather conditions, the forms are removed, the exposed interior and exterior surfaces being then rubbed down with emery bricks. Steel reinforcement consists of square deformed bars, with flat sheets of rib metal in the walls, the joints of bars being lapped and wrapped with wire. Frost-proof covering on the inlet and discharge pipes consists of two layers of tar paper, two layers of 1-in hair felt and two layers of tar felt, each layer being wrapped spirally with wire. Over this is a canvas jacket which is given two coats of asphalt paint. A door and two windows are formed in the tower.

Design Figures.—For the typical tower shown in the drawing the total assumed load on the base is 759,000 lb., including 429,000 lb. for tank filled with water, 316,500 lb. for 81 cu.yd. of concrete, 8,500 lb. of reinforcing steel and

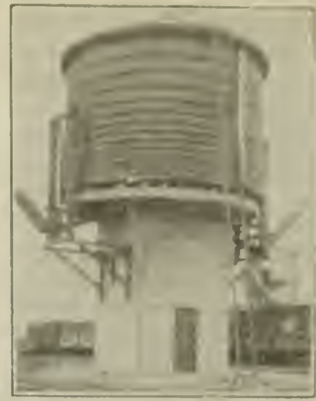


FIG. 1. WATER STATION WITH CONCRETE TOWER, CHICAGO & NORTHWESTERN RAILWAY

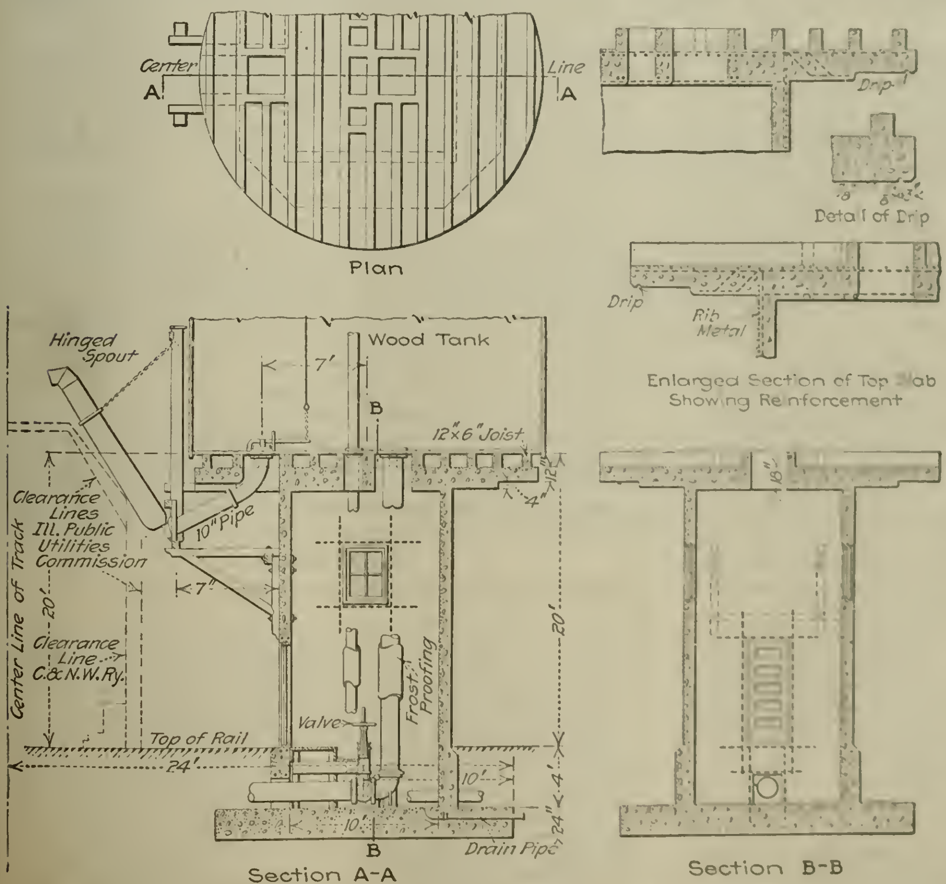


FIG. 2. DESIGN OF CONCRETE TOWER FOR WATER TANKS

5,000 lb. for piping. The soil pressure averages 1,900 lb. per square foot, with an allowable maximum of 2,300 lb. Wind pressure is taken at 25 lb. per square foot on the horizontal projection of the tank and 50 lb. on the tower. Unit stresses are 16,000 lb. for tension in steel, 750 lb. compression in concrete, 120 lb. shear in concrete reinforced with stirrups and 40 lb. where there is no shear reinforcement. The ratio of moduli of elasticity of steel and concrete is 15.

A life of about 70 to 80 years is expected for these concrete towers, as compared with an average of 35 to 40 years for steel towers and 18 to 20 years for framed timber towers, all under similar conditions of climate and service.

The concrete tower design was worked out under the direction of O. F. Dalstrom, engineer of bridges, Chicago & Northwestern Ry. Construction is done both by company forces and by contract.

Engineers' License Examinations in Different States

ABSTRACTS of the examination conditions in those states which require the licensing and registration of engineers for the practice of their profession, as published in the November "Proceedings" of the American Society of Engineers, are given herewith:

Colorado—Each candidate is examined in that branch of engineering in which he is proficient, as set forth in his application. The board conducts the examination in such manner as it deems best suited to determine the fitness of candidates, and it may summon any licensed engineer to assist in preparing for and in conducting examinations. Fee for examination, $10; for license certificate, $5, and for renewal certificate, $5 annually. Application is made to State Engineer, Secretary, State Board of Engineer Examiners, Denver, Col.

Florida — The board has ruled that examinations may consist of the applicant's sworn statement of professional education and experience in responsible charge of engineering work. If this statement is not complete or qualifying the board may summon the applicant to appear for further examination and may investigate his record of professional service. Examinations may be either oral or partly oral and partly written. Fee for examination, $15; for certificate of registration, $10 additional; for registration without examination, $25, and for renewal of certificate, $5 annually. Application is made to the Secretary, State Board of Engineering Examiners, 215 East Bay St., Jacksonville, Fla

Idaho—Examinations are held semi-annually in the State Capitol, Boise, Idaho, beginning at 9 a.m. the second Tuesday of March and September. Applications must be received ten days before the date of examination. Fee for residents, $10; for non-residents, $25; for renewal, $2 annually. Application for a certificate of registration is made to the Department of Law Enforcement, Boise, Idaho, under oath, in such form and accompanied by such proof of the applicant's fitness to practice as the department may prescribe. The application is made in writing accompanied by an unmounted photograph taken within a year.

Illinois—Structural engineers' examinations include written and oral tests and embrace subjects normally taught in schools of structural engineering. They occupy three days and cover theoretical and applied mechanics, definitions, general engineering knowledge, stress analysis, static and moving loads, design and construction in reinforced concrete, steel, wood, masonry and foundations. Fee for examination, $10; for certificate of registration, $5; for examination to determine prelimnary education, $5; for restoration of an expired certi,cate, $5; for renewal of certificate, $1 annually; for certificate to those who hold a like certificate from another state or country, $15. Application is made upon prescribed blanks to the Department of Registration and Education, Springfield, Ill. [Separate examinations by other boards are required for surveyors and for architects.—EDITOR.]

Iowa—Examinations are as prescribed by the board. Fee for examination, $15; for certificate of registration, $10 additional; for certificate without examination to person registered in another state, $10. Application is made to the State Board of Engineering Examiners, Box 923, Des Moines.

Louisiana — Examinations are required of all who are not graduates of an engineering college or school of good standing. Examination for surveying covers geometry, plane trigonometry, plane surveying and practical use of instruments. For engineering it covers also physics, including practical problems in design and construction. Fee for examination, $25; for registration by diploma, $25; for registration of holder of license from another state, $15; for issuing license certificate, $1; engineering renewal license, $3 annually; surveying renewal license, $1 annually. Application is made to the State Board of Engineering Examiners, Maison Blanche, Building Annex, New Orleans, La.

Michigan—Examinations are required of all who desire to begin the practice of architecture, engineering or surveying as principal or in responsible charge, except those from other states. These examinations include English language and other appropriate subjects. Fee for examination, $5; for certificate of registration, $15 additional; for certificate of registration without examination, $20; for renewal of certificate, $5 every five years. Application is made to the State Board of Examiners for the Registration of Architects, Engineers and Surveyors, 80 Griswold St., Detroit, Mich.

New York — Present practitioners must obtain licenses before May 14, 1922. If evidence presented in the application does not appear to the board to warrant a certificate the applicant may present further evidence, which may include the result of a required examination. Fee for certificate to practice engineering or land surveying, $25; for certificate to practice both engineering and land surveying, $35. Application must be made on a prescribed form to the Regents of the University of the State of New York, Albany, N. Y.

Oregon—Examinations may be either oral or partly oral and partly written. Fee for examinations, $10; for certificate of registration, $5 additional; for certificate of registration without examination, $15. Application is made to the Secretary, State Board of Engineering Examiners, Corbett Building, Portland, Ore.

Virginia — Examinations are required of all applicants except those from other states. They are held at least once each year at Richmond, Va., and at such other places and times as the board may designate. Fee for each exabination, $20. Application is made to the State Board of Examination and Certification of Architects, Professional Engineers and Land Surveyors, Richmond, Va. Registration is optional. Present practitioners are not limited as to the time within which to register.

Wyoming—Examinations are required of all applicants except those licensed under previous acts, and consist of a written examination and an investigation of record, training and experience. Fee for examination, $10; for certificate of license without examination, $5. Application is made to the State Board of Examining Engineers, Cheyenne, Wyo.

Survey of Tennessee River Basin

The United States, in co-operation with the Tennessee River Improvement Association, is conducting a survey of the Tennessee river and its tributaries, the work being conducted by the Corps of Engineers, U. S. Army. This river and its tributaries possess a large aggregate power capacity, the development of which will have a direct bearing on navigation. The survey includes a study of the resources of the basin to determine the influence of water transportation on their development and the amount of tonnage that they might contribute.

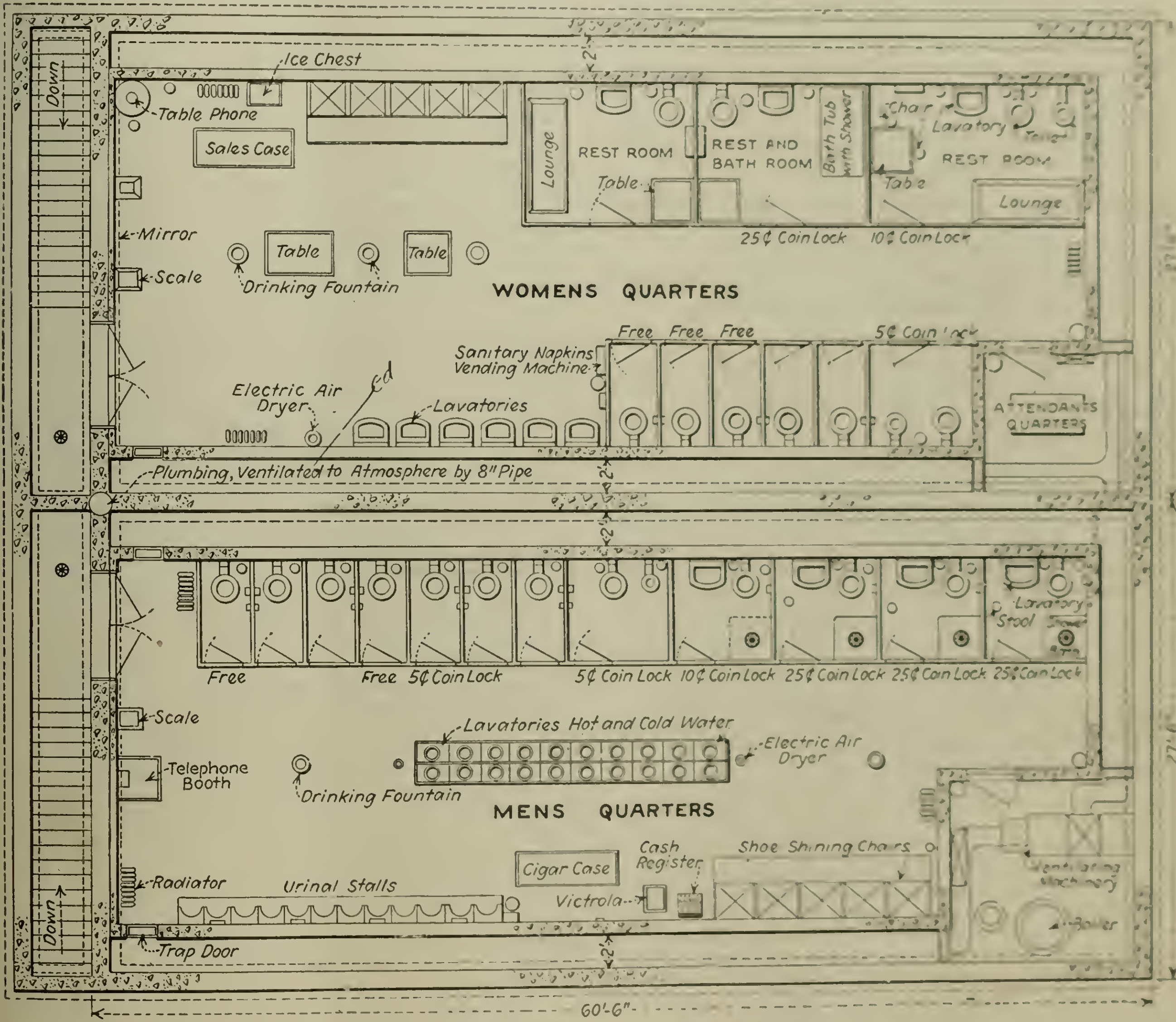
Public Comfort Station with Unusual Equipment

THE new public comfort station at Allentown, Pa., is located under Center Square to avoid renting or purchasing property and affords an unusual variety of accommodation. The structure is 65 x 55 ft., projecting under the sidewalk to provide for stairways with covered entrances. In the women's side are 6 lavatories, 3 free toilet rooms, 3 toilet rooms at 5c., 2 rest rooms at 10c. and one rest room with bath at 25c. In the men's side are 20 lavatories, 12 urinal stalls, 4 free toilet rooms, 5 toilet rooms at 5 and 10c. and 3 toilet rooms with shower baths at 25c. Coin locks are fitted to the doors of the pay rooms.

As it was specially desirable to avoid dampness the excavation was carried 2 ft. outside the walls to facilitate removing the forms and applying the waterproofing. After the footings had been poured the concrete was allowed to set for 2½ days before erecting the forms for the 12-in. walls. For these walls a dense concrete was made with a 1 : 2 : 4 mix having added to it hydrated lime and stone dust in proportions of 10 and 20 per cent of the weight of cement. Trap rock of [illegible] to [illegible]-in. size was used, and the walls are reinforced with wire mesh. After the walls had been poured the plumbing pipes beneath the floor were laid and covered with a 6-in. slab, which was allowed to set for six days before erecting upon it the falsework for the roof forms.

As the two 27-ft. roof spans have to carry heavy trucking, a concrete T-beam and slab construction was adopted, the usual rod reinforcement being supplemented by a layer of steel mesh in the top of the 5-in. slab. This design was about 33 per cent cheaper than an alternative design with steel beams and it reduced the depth of excavation. The outside of the enclosing wall was given a coat of hot pitch and the trench was backfilled with wire mill cinders which were flushed and tamped. Finally the street surface was finished with asphalt paving.

The interior arrangement provides free and pay accommodation for both sexes. Heating is by steam from the mains of a central heating company. For ventilation, foul air is drawn off through registers to conduits leading to an electrically driven exhaust fan, fresh air being admitted through the doors and by registers. All piping is laid in the ventilating con-



PLAN OF COMFORT STATION AT ALLENTOWN, PA.

duit for accessibility, and the plumbing is ventilated to a 20-in. pipe inclosed in an ornamental concrete stack 20 ft. high. White enameled brick is used as the interior finish, with rounded edges at doorways and curved fillets at all corners to permit of thorough cleaning. An unusual feature is the use of electric air-drying devices at the free wash basins. By pressing a pedal a current of warm air is discharged, thus avoiding the use and nuisance of paper towels. Shoe shining stands, telephone booths and other conveniences are provided in both rooms. Two male and two female attendants work in 9-hour shifts from 6 a.m. to midnight.

This public comfort station was designed and constructed under the direction of H. F. Bascom, city engineer. Geo. H. Hardner was the general contractor. The total cost, including all fittings and equipment, was $40,000, half of which was paid by the county and half by the city, the latter raising its share by a bond issue. The station was opened in June, 1920.

Tile Drain Maintenance and Repair on U. S. R. S. Projects

Bedding in Gravel and Laying on Cradles Frequently Only Method of Preventing Settlement in Quicksand

DRAIN tile laid in gravel on the Shoshone Project of the U. S. Reclamation Service, where 85.85 miles have been put down by government forces, stand up well. Breaks have occurred only in quicksand and in every case the tile has settled and some has been broken. Invariably the tile was found filled with material, a hole showed in the backfill above the break and water flowed from the hole. Breaks are expensive to repair, averaging $10 per foot, and a special study has been made so that care in the construction may prevent failure. C. M. Jump, superintendent of irrigation on the Shoshone Project, has an article in the *Reclamation Record* for October giving details of maintenance, and A. R. McGinness, assistant engineer of the Huntley Project, describes in the same issue the method of building closed drains. The following abstract is from these articles:

It has been the practice on the Shoshone Project, wherever the grade of the drain is not in gravel, to use a cradle made of 2 x 4-in. lumber beveled on the edges and spaced so as to bring the support on the tile at the quarter points at an angle of 45 deg. to the horizontal and vertical axes of the tile. Some of these cradles have been used as short as 6 ft. in length, but at present no length shorter than 12 ft. is used. In exceptional cases where the subgrade has been in quicksand piling has been driven and the tile cradles hung in yokes on the piles. This piling has usually been of broken lagging boards.

The generally accepted practice has been to cover the upper five-eighths to three-fourths of the circumference of the tile at the joint with tar paper, thus leaving an opening at the lower portion where water can enter the tile line. As tight a joint as desired is not always obtained even by turning the tile in laying to secure the best possible fit. During construction water and muck often stand more than halfway up the tile.

Often water is forced up through the subgrade, which no doubt aids in forcing material into the tile and, in addition, keeps the subgrade loosened and in an unstable condition. Such conclusions as to the cause of the failures must of necessity be drawn from circumstantial evidence, but they are the result of several years' experience and embody the conclusions of project employees who have been interested in both the construction and maintenance of tile drains.

The problem of preventing such failures must be taken care of in the construction of the drain but there is no uniformity of opinion as to the best method. There is also considerable doubt whether a tile drain can be made a permanent success in quicksand or fine clay except at a cost that would be prohibitive.

Certain conclusions and suggestions may be offered: (1) To construct a tile line in quicksand or fine clay with gravel or to support it on ladders set on piling of sufficient bearing strength may make the cost prohibitive as compared with open-drain construction. To this may be added the doubtful permanency of such construction; (2) a tile line should have no rigid points of support. It should be allowed considerable flexibility so as to adjust itself to the different conditions of support. This is not practicable when drain tile is used. If it were practicable to use sewer pipe in such construction any deviation from a straight line would have a tendency to tighten the joint rather than to open it as is the case with drain tile.

Repair Methods — The general practice on the Shoshone Project in repairing breaks in tile drains is to begin opening the trench below the break where the water is running out of the top of the trench, since it is impossible to start a crib immediately over the break. This work consists of driving solid cribbing in sections 12 to 14 ft. in length, 3 or 4 ft. wide, depending upon the size of tile. In putting down these cribs 6 x 8-in. timbers are used as wales and 2 x 8-in. timbers for lagging or piling. The surface is taken off to a depth where the ground will stand up before the crib is started. The lagging is driven as fast as excavation is made to keep the banks from caving. When the first crib has been put down and the tile has been uncovered the drain is opened by taking out or breaking a tile, in order to lower the water so as to extend the crib over the break. Considerable care has to be used not to fill the down-stream section of tile with mud. In some cases it has been necessary to permit the water to come to the hydraulic gradient of the tile line and wait until the water table has lowered in the fall before the broken line can be relaid.

All this work requires hand labor and is very expensive as it usually takes from ten days to two weeks to open the line. If repairs are to be continued as in the past, instead of using wood piling or lagging, light steel sheet piling would be better and less expensive in the long run, as the timber is practically destroyed.

Trap Boxes — Another important feature in the maintenance of closed drains is the wooden trap boxes, which are beginning to deteriorate to such an extent that it will soon be necessary to repair or replace them. It is a simple matter to repair them temporarily by boarding up on the inside of the 4 x 4-in. posts used as the frame of the structure. This method, however, does not secure satisfactory construction, as the nailing must be relied upon entirely to hold the earth pressure. When decay starts it is usually the nail holes which soften first, so that the danger of collapse would be greater in the repaired structure than in the original construction. The water plane does not usually recede in the fall and show the necessity of repairs until so late in the season that the ground is frozen to such a depth that repairs from the outside would be very costly.

The life of a wooden structure alternately exposed to water and air, which is the condition obtaining in all trap boxes where repairs have been necessary, is 8 to 10 years.

Lining the trap box with a fairly thin concrete wall seems to be the simplest solution. This would support the old timber walls and would protect them from the deteriorating action of air and water. The trap boxes on the Shoshone Project are fairly uniform in dimensions, and it is believed that a collapsible metal form could be designed for this purpose, which, taken with the ease of obtaining materials, would allow an economical and efficient method for this repair, as well as obtaining a permanent structure.

Trap boxes are cleaned in the spring and fall. In the spring there is very little sand in the bottom of the boxes. In the fall, after the heavy run of water, the bottoms of the boxes are full of sand. It is a question whether it is necessary to clean these trap boxes, as there is plenty of room for sand to deposit at the end of drains and there has been no indication of sand lodging in the tile. At the time of constructing the drains it was believed that after a drain had been in operation for a year or so very little sand would get into them. But the drains that were constructed eight years ago are now carrying nearly the amount of sand that they did the year after construction.

Trouble With Drains in Sandy Soil

Construction of drains in quicksand, sandy loam and other material saturated with water is one of the most important features in connection with drainage on the Huntley Project. The first trouble with this class of material was in 1914, in the construction of a drain 6,953 ft. long. The slope where the greater part of the trouble has been experienced is 0.002.

For about 3,000 ft. the top soil was a heavy gumbo, exceedingly hard, but underlaid with quicksand, so that after the trench was opened and sheeted the sand flowed so continuously that it was necessary to remove it with buckets. Thus the banks on either side were undermined and the 6 ft. of gumbo was held in place only by the bracing. These banks usually cracked from 4 to 8 ft. back from the trench and gradually settled down, placing a great pressure on the sheeting and making the work dangerous. After about 3,800 ft. work was suspended temporarily, as the tile had become clogged with sand and it was necessary to go back 1,000 ft. to open it up. In doing the repair work the tile was uncovered at several points and in every instance was found to have settled vertically varying depths. It was then decided that the original plan of construction was at fault, and in the repair work or construction substantial ladders replaced those of lighter design and large quantities of gravel were hauled and placed under and around the tile.

The reconstruction was completed and the entire drain finally built, using what was at that time supposed to be good construction methods. Nevertheless, the drain has always given a great deal of trouble and each year has required the expenditure of considerable sums to keep it in operation. The major portion of the expenditure has been used in repairing breaks where tile settlement has occurred in quicksand or other unstable soil. Even the stiffer clays seem to disintegrate and become unstable, producing the same conditions that obtained in quicksand.

In the construction of a 4,156-ft. drain in 1917-18 4-in. timbers and 1 x 6-in. crossties 6 in. apart were used for the entire length of the drain. Quantities of large rock and gravel were rammed into the subgrade and the tile covered to a depth of 4 or 5 in. with good gravel. Approximately 16 cu.yd. of gravel to the station was used in the worst places.

Drain Lost — The drain gave good results and operated satisfactorily until March, 1919, when two or three breaks occurred in the line owing to tile settlement. These were repaired, and the drain was in successful operation until August, at which time about 1,200 ft. of the drain began to settle and finally became entirely clogged. Some repair work was attempted, but conditions became worse so fast that it was deemed inadvisable to continue.

The settlement seems to occur gradually, and apparently is caused by infiltration of sand from under the tile into the drain whence it is washed into the trap boxes. The first settlement is probably very small, and the tile joint is only slightly opened, but as the variation from grade becomes more pronounced the larger the joint opening becomes, the more rapidly the settlement proceeds. Instances have been noted where this vertical settlement has been as great as 6 ft. and equal to four or five times the diameter of the tile. Trap boxes with bottoms have settled as much as 2 or 3 ft. in some cases.

On the Shoshone Project one such failure occurred five years after construction and another three weeks after construction. In all these cases no special precautions had been taken, such as placing heavy ladders or surrounding the tile with gravel. Wherever failure has occurred in quicksand some broken tile have been found and settlement has taken place. Whether the tile were broken before settlement or after displacement it is hard to determine, though the indications are that they were broken during settlement.

Information from the North Platte Project, where a great deal of trouble with the drains similar to that on the Huntley and Shoshone projects is reported, reveals practically the same class of material with the same conditions obtaining. It has been necessary to construct portions of these drains as many as three times.

The first time some of these drains were built the material was dry. As soon as the ground became wet the tile began to settle out of line and soon the drain became plugged and was put out of commission. The second time these drains were built they were laid on cradles similar to the ones used on the Huntley Project, but no gravel was applied, the cradles simply being laid on a firm base. This method, however, proved unsuccessful, coinciding with experience on the Huntley Project.

The third time these drains were replaced piling was driven to refusal at intervals of 3 or 4 ft. In addition to the cradles and their supports gravel was placed around and especially under the tile. So far there has been no trouble with the lines thus constructed, provided the piles and supporting posts were placed at close enough intervals.

Open Drains a Last Resort

An important condition should be noted on the North Platte Project. It has been found impossible to construct drains through some of these places after the water table has risen 2 or 3 ft. above the grade line, except by building open drag-line ditches and then resorting to all manner of vertical and horizontal sheet piling, providing for upward as well as downward pressure on the tile in order to hold them in place. It follows that this kind of work is seldom done except for every short stretches and when the engineer is driven to it by the utmost necessity. Other- is seldom done except for very short stretches and when the water table is below grade. If such conditions are not obtainable then open drains constitute the only resort.

On the Huntley project, after the water table has once risen to a point where crops are endangered, it seldom recedes below any desirable grade line, therefore for our difficulties open drains would appear to be the solution, but these are impracticable from both a construction and a maintenance standpoint, and also because of the small farm units.

T. W. Macartney, drainage engineer, states that little difficulty has been experienced in Yakima County, Wash., with the drains constructed in quicksand or other mucky material where a sufficient foundation of gravel has been used. The method used is to have the pipe man or tile layer tramp in as much gravel as he can until a firm foundation has been made.

In the cases where extremely soft material was encountered approximately the same system of construction was used as on the Huntley Project; that is, boulders were rammed into place and then surfaced with finer gravel. Cradles were not used to any great extent. The amount of gravel and boulders used varied; in one instance 20 cu.yd. were used to the station. No case of failure or settlement on this work has yet been noted where sufficient gravel was used.

Summarizing the various construction methods noted it appears that cradles alone, cradles with gravel under and around the tile, and cradles supported on piling at too great distances have all proved unreliable in quicksand with the exception of the work at Yakima, Wash., regarding actual conditions of which we have very little information. Balanced against this we have cradles supported at frequent intervals (3 to 4 ft.) and gravel placed around the tile as the only successful method yet developed posi

tively to prevent the tile settling away from the original alignment. This method, however, is so expensive that it can be used only for short distances and in cases of extreme necessity. It would probably be impossible to accomplish this class of work where a trenching machine is doing the excavation.

One method suggested is the use of sewer pipe calked with a good filter material laid on substantial ladders and well blinded in gravel. Another suggestion is to use a wood-stave pipe the lower portion of which is solid and the upper portion perforated with holes and covered with a good filter material which would effectually screen out the minute solid particles, allowing only water to enter the pipe. The problem resolves itself into devising a method of building tile drains in such a manner that the water alone, with all solid material—such as sand, clays, loam, and various other soil ingredients—screened out, will have free access to the tile.

Brick Stack Ripped by Lightning Repaired While in Use

By P. S. Toney

Engineer, Sinclair Refining Co., East Chicago, Ind.

On June 14, lightning struck a stack at the Sinclair Refining Co., East Chicago, Ind., doing considerable damage. The stack is of the radial hollow brick type laid with lime cement mortar and having approximately the following dimensions: Height, 150 ft.; base diameter, 15 ft.; and top diameter, 11 ft. The ladder is inside the stack built up of separate rungs laid in every fourth course of brick. The rungs are made of $\frac{5}{8}$-in. round stock forged into the shape of a U, and with 2-in. hooks bent in the ends to fit down into the hollow tile securing the rungs firmly in place. The stack was erected by the Heine Chimney Co. and was completed in March of this year. It was not protected by lightning rods.

FIG. 1. STACK UNDERGOING REPAIR—NEW BRICK SHOWS EXTENT OF DAMAGE DONE

The lightning struck the top rim of the stack in a number of places, then followed down the ladder, jumping from rung to rung until it reached the breeching, from which point it had a metallic path to the ground. The top ring of the stack, though damaged in several places, was intact, and in no place was the ring broken completely through. This fact, no doubt, was due to the iron band laid in the brick work at that point. The first 50 ft. below the top were badly damaged, a hole varying from 12 to 30 in. being torn completely through the wall. For the following 25 ft. the stack was badly shattered and cracked so that part of it fell later. The remaining 35 ft. of stack, to the breeching, contained three or four cracks gradually reducing to one. A careful examination of the remainder of the stack disclosed no further damage.

A number of methods were proposed for repairing the stack, all of which could be carried out with a minimum shut down of plant. Chief among the methods suggested were the following: Pointing up the cracks and repairing the damaged portions of the brick work and banding; encasing the entire stack in a jacket of concrete properly reinforced and tapering from 8 in. at the bottom to 4 in. at the top using either an adjustable steel form or a cement gun to place the concrete; and, repairing by means of rebuilding and reinforcing the brick immediately about the damaged parts of the brick work, tying it into the uninjured portions with special reinforcing rods. The last method was decided upon as being cheaper, quicker and sightlier.

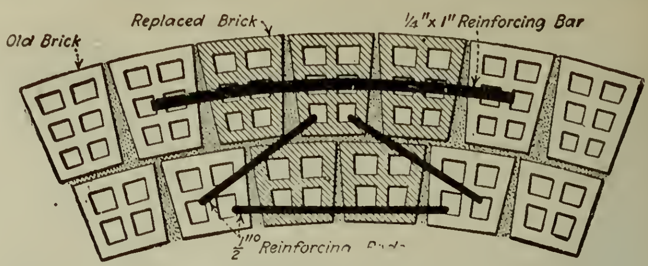


FIG. 2. TYPICAL METHOD OF REINFORCEMENT THROUGH EXTENT OF DAMAGE

As no great amount of material was needed at any one time a very light scaffold was sufficient. It was erected by placing a cable with a turnbuckle around the stack and hooking to this cable the brackets upon which the scaffold boards were laid. The scaffold was raised about 5 ft. at a time. To do this it was necessary only to fasten another cable above the first and with two extra brackets it was possible to raise the scaffold, using the material from the lower to build the upper, the last two brackets being raised from a swing.

Repairing was accomplished at first by reinforcing each fourth course, and increasing this to every course where the damage was greatest, enough brick being removed to allow the placing of the rods. The brick about the crack were replaced so that upon completion the only evidence of the damage was the new brick. Fig. 2 shows how the rods were placed. The rods were made on the job as needed of $\frac{1}{2}$-in. round reinforcing steel, and $\frac{1}{4}$-in. x 1-in. flat steel, each with a $1\frac{1}{2}$-in. hook bent on either end. Great care was used in placing these hooks so that the new portion of the stack was securely anchored to the old on either side, the rods being interlaced and crossed until the outer courses were firmly secured to the inner. The stack was in use for the entire period during which it was being repaired. The contract for the repair work was let to Peter Drolshagen, Chicago.

Column Head Inclosures Insure Safety

Several men were injured recently by falling into unguarded holes in floor forms left for column heads. For the prevention of such accidents the *Travelers Standard*, which is issued by the engineering and inspection division of the Travelers Insurance Co. and the Travelers Indemnity Co. suggests a square inclosure composed of four posts, two sets of rails and a toe-board. When the columns have been poured the inclosures may be transferred to higher levels. In many cases inclosures should be stronger and of a more permanent character. Toe-boards should not be omitted especially when persons working on the lower floor might be struck by objects falling from above.

Letters to the Editor

New Spirit at New York Section Meetings

Sir—Your editorial note on the activities of the Western Society of Engineers in the Nov. 25 issue, p. 1017, prompts a reminder as to the changed atmosphere visible at the meetings of the New York Section of the American Society of Civil Engineers.

The regular meetings of the society in New York used to be a synonym for all that is dull and deadly in technical society meetings. By the careful selection of officers representative of all sections, independent in thought, eminent in the profession, but not blasé, and most willing to devote time and energy to the work, we have secured the long desired result of a live discussion of live topics, crowded and enthusiastic meetings and a real constructive interest by engineers in civic affairs.

It is not, as you point out, a large membership alone that secures this result but intelligent direction and hard work. I venture to hope that the same high purpose displayed in the selection of officers for the New York Section, whose ability and willingness to serve has been so eminently successful, may yet be displayed in the selection of a set of officers for the national body and so avoid a conflict of two opposing tickets whose members have been chosen, rather because they are conservatives or radicals, than because they can and will lead the society out of its present chaos.

F. LAVIS,
Consulting Engineer, American International Corporation.
New York, Nov. 30.

Industrial Situation in France

Sir—The article in the Nov. 4 issue of *Engineering News-Record*, p. 876, entitled "Industrial Situation in France," by an American resident in Paris surely did not receive its proper title. The *raison d'être* of this article seems to appear in the last few paragraphs in which your correspondent gives light to his real thoughts. Furthermore, your correspondent did not have the courage to sign his name, evidently believing that with the rather sweeping statements that he makes, it would be best to keep under cover. This gentleman sees the straw in his brother's eye, but is serenely unconscious of any obstruction that is plainly affecting his own vision.

Gratitude and square deal? He should look up Webster and find out the meaning of these words. He is out of patience because Frenchy refuses to see things in the same color as he does and declines to accept blindly the well meant and conflicting advice of his friends. Frenchy is too individualistic; he listens respectfully to suggestions, but persists in rebuilding his house according to his own ideas; he believes that the rest of the world, particularly America, should pay the greatest part of his war losses; he refuses to tax himself; he discriminates against American goods; he is ungrateful, etc. Why did the gentleman stop there. Everybody is familiar with the propaganda carried on here for a generation back. Frenchy is immoral; he is fussy and excitable; he is degenerating; he is uncapable of doing serious work—all of which has been proven by the war.

Can the French really be expected to feel grateful? The war was fought out in his front yard and after it was over, the battling armies, Doughboys, Tommies, Fritz and others returned to their own unscathed firesides, but the Poilu remained amidst his ruins to mourn his two million dead. Naturally he expected his comrade in arms, who certainly did not fight for the love of the French alone, to stand by a bit and lend a hand. The world knows what help he received. Now some of his fighting partners are even trying to deprive him of the indemnity that he has a right to expect from the despoilers of his land.

The help the world is giving France may be compared to helping a neighbor when his house is afire in order to save ours next door, and after the danger is over tell him he should feel very grateful to us for our help—that since the cellar walls are still standing he can live in the cellar quite nicely with his family and that when he is ready to rebuild we will furnish the plans and loan him the money on his notes at 70 per cent discount. With the franc worth but 30 cents on the dollar, can we really blame the French for trying to restrict trade with us to the minimum? And this is not all. With the purchasing value of the dollar but 30 or 40 per cent of the pre-war basis, what can Frenchy buy in America with his depreciated currency? Whether he wants to trade or not, he can't buy very much on such basis. France has great cause for provocation. Her chief partners feeling themselves secured and after depriving her of the very things she considered essential for her own safety and peace, are leaving her to battle alone.

Great Britain is already forgetting her murdered sailors and is getting back to old traditions of placing trade above everything. She is willing to sacrifice the future for immediate gain. She will follow her old policy of setting up rival interests on the continent of Europe ready to supply the balance of power against the most aggressive one, be it German, French or Russian. No wonder the French are sore.

We, at least, can say without fear of contradiction, that we have no axe to grind in Europe. Our only interest is to see that justice is done, but why have we placed Britain's interest above everything else. Only Mr. Wilson, of course, can answer that. Nevertheless, the French cannot but wonder why. The burden of taxes in France is five times higher than before the war—a greater increase than both in the United States and Great Britain. This certainly does not agree with your correspondent's statement.

Regarding his grievance about French individualism: French workmen have voted to work nine hours in place of eight. We certainly need some of this kind of individualism in this country.

Your correspondent did not seem to worry himself about stating facts. However, he probably said what he wanted to say, but his article would sound better dated from Berlin instead of Paris.

GEORGE P. THOMAS,
President Thomas Spacing Machine Co.
Pittsburgh, Nov. 19.

Rail Improvement and Inspection

Sir—I have read with great interest your editorial in your issue of Nov. 18, p. 969, on "Successful Prophecy and the Future of Rail Quality," and as the quality of steel rails is a matter of such grave importance from every point of view I am glad that you have given it the prominence which an editorial article in your journal is sure to have, but I cannot agree with you in all your premises and deductions.

There is no question as to the improvement which has been made in the quality of steel rails during late years. In consequence of the increased weight and speed of the traffic which the rails have to bear a harder metal became a necessity, and as the element which, under existing knowledge, would give hardness without carrying with it dangerous brittleness is carbon, and as the element of phosphorus gives absolutely opposite effect, it became imperative that a lower phosphorus content steel would have to be used, and as the chemical character of the available ore supply of the country precluded the use of low phosphorus ores the basic openhearth process became a necessity. In other words, we have been enabled to produce a metal on a commercial basis by the use of that process which would have been impractical by the bessemer process. At the same time the basic openhearth as well as all other metallurgical processes has peculiarities of its own, which must be recognized and practiced upon such recognition to produce satisfactory results. The largest bessemer heat of steel was limited to about 15 tons, while, as is well known, the openhearth heats in many cases run as heavy as 100 tons. Therefore, a bad heat of bessemer was not as serious a matter as an unsatisfactory heat of openhearth steel.

You are quite right in your assumption that in most instances the unsatisfactory rails are what may be desig-

nated as sporadic and seldom apply to the general character of a large lot of rails. There is another fact, that these unsatisfactory rails can be, as a rule, traced to individual ingots of a heat. In other words, because some of the rails from individual ingots gave bad results it does not follow that the rails from the other ingots of the same heat should prove equally unsatisfactory.

I think it is well known how strongly I have for years taken the position that each ingot should be regarded as an individual factor, and it is of the greatest importance that all ingots should be sound castings, and that the only certain way to detect the character of the rails produced from each ingot is to make physical tests representing the product from each ingot, and that if such testing cannot be carried to so great a degree it should come as near it as is commercially practical.

The rationale of the whole proposition is that the operation in the openhearth furnace should be intelligently and properly conducted; then that the metal should be properly recarburized and deoxidized; then that the ingots should be cast sound; that they should be handled in a proper manner until their outer skins have been firmly set; that their subsequent treatment in the soaking pits should be intelligently conducted, following which, that the rolling process should be one of intelligence and care, this covering the reductions and manner of reductions of the ingot into the rolled rail of the desired section; that the sawing of the ends should be carefully executed and the manipulation or handling of the steel upon the hot beds should be carefully done, and if the rails are to be cold straightened under existing presses that the rails should go to them from the hot beds in a condition requiring the minimum of that practice; and finally that the ends of the rails should be finished square, and this can only be done by milling them.

You say, "we cannot safeguard ourselves against a return to the more dangerous rails of ten years ago merely by pleading with the producers to be careful! We must translate our request into terms of procedure to be followed, properties desired, or tests to be met. This may become possible when the steel men reveal the secret of their campaign for rail improvement." And you have previously stated in your article, "Nor is more careful inspection a probable factor. It seems necessary to conclude that the improvement was brought about in part, if not wholly, by persistent effort of the steel-mill men themselves."

You will permit me to say that in my judgment there is no secret or mystery surrounding the production of good rails, as it is well known that the careful observation of certain procedures will inevitably result in their production. It may be undetermined as to exactly what deviation from such good practice will result in certain defects, but, as stated, the fact is that if none of those deviations are permitted the "mysterious" defects will not occur.

Reverting to your assumption that more careful inspection has not been a probable factor in the improvement of rails, I would beg to differ with you, which difference, I believe, is borne out by my own experience. Julius Kruttschnitt, then director of maintenance and operations of the Harriman Lines, and John D. Isaacs, consulting engineer of the same large system, were not satisfied with the results they were obtaining from their rails and became convinced that a more thorough and comprehensive inspection than had yet prevailed would be a desirable procedure, and as my firm were inspecting under the then accepted practice all the rails which they purchased they consulted with me as to the practicability of establishing a more thorough system of inspection, and expressed their willingness to meet the greater expense which would be inevitably incident to such a procedure.

I was convinced as to the practicability of the more thorough and complete inspection scheme, and we arranged that we should establish it for them, but almost immediately folllowing my interview with them, when this agreement was reached, I was enabled to lay the matter before the late William A. Gardner, then president of the Chicago and Northwestern Ry. Co., and Daniel Willard, president of the Baltimore & Ohic R.R., with the result that both of those gentlemen expressed their willingness, and in fact pleasure, of joining in my scheme. With that additional support, my firm saw their way clear to inaugurate what has since been known as "Special Inspection" at all the rail millls of the United States and Canada, feeling confident that we would receive the support of a large number of our other clients, and, therefore, the "Special Inspection" was established for the rails produced in 1912, and it has been, as anticipated, adopted by nearly all of our patrons, with the result that since that time we have covered by that system about 8,000,000 tons of rails produced in the various rail mills of the United States and Canada. That at least encouraging results have been obtained, we refer to the published statistics of the American Railway Engineering Association, of which, as you know, Mr. Wickhorst is the engineer of tests of the rail committee.

From the association's reports of failed rails for the period ending Oct. 31, 1918, it was shown that there were 18,641 track-miles of rails covered by the "Special Inspection" method, and the total number of failures amounted to 35.6 per 100 track-miles. On the remaining 24,090 miles reported and on which "Special Inspection" was not performed, there were 51.9 per 100 track-miles of failures shown. Based on these figures it would seem that the application of "Special Inspection" had resulted in a saving of, roughly, 30 per cent in the number of failures, which results certainly would seem to controvert your assumption that more careful inspection was not a probable factor in any improvement which had taken place.

As playing an important part in the satisfactory results obtained from "Special Inspection," I am fully convinced that the personal responsibility which it established among the mill operations has been a large factor. As is well known, all the skilled workmen are paid by the ton of production, and therefore the more produced the larger their pay, and under the old procedure, as there was no means of personal identification attached to the product, it naturally led to the absence of the feeling of personal responsibility. On the other hand, under the procedure of "Special Inspection" every rail carries with it a means of analyzing its history from the time the steel leaves the openhearth furnace until it is loaded upon the cars for shipment, and means of identifying the actual workmen in the several departments who took part in the manufacture of that rail. The existence of this condition has led to a realization by the men of personal responsibility, and naturally a personal pride in the result of their work; and instead of causing trouble in the operation of the works, as at first was feared it might, it has produced exactly the opposite effect, as no one can be held responsible for another man's careless work.

You undoubtedly are quite right in your feeling that the stress of the war time, attended as it was by a slackening in the demand for steel rails, had an effect of diverting the attention of the steel-mill engineers to other and for the moment more important steel products, but as the railways have, under existing conditions, again become purchasers of rails, and, thank Providence, the war demands have ceased, I feel confident that the improvement in the character of rails produced will continue, but not so much through the discovery of new things as the avoidance of those things already known, and surely the prominence given to the matter by such articles as yours will help to bring about the desired results.

ROBERT W. HUNT,
Chicago, Nov. 26. Robert W. Hunt & Co., Engineers.

[Our editorial remark "Nor is more careful inspection a probable factor" was meant to apply to new ways of determining the quality of rails or checking up their uniformity. The not very appropriate term "careful" obviously invites protest in the sense of Mr. Hunt's comments, and his demonstration of the large influence exerted by the psychological factor in inspection contributes a valuable element to public knowledge of the rail problem. Does it not also tend to support our suggestion that the recorded improvement in rails during the past half-dozen years "was brought about in part by the persistent effort of the steel-mill men themselves"?

Though the point is perhaps only incidental to Mr. Hunt's argument, his statement that the unsatisfactory rails can be

traced to individual ingots of a heat is so important that we believe it should be tested critically and as soon as possible either proved or disproved. If the ingot is at fault then the heat is not at fault, and uncertainty as to where to look for the sore spots in present practice is greatly narrowed. But a good bit of circumstantial evidence that bad rails run in heats has already been put on record, and, as our editorial undertook to show, the purely statistical evidence points the same way. On the basis of this evidence ingot practice would be a secondary though possibly a necessary factor. The problem would be greatly simplified if the particular question here involved could be decided at the earliest possible moment.—EDITOR.]

United States Should Be a Member of International Road Congress

Sir—The First International Road Congress was held in Paris in 1908. At this congress the Permanent International Association of Road Congresses was formed with headquarters in Paris. The second congress was held in Brussels in 1910.

The third international road congress was held in London in 1913, at which time there were 3,793 members of the association. The business sessions occupied about one week and were devoted to a thorough discussion of the subject matter of 123 reports pertaining to the 19 topics on the program. During the final business session, progressive conclusions relative to each topic were adopted.

The government of the United States is the only world power not a member of the association.

The international commission of the Permanent International Association of Road Congresses, at its meeting held in Paris, June 21, 1920, unanimously voted to accept an invitation to hold the fourth congress in the United States in 1922, provided an invitation from the United States government is received by the executive committee of the association before Jan. 1, 1921. If an invitation is not received from the United States on or before Dec. 31, 1920, the invitation from the Italian government will be accepted.

As a regulation of the association stipulates that an international congress cannot be held in a country whose government is not a permanent member of the association, it will be necessary for the United States Congress during December, 1920, to pass an appropriation which will provide for the annual subsidy of the United States as a government member of the association and which will enable the Secretary of State to extend an official invitation to the association to hold the fourth congress in the United States in 1922.

The object of the association is to promote progress in the improvement of highways and the efficiency of highway transport throughout the world. The work of the association consists in organizing international road congresses, publishing reports, papers, proceedings and other documents and collecting information relative to highway improvement and highway transportation. The membership of the association consists of representatives of governments, delegates of corporations and individual or private members. Each government has the right to one representative for each 1,000 francs of its total annual subsidy, provided, however, that the number of representatives from any one government does not exceed fifteen.

Individual or private members pay annual dues of 10 francs, or compound for a life subscription by the payment of one sum of 125 francs. Due to the current rate of foreign exchange, it is practicable for Americans to become life members by the payment of the subscription of 125 francs through the medium of a bank draft, which will cost, at the present time, between $9.50 and $10. Life membership dues should not be sent by an international postal money order, as an order for 125 francs will cost approximately $25. Bank drafts should be made payable to the Permanent International Association of Road Congresses and be sent to Professor Paul LeGavrian, general secretary, Permanent International Association of Road Congresses, 1 Avenue d'Iena, Paris, France.

Individual members receive, free of charge, all of the publications of the association. The reports and proceedings of the third congress measure, when stacked, about 6½ x 9½ in. by 8 in. in height. Members also receive the bulletin of the association. All the literature sent to American members is printed in English.

The international association should be supported by Americans who wish to see the science and art of highway improvement and highway transport rapidly develop throughout the world, who believe in an international medium for the exchange of opinions and conclusions, and who wish to be well informed relative to progress in highway engineering and transportation in foreign countries. Americans should not be satisfied with joining the association as individual members. Although every courtesy was extended to the United States members of the association at Paris, Brussells and London, nevertheless every American who has attended an international road congress has wished to apologize because his Government was not a permanent member of the association.

Considering the phenomenal development of highway improvement and highway transport in the United States, and the active part which the United States Government is taking in highway construction through the medium of the Federal-Aid Act, it requires no elaborate arguments to demonstrate the advisability of the United States Government becoming a permanent member of the association. The status of the United States as a leading world power demands that its annual subsidy should be the maximum allowed by the constitution of the association, that is, 15,000 francs, which will provide for fifteen representatives of the United States on the permanent international commission. It is the duty of every American who wishes to support the work of the international association and to have an international road congress held in the United States in 1922 to write to his representative in Congress, where it is hoped the necessary bills will soon be introduced, urging them to vote favorably on an appropriation to provide for the annual subsidy of the United States as a government member of the Permanent International Association of Road Congresses.

ARTHUR H. BLANCHARD,
Professor of Highway Engineering,
University of Michigan.

Ann Arbor, Mich.

Engineers and the Law

Sir—At a recent meeting of the Boston chapter of the American Association of Engineers, Thornton P. Alexander, attorney for the Boston & Maine R.R. and past major in the construction division of the United States Army during the war, spoke on the topic "As the Lawyer Sees the Engineer." Both the lawyer and the engineer, in order to properly serve their clients, must study their problems analytically and construct synthetically the framework of data upon which they form their judgments. But whereas the lawyer deals with laws which are variable and unsettled the laws of engineering are founded in nature itself and are steady and unshaken. Each must be careful to employ thoroughness of research and to use soundness of judgment.

Mr. Alexander then went on to say that many engineers neglect the fact of the existence of law and see that their projects line up with the principles of law. Thus many troubles have arisen through neglect to investigate what laws are on the statute books regarding navigable waters. Upon receiving a contract for a bridge over a stream or a wharf extending into the waterway the engineer may proceed to design the structure without investigating what kinds of bridges or wharves are restricted by law or what the laws have to say about such construction. Even though the stream may be small it may be called "navigable" on the statute books. He must obtain a license by the state or the government, or have his plans approved by the government, or he may be forced to pull out his structure after it is built.

Regarding contracts Mr. Alexander mentioned the fact that care must be taken in drawing them up, they must be clear and definite. there must be no loop holes through

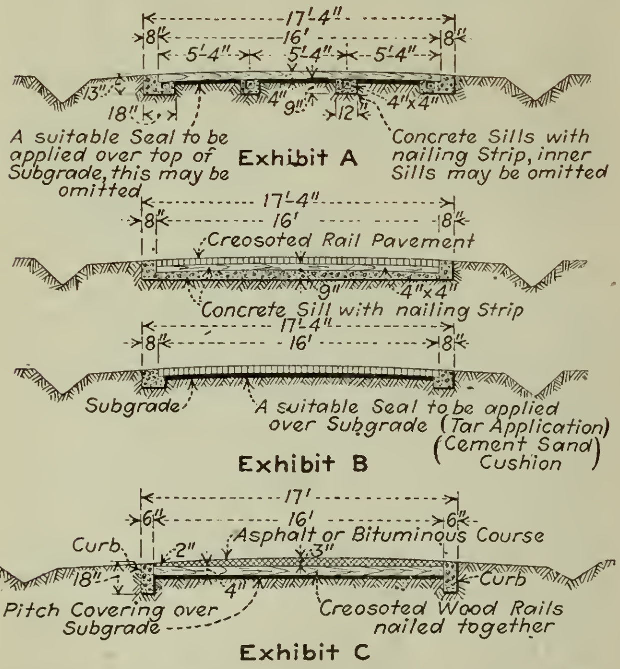
which unscrupulous subcontractors or workers can crawl. Care must be taken also to see that the construction agreement is clear and definite, and that all plans and specifications are correct, for if trouble results from the use of these he is responsible. The engineer must also see that the object of the project is not against the law, as work which is done on unlawful projects need not be paid for.

Touching upon the part that engineers take on the witness stand he stated that they must be fully prepared through training and experience and careful study to make proper statements and decisions, that they must present the case openly and fairly but not too zealously, and they must speak without conceit. L. B. COREY.

Stoneham, Mass., Nov. 27.

Proposes Creosoted Rail Pavement for Long Life Under Traffic

Gentlemen—The accompanying sketches show a proposed creosoted rail pavement. Exhibit *A* is the lateral rail system, showing timbers laid at right angles to the center line of the road supported by longitudinal concrete sills imbedded in the subgrade, with nailing strips, as shown. The nails are toe-nailed into the nailing strips and the rails to each other. The nailing system is designed to develop beam sections of sufficient strength to carry the various pavement stresses. The strips will be edge grain, and there could be an argument advanced that the pavement would not stand the wear, but the writer truly believes that if an asphalt filler is applied, forming a coating over the wood surface which would keep the wood from wearing, that a high-class pavement would be developed. Depression to a great



THREE CROSS-SECTIONS OF PROPOSED RAIL PAVEMENT —EXHIBIT *A*, RAILS LAID LATERALLY; EXHIBIT *B*, RAILS LAID LONGITUDINALLY; EXHIBIT *C*, ASPHALT TOPPNG USED

extent would be eliminated. No doubt there would be a certain resiliency in the pavement which would mean easy riding for the motorist. Exhibit *B* shows the rails laid longitudinally. It has an advantage over exhibit *A*, in that the rails will take the roadway crown.

The writer also contends that a pavement developed by nailing creosoted lumber together to form a base, for instance, laid on a cement-sand cushion with an asphalt applied over the top as shown in exhibit *C*, would result in a permanent pavement of long life. It is well at this time when enormous sums are being expended to improve highways, to investigate and calculate if some different designs in pavements will not carry the heavy loading to better advantage than those now in standard practice.

The cost of the creosoted rail type of pavement will run somewhat high for the various types which are shown. Taking exhibit *B*, and omitting the roadway edging, but retaining the lateral sills with nailing strips, an approximate cost per sq.yd. is as follows:

Lumber (including nailing strips in concrete sills)	$3.83
Concrete (1 : 2½ : 5) sills	.40
Asphalt filler	.25
Nails	.08
Laying	.10
Fine grading	.08
Bond and insurance	.03
Incidentals	.10
Overhead	.10
Actual cost	$4.97
Profit	.50
Cost with 10 per cent profit	$5.47

According to the present prices of pavements this cost is not prohibitive.

It occurred to me that a concrete slab in place of the wood surfacing, using the concrete sills as abutments or slab supports, might work out very nicely. You could place the reinforcing in tension and figure your steel area and slab thickness. This will give a definite way to know the loadings a highway or street will carry. EARL A. SMITH,

Dayton, Ohio, Sept. 16. President, Smith-Foster Co.

Why Reservoir Stations Are Not Used in New York Subways

Sir—Your recent articles on subway stations [Oct. 28 and Nov. 4, pp. 824 and 894] are very well presented, and the reference to "reservoir stations" was of particular interest. Had stations of this character been introduced at a few of the important points of the dual subway the capacity of the subway would have been increased 50 per cent with comparatively little increase of cost. The Brooklyn Bridge formerly operated with an arrangement of this kind and had a loading capacity through the station of 60,000 passengers per hour—on a single-track railroad, using trains of only five cars. This was well known as the greatest passenger traffic in the world for a single-track line, and its operation was studied by all transportation engineers.

A "facing-point switch" has been mentioned as an objection and a source of possible danger in applying the reservoir station to subway operation, but as a matter of fact there is no "facing-point switch" in the usual acceptance of that term and from which dangerous operation arises. Every switch, when used, has facing points and this one is no different from others, but it is merely a switch leading into a station, is not used at high speed (in fact, high speed is not used in the subways), and there would be no loss of subway capacity if this switch were used under a controlled limit of speed. A "facing-point switch" on the main line of a railroad, where express trains travel at 60 miles per hour or faster, becomes a danger because, if misplaced, the train will not take the switch, but will be derailed and overthrown. Such would not be the condition here.

While the original proposal to introduce these stations into subway practice was merely an adaptation of the principle so successfully used for years on the Brooklyn Bridge, its adoption was approved by Bion J. Arnold of Chicago, who gave the station the name of "reservoir station," which very aptly and correctly describes its function in railroad operation. The first plans of the Triborough Subway had reservoir stations at 42d St., 86th St. and elsewhere. A member of the lay Public Service Commission raised the question of "facing-point switches," however, and by ruling out the reservoir stations reduced the capacity of the subway 30 per cent, increased the cost from $116,000,000 to $119,000,000, and the commission and its chief engineer parted company, if I remember correctly.

HENRY B. SEAMAN,

New York City, Nov. 10. Consulting Engineer.

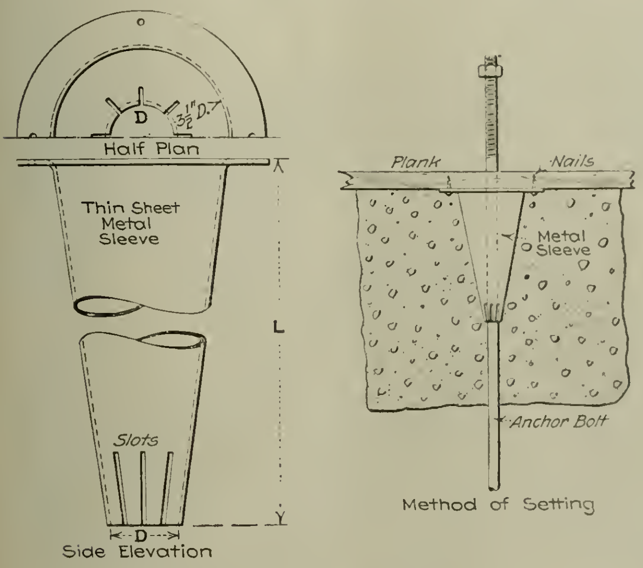
HINTS FOR THE CONTRACTOR

Device for Setting Anchor Bolts

BY JOHN H. SAWKINS
Schenectady, N. Y.

A CHEAP means for the accurate setting of anchor bolts in concrete foundations is provided by the metal sleeve shown in the accompanying drawing. This simple device consists of a thin metal cone provided with a lip at the larger end so that it may be nailed to planking fixed at the upper level of the concrete, as shown. The lower end of the cone is slotted to provide a close fit with various diameters of bolts, the diameter *D* ranging from $\frac{3}{8}$ to 2 in. The length, *L*, ranges from 6 to 24 in. the longer lengths being used for the heavier bolts.

After the concrete has set the sleeve is easily removed



SLEEVE FOR ANCHOR BOLTS

and if care is exercised the same sleeve may be used several times. The $3\frac{1}{2}$-in. diameter at the top allows the bolt to be accurately centered by bending it slightly. The space around the bolt may afterwards be filled with grout. This device has been used successfully by the Grounds and Buildings Department of the General Electric Co., Schenectady, N. Y.

Be Careful or Lose Your Job!

That "safety first" is a condition in holding a job and that accidents due to carelessness of workmen or foremen will lead to the discharge of those responsible is the keynote of a safety bulletin issued by Fred T. Ley & Co., contractors, Springfield, Mass., and signed by C. C. Clough, superintendent. After pointing out that carelessness, incompetency and negligence are the causes of 99 per cent of the accidents on construction work, Mr. Clough's circular says:

"In the future any employee on the job injured through his own carelessness need expect no consideration in prolonging his stay on the job.

"Foremen will be held strictly responsible for accidents occurring to men in their charge. Any accident due to negligence of a foreman will materially affect the length of his stay on this job. Watch your step. Look out below. Pull those nails. Cover that shaft. Don't bunch on that scaffold."

Stumps Pulled and Piled by Gin Poles

BY JACOB L. CRANE, JR.
With Gannett, Seelye & Fleming, Inc., Harrisburg, Pa.

RAPID progress in clearing the 30-acre site of an earth fill dam for the Girard Water Co., near Ringtown, Pa., was effected by an improved gin-pole rig. Two types of horse operated stump pullers were used at first, but even with the aid of dynamite to loosen the roots the process was slow and expensive, as was also that of dragging out the stumps by horses after the use of dynamite. This latter process required from 16 to 20 horses to loosen the stumps and 4 to 6 horses to drag and pile the stumps for burning.

To expedite the work a gin pole arrangement was devised, a 30-ft. pole being erected and guyed to four stumps, with a double-drum engine braced against it and having $\frac{5}{8}$-in. cables led through two pulleys at the top of the pole, as shown in the accompanying view. These pulleys are mounted in hangers which stand out horizontally for long reaches, the working radius of the cables being about 440 ft. When the stumps are loosened by dynamite they are easily dragged out of the ground and up to the pole, incidentally loosening and clearing away the surface vegetable matter. They are piled to the height of the pulleys, which are then detached, a new pole being cut for each pile of stumps.

A crew of eleven men with two mules averaged 50 stumps per hour, pulled and piled for burning. Besides the foreman (who did the blasting), an engineman and a fireman, there were four men and a mule to each cable; one man drove the mule to haul out the cable, two men fastened it to the stump, which they trimmed and notched if necessary, and one man detached the cable at the pile. The work was done at greater speed

GIN-POLE RIG FOR HANDLING STUMPS

than by the old method and at less cost, even including hoist rental, repairs and fuel. This scheme was devised by Thomas Kelshaw, superintendent of the Girard Water Co., who has direct charge of the construction of the dam and is building it on force account for the company. James Archbald is general manager. Gannett, Seelye & Fleming, Harrisburg, Pa., are the engineers for this work.

Dragline Excavates Pits for Bridge Foundations

By Chas. H. Paul
Assistant Chief Engineer, Miami Conservency District

INSTEAD of enclosing the pier foundation in separate pile cofferdams in building the Black Street Bridge at Hamilton, Ohio, large pits were scooped out by dragline excavator and the banks built up to hold back the water. One of these pits, as is indicated by the illustration, was excavated large enough to include the foundations of two piers.

The Black Street Bridge is a seven-span concrete arch structure being built across the Miami River by the Miami Conservency District. Construction of the piers has been by force account and the superstructure may be built in the same manner or by contract as will later on be decided.

In place of a steel sheet pile cofferdam for each foundation, which is the common practice in this valley, we scooped out a hole with the dragline machine, pumped it out without any difficulty (although most of the pier foundations are 15 to 20 ft. below water surface), hung the leads from the end of the boom and drove the foundation piles, and for the first two piers before the cableway was erected used the dragline also for placing the concrete. This particular view shows the excavation for two piers, the first and second out from the west bank of the river. In this case it worked out best to excavate *both at once*, and to throw the whole river out of the way beyond the next pier. The pile foundation for one of these piers has been driven and the form work is being started. The other pier will be located in the foreground close to the toe of the slope of the excavation.

This view is taken from one of the cableway towers and therefore does not give a proper idea of the depth of the excavation. The pier foundation where the piles are driven is about 15 ft. below river surface, and the one toward the foreground will be within 3 or 4 ft. of that depth. The cableway is being used for handling the form material, etc. and for placing the concrete. The concrete mixing plant is just in front of the head tower, which is visible in the distance.

PIT EXCAVATED BY DRAGLINE FOR TWO ADJACENT BRIDGE PIERS

The work is under the direct charge of C. H. Eiffert, division engineer; W. T. Rains, general superintendent, and W. A. Roush, superintendent on concrete.

Charring Posts of No Value

Service tests made by the Forest Products Laboratory on fences whose posts were charred at the lower end to prevent decay, in comparison with fences having untreated posts, showed that the charred posts were if anything less durable than the uncharred posts. It is concluded by the laboratory that charring is of little value in protecting the butts of fence posts and telephone poles from decay. One reason for the conclusion, apart from the test results, is that the charring is unlikely to reach to the bottom of season checks and similar depressions in the surface of the wood.

NEWS OF THE WEEK

New York, December 9, 1920

Seven Further Amendments Before Civil Engineers

New proposals to amend the constitution of the American Society of Civil Engineers have just been placed before the membership for discussion at the annual meeting, Jan. 19. Two of these proposals relate to officers and nomination, one to the selection and function of the secretary, one to local sections, one to local sections and an annual conference, one to officers, nominations and local sections, and one to public relations and personal welfare.

Revision of Kansas Water Laws

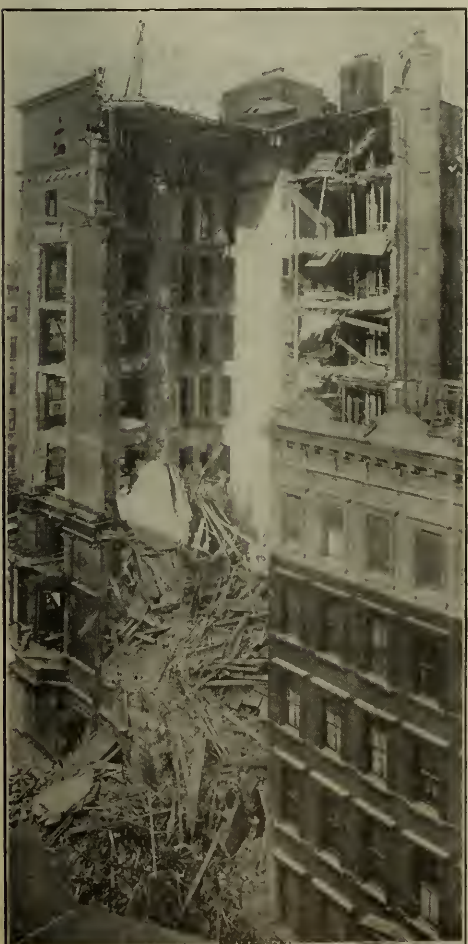
A state congress to discuss changes in state legislation on floods, drainage, water power, irrigation and navigation, as recommended by the Kansas Water Commission in its second biennial report, has been called by Governor H. J. Allen to meet at Topeka on Dec. 15. Representatives of cities, counties and drainage districts as well as "all others who are interested in the subject" are invited to attend.

Part of Old Nine-Story Building Collapses During Reconstruction

Weak Rear Wall of New York Apartment Crushes—Difficult Underpinning of Front Walls Believed Not Involved

Sudden collapse of a 30 x 30-ft. section of the nine-story Strathmore apartment house at the northeast corner of 52nd St. and Broadway, New York City, on Dec. 1, caused the death of one workman, injured about a dozen persons, and blocked a number of important arteries of traffic for a time. The accident occurred in the course of extensive reconstruction operations, which were to convert the lower stories of the building for commercial use by the placing of steel columns to support the major part of the front walls and interior of the building. The collapse affected one corner of the rear portion of the building, where the difficult and delicate underpinning work preparatory to setting these columns was not being carried on. So far as determined up to the present the accident was not caused by or connected with this underpinning. Failure of half of the rear wall of the building by crushing or "buckling" is responsible for the failure, in the opinion of the building authorities of the city.

The Strathmore building measures about 70 ft. on the Broadway and 62 ft. on the 52nd St. sides. It consists of brick walls and wood joist floors, and was built in the early '80's. Numerous changes in the structure were made at several subsequent dates, the most extensive being the insertion of steel floor girders in the first and second floors along the two street fronts, and columns to replace many of the brick walls at these girders. The floors were of decidedly unusual construction,



STRATHMORE RUINS FROM SOUTHEAST AND SOUTH (BROADWAY AT LEFT)—FAILURE ATTRIBUTED TO WEAKNESS OF WALL AT RIGHT

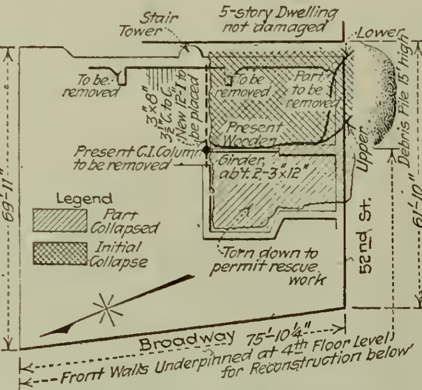
consisting largely of 3 x 8-in. joists set nearly solid (3½ in. on centers), and in part of 3 x 8's 5 in. on centers. In the easterly part of the building, where the collapse occurred, these joists ran east and west, spanning about 18 ft. from interior wall and girder supports to the east wall of the building, where they rested on a corbel course of the brick wall, their ends barely entering the wall. The brickwork generally, except for portions involved in the subsequent alterations, was laid up in lime mortar. However, in spite of some cracking that developed during an alteration eight years ago, the structure appears to have been in satisfactory condition and was generally described by the building authorities as "a substantial structure of massive character."

In order to convert the building to more modern business use, its reconstruction by placing columns in the first story and rearranging the interior was recently begun by the lessees, Walter J. Salmon & Co., of New York City, under plans drawn by their architect, J. Kleinberger, and carried out by the Paul Chapman Construction Co. In the conduct of the work the wall piers on Broadway and 52nd St., the west and south sides of the building, were needled at the fourth-floor level by double sets of I-beam needles, one about 2 ft. above the other, between which were inserted blocking girders parallel to the wall on the inside and outside. The portion of wall between the sets of needles being then cut out, wall girders were being inserted, preparatory to placing columns below. While this work and reconstruction of some interior partitions were in progress, about 1:30 p.m., Dec. 1, the two south panels at the east wall of the building and the entire north half of the east wall collapsed without prior warning. The failure was sufficiently gradual that several persons in an automobile salesroom occupying the floor at the corner managed to escape. Only a few workmen were in the building, but only one was caught in the collapse and killed. Several hours later some loose sections of wall and floor were pulled down, and these carried other parts with them, about doubling the failure area.

In the collapse section all floors, the entire south half of the east wall, and the east half of the south wall, and an interior bearing partition parallel to the east wall and carrying the inner end of the span of joists bearing on this wall, are down, from second-floor level to roof. The two exterior walls involved in the collapse are cut off along fairly vertical lines through window openings. The remainder of the structure does not appear to be seriously disturbed.

According to eye witnesses and F. C. Kuehnle, chief inspector of the Bureau of Buildings, the seat of the failure was at the east wall, which failed, possibly from some local overloading. Mr. Kuehnle believes that this wall buckled near the third-floor level. The reconstruction plans provided for cutting out some fireplace brickwork integral with this wall, in the southeast corner of the building and at a point about 20 ft. north of here, but it is not known whether this work was in progress at the time. The wall piers at these points carried a number of smoke flues. It is claimed that some shoring and other material had been piled near the east wall shortly before the failure, increasing the load on the wall.

An interior wooden girder, a double header-beam apparently of two 3 x 12 timbers, carrying the westerly end of the span of joists resting on the east



STRUCTURAL ELEMENTS IN STRATHMORE COLLAPSE

wall, and shown in the plan sketch, is broken off at its seat on the cast-iron column supporting its north end, at each floor. This is believed to have been broken down by the second collapse. The early appearance of the wreckage indicated a movement toward the east side of the building, and the later fall moved partly to the south, but only a very small amount of débris fell outside the lines of the building itself. East of the building and separated from it by a narrow court 4 or 5 ft. wide is a five-story brick dwelling house of ordinary type. This structure apparently was not injured by the collapse, although the lower portion of the court is filled up to the height of the second-story level. On the south side the débris mainly occupied the north half of the street.

Fuller investigation of the case is in progress in charge of officials of the Building Department and of the District Attorney's office. No statement of fact or cause was obtainable from the contractors.

Dr. Tudsbery to Retire

The early retirement of Dr. J. H. T. Tudsbery as secretary of the Institution of Civil Engineers (London) has been announced, with the fuller statement that it has been decided that his successor must be a corporate member of the Institution. Dr. Tudsbery, whose portrait was published in *Engineering News-Record*, Nov. 4, p. 901, has been secretary since 1896 and has had much to do with the growth of the Institution and its work.

German Industries Receive Foreign Orders for Equipment

The German-Chilean firm Saavedra Benard representing the Maschinenfabrik Augsburg-Nurnberg A. G. has closed a contract with the Chilean Government for eight electric cranes of 3 tons capacity each and fourteen of 1½ tons capacity, which are intended for use in the harbor of Valparaiso. The purchase price is 1,200,000 gold pesos. This is the first large Government order from Chile since the war. The Norddeutsche Seekabelwerk Noordam has received an order from the Dutch Government for cables for the Dutch Indies, which will keep the works fully employed for several months.

Another order for electric cables from the Swiss Government has been placed with Siemens & Halske. This order, amounting to 2,500,000 francs, has been given for immediate delivery. Siemens & Halske had the cables ready for the German - Telegraph Administration, which, however, withdrew from the contract in favor of the export to Switzerland. The same company received a large order for electric machinery for Chinese mines, railroads and industrial establishments. This order has been secured in competition with American, English and French manufacturers, which have been considerably underbid by Siemens & Halske.

The A. E. G. electric company has received an order from the North of England for electric material amounting to £200,000. Another English order has been given to the Orenstein & Koppel A. G. for mine equipment and narrow gage railroads, and to the Linke Hoffman-Werke, one of the largest railway-car building works in Germany, for special purpose machinery.

The German ship-building industry is nearly to half of the manufacturing capacity employed with foreign orders. The shipbuilding works of Schichau have lately received an order for three cargo steamers equipped with turbines, which are the first of their kind to be built in Germany. The reduction of speed between the turbine shaft and the screw shaft is done by a gear which is patented to Schichau. The ships have a tonnage of 7,300, the turbines having 1,600 hp. each. Two steamers of the same type have been ordered by a shipping firm in Finland.

Health Conference Organized

A "health conference," to include health officials in cities of 100,000 and more, was organized during the recent health and housing conference held at Detroit. Dr. Royal S. Copeland, health commissioner, New York City, was made chairman and Dr. Henry F. Vaughan, health officer of Detroit, was made secretary. Dr. Vaughan is an engineer. The first meeting of the new organization will be held in New York City, October, 1921, in connection with the meeting of the American Public Health Association.

Oppose Plan for Destroying High Bridge

Civil Engineers Discuss Means of Saving Historic Structure Now Obstacle to Navigation

Active discussion of the War Department's demand that High Bridge, carrying the first Croton aqueduct over the Harlem River into New York City, be removed as an obstacle to navigation, and various subsequent projects for reconstructing the bridge with larger channel openings, marked the meeting of the American Society of Civil Engineers in New York Dec. 1.

Nelson P. Lewis, chief engineer of the city's Board of Estimate and Apportionment; Colonel Edward Burr, district engineer of the War Department; Colonel Merritt H. Smith, chief engineer of the Department of Water Supply; and A. W. Brunner, representing the American Institute of Architects, and Colonel W. J. Wilgus speaking for the Institute of Consulting Engineers, were the formal speakers. With the exception of Colonel Burr, who outlined the case as to navigation, all urged the retention of the bridge.

In discussion J. O. Eckersley defended the position taken by the city's Department of Plant and Structures, which has prepared a reconstruction plan objected to by others as unworthy of the structure and has recommended demolition as most advisable in the city's interests. Prof. Alexander Haring aggresively championed the claims of Bronx Borough interests for unrestricted navigation in the Harlem River and asked complete removal of the bridge in the channel width. T. Kennard Thomson and Philip Aylett also spoke, the latter presenting a detailed study of salient points in European masonry arch design.

Mr. Lewis outlined the ten-year old movement for clearing the Harlem River of obstructions to navigation, and the city's postponement of action on High Bridge, whose piers, stepping out below water, leave only a 44-ft. width of opening at 5-ft. depth. Colonel Burr stated that the War Department has refrained from pressing the city to a decision, but will not proceed with Harlem River improvements until the channel at High Bridge is clear. Colonel Smith asserted that the bridge will, after some years, be necessary to supplement the water-carrying capacity of the Croton and Catskill aqueduct tunnels. Mr. Brunner spoke of the high esthetic rank of the old bridge, and stated that New York has only a few structures worth saving for their artistic value, the City Hall and High Bridge being prominent among these. Colonel Wilgus argued the engineering and architectural excellence of the design prepared by a joint committee of architects' and engineers' societies, described in *Engineering News-Record* of July 29, p. 229, and presented verification of his cost estimate in the form of an estimate by Lincoln Bush of about $900,000. He emphasized, also, the utilitarian value of the structure as a traffic link between Manhattan and the Bronx.

Mr. Eckersley referred to the War Department's order and claimed that the girder design of the Department of Plant and Structures is the only project meeting the terms of that order. The cost of the committee design was estimated by two independent contractors at more than $1,300,000 as against a net cost of $500,000 for removing the bridge. The difference, it was stated, will provide a better water conduit across the Harlem, which can be built when needed. Professor Haring demanded vertical clearance for ocean-going ships, and forecast the development of the Harlem River as an important navigation channel between the Hudson River and Long Island Sound, which will be used by foreign Shipping.

At the close of the discussion, on motion by Colonel Wilgus, it was voted the sense of the meeting that High Bridge be preserved, and that copies of the resolution be forwarded to the Board of Estimate, before which the question is pending.

China Asks Bids on Huge Bridge

Bids are asked by the Ministry of Communications of China on the construction of a heavy modern railway bridge nearly two miles long. It is to replace the present Hwang-ho or Yellow River bridge of the Peking-Hankow Ry., a structure 9,875 ft. long. The existing bridge, fabricated partly in Belgium and partly in France, has both through-truss and deck girder spans, supported on screw piling, and is only 11 ft. above water. Its capacity is stated as about equivalent to Cooper's E 35 loading, while the new bridge is to be capable of carrying E 50. The above facts are given by Julean Arnold, U. S. Commercial Attaché at Peking, in a cablegram of Nov. 27. A copy of the specifications is expected in Washington within a short time. The cost of the proposed work will probably range from $15,000,000 to $20,000,000.

Ontario Buys Out Private Electric Power Interests

Private electric power interests in Ontario are eliminated by the purchase made on Dec. 1, by the Hydro-electric Power Commission of Ontario, of the properties of the Toronto Power Co., the Toronto & York Radial Co. and the Schomberg & Aurora Ry. Co. The purchase price was $32,734,000, financed by an exchange of bond issues.

The three companies purchased control the electrical power and distribution developments commonly known as the Mackenzie interests. With the purchase the Hydro-electric Power Commission becomes one of the largest power generating and distributing organizations in the world and represents perhaps the most ambitious undertaking in public ownership of electrical service. The total capacity of the generating plants will exceed one million horsepower

Spring Value Property Valued at $37,000,000

California Railroad Commission Fixes Price Which Will Be Voted on at Election in February

After investigations extending over nine months the Railroad Commission of California has placed a valuation of $37,000,000 on the properties of the Spring Valley Water Co., which it is proposed should be acquired by the city of San Francisco. The valuation was undertaken last March at the request of city authorities who at that time agreed to submit to the voters a proposition for purchase by the city at the price fixed by the commission. The Spring Valley Co. also agreed to submit to its stockholders a proposition to sell to the city at the price fixed by the commission. It is now planned to hold a special election in February at which time the people will vote on the proposed purchase.

In announcing the valuation determined upon the commission states: "We have before us our engineering department's inventory of the property and the estimate of costs to reproduce the properties desired by the city. This estimate was not based on present 1920 prices for structures and plants, but on average prices for a six-year period from 1914 to 1920, a time which is considered a reasonable construction period for the property. We have also approached the problem from another angle; beginning with the figures agreed to by the city and by the company in 1914 (at which time a proposition to purchase the system was defeated at popular election) we have proceeded on the assumption that the price agreed upon for the property then under consideration would today still be a fair price for the same property after additional accrued depreciation is allowed for. To the then agreed figure we have added the actual cost of additional property since put in the public service by the company, and have deducted property that since has been retired or gone out of existence."

Quick Decision Urged

With reference to the wisdom of the purchase the commission says: "if the Spring Valley system is to be acquired by the city at all it should be acquired now. In our opinion the city has already delayed too long in making this purchase and the failure of the bond issue in 1914 has meant a very considerable loss to the city through inadequate water development, having in mind the future development of San Francisco and its continued growth. There is no escape from the conclusion that the present supply of water for the city of San Francisco is dangerously near the point of insufficiency. Immediate steps to increase the supply should be taken. The water supply can be increased only in two ways: either by the city doing its own development in the immediate future or by creating conditions where the Spring Valley

Water Co. can be put in a position to proceed with such development. In view of existing conditions it is not to be expected that the company is ready or able to raise the necessary new capital for construction and extensions and the city cannot afford to wait for an improvement of the urgent present water situation until the completion of the Hetch Hetchy system.

"With efficient operation and under reasonable water rates the purchase of the Spring Valley system will carry itself. It may be assumed that the Calaveras dam will be completed in the case of the purchase of the system by the city. The completion of the Calaveras reservoir will make available an additional supply of water sufficient to take care of the present urgent needs of the city. It is estimated that this addition will be sufficient to meet the demands of the city until the completion of the Hetch Hetchy system and supply the needs of a population in excess of 700,000."

New York City Begins Operation of Some Street Railways

Municipal operation of 28 cars on that portion of the electric street railways of Richmond Borough, New York City, known as the Midland lines, was begun on Dec. 2. The company owning the lines shut them down last January because it could not get an increase of fares above 5c. The city will charge a nickel a ride.

Wireless Telephone Service Established in California

For several months the Pacific Telephone & Telegraph Co. has operated a wireless telephone service between the mainland and Catalina Island, 27 miles off the southern California shore. This service is so connected with the company's system that any subscriber can use it after placing a call with the long distance operator just as he would for any other connection beyond city limits. When "connections" are established the voice is heard as clearly as over the ordinary wire service.

At first the radio communication was carried on by the usual single wave method, which could be picked up and understood at any radio receiving station. It therefore became a popular diversion, particularly among amateurs, to "listen in" on the commercial messages between Los Angeles and Avalon. This was deemed a drawback to the service and means were devised whereby the communication is now carried on over double wave which can be read only on special receiving apparatus.

The application of long range telephony in the radio field was used recently in a twofold manner when a telephone conversation was carried on between the Catalina Island station and a steamer on the Atlantic Ocean 4,100 miles away. For this message the voice vibrations were successfully carried by radio both before and after traversing the transcontinental telephone line.

New Public Works Bill Merits Support, Says Leighton

The following supplementary statement concerning the new McCormick bill providing for a National Department of Public Works, as outlined in the news section of last week's issue, p. 1107, has been prepared, at this journal's request, by Marshall O. Leighton, Chairman of the National Public Works Department Association, Washington, D. C.

"The underlying principle of the McCormick bill and the Jones-Reavis bill is that the engineering and public works functions should be grouped in one department, but that no attempt should be made in initial legislation to effect consolidations and rearrangements; that this is a task which cannot be accomplished wisely until the several bureaus and agencies have been brought together, placed under observation, and subsequent co-ordinations made as a result of that observation and of actual experience. The only exception to this is in the case of the Corps of Engineers, which obviously cannot be transferred bodily out of the War Department, and therefore some other expedient will be required.

"The McCormick bill includes a number of transfers to the Department of Public Works which the framers of the Jones-Reavis bill thought it wise to postpone. The important new feature in the McCormick bill is the provision for a Department of Public Welfare, which includes health, education, war insurance, and other similar functions. We anticipate much opposition to this, especially on the part of the National Education Association, because that organization and its supporters are insisting on a separate Department of Education. There will also be considerable opposition in Congress arising from the antagonism to the creation of additional Cabinet offices. If the creation of a Department of Public Works must wait upon the creation of a Department of Public Welfare it will undoubtedly mean some delay as to the former, but it is hoped that inasmuch as the case for the Department of Public Works is well prepared the joint committee of Congress, to be created under the Smoot-Reavis resolution, will push forward the public works department feature.

"Even if this does not occur, the merit of the McCormick proposal will be so obvious to all those who advocate the efficient conduct of governmental business that the McCormick measure must command support notwithstanding possible delay in the enactment of the public works law.

"I am not informed as to any agreement or understanding between Senator McCormick and the supporters in Congress of the Jones-Reavis bill, but it is fair to assume that inasmuch as both are attempting to achieve the same result there will be no difficulty in arriving at some satisfactory legislative arrangement."

Transport Committees of Federal Highway Council To Meet

The three transportation committees of the Federal Highway Council are to hold a meeting Dec. 10 in the east ballroom of the Hotel Commodore, New York City. The meeting will convene at 10 a.m. The three committees which have prepared pertinent discussions of problems within their respective fields are the committee on relation of highways to railroads and waterways, the committee on study of rural motor express, and the committtee on study of highway transport functions of state highway departments.

Chicago Settles with Strauss for Infringing Bridge Patent

Final settlement of a long drawn-out patent suit (filed March 11, 1913) in Chicago over a bascule bridge patent was concluded Nov. 19 when payment of $348,500 was made to the Strauss Bascule Bridge Co. by the city for infringing U. S. Patent 995,813, issued June 20, 1911, in ten bridges constructed or to be constructed. J. B. Strauss summarizes the case as follows:

"The Strauss patent in question relates to a method of supporting the bascule leaves which eliminates the interference of the inside trunnion supports with the movement of the tail end of the leaf or the counterweight, and thus does away with the costly means otherwise necessary to meet this difficulty. The testimony showed that this is a vital fundamental of design and not an incident of minor detail; that it embraces a new type of bascule truss which permits a cross-girder to be passed through it without limiting its full opening, on which the trunnions are mounted, allowing necessary room for the large volume required for a low-cost counterweight such for example as concrete. The *large-volume low-cost counterweight* was one of the chief underlying aims and objects of the Strauss construction. It was first applied in service in the Strauss through-trunnion supporting-girder bascule bridge of the Wheeling & Lake Erie R.R. at Cleveland, built in 1904. The truss construction with the through-trunnion supporting girder and large bulk counterweight was employed by the city of Chicago for the first time in the Washington St. bridge, completed about 1913 (the bridge named in the infringement suit).

All the proceedings were in the Federal courts. Testimony was taken before a Master in Chancery. The final decision was rendered in the U. S. Circuit Court of Appeals, which affirmed the decree of the lower court. During the accounting before the Master to ascertain amount due the bridge company, negotiations were opened looking toward a settlement. A tentative figure of $527,095 was arrived at. This amount is equivalent to 7¾ per cent of the cost of the superstructure of thirteen bridges, ten of which were completed or

under construction and three designed. In the final negotiations an investigation was made for a sub-committee of the finance committee of the city council by Parkinson & Lane, patent lawyers, J. H. Prior, consulting engineer, and a committee of the Western Society of Engineers, but nothing of sufficient value was developed to warrant a reopening of the case. The finance committee of the council upon receiving this report continued the settlement negotiations, finally arriving (in July, 1920) at the $348,500 figure for ten bridges instead of the original thirteen. The other three, which had proceeded no further than the design, were included in the injunctive order granted by the court.

For Distinction Between Steel and Wrought-Iron Pipe

A resolution accepting the terms employed by the American Society for Testing Materials for differentiating steel from wrought iron pipe was adopted by the executive committee and advisory board of the National Pipe & Supplies Association at its meeting in New York City on Nov. 11. The terms thus adopted are "welded wrought iron pipe" and "welded steel pipe." The manufacturers of welded wrought iron pipe urge that wrought iron should be applied only to "pipe which is made from genuine puddled wrought iron" and steel only to "pipe made of soft Bersemer or open-hearth steel."

Standards Committee Elects Officers for 1921

At the annual meeting of the American Engineering Standards Committee held in New York on December 4, A. A. Stevenson (American Society for Testing Materials), was re-elected chairman for 1921, and George C. Stone (American Institute of Mining and Metallurgical Engineers), was re-elected vice-chairman. The following were elected to the executive committee: C. A. Adams, American Institute of Electrical Engineers; M. Schreiber, American Society of Civil Engineers; F. E. Rogers, American Society of Mechanical Engineers; A. H. Moore, Electrical Manufacturers Council; D. Pierce, Fire Protection Group; A. C. Morrison, Gas Group; N. A. Carle, National Electric Light Association; A. W. Whitney, National Safety Council; C. F. Clarkson, Society of Automotive Engineers; T. H. MacDonald, Department of Agriculture; E. B. Rosa, Department of Commerce; O. P. Hood, Department of Interior; F. J. Cleary, Navy Department; J. H. Rice, War Department.

Four new organizations have recently joined the standards committee. These are the Department of Agriculture, the Department of the Interior, the American Electric Railway Association, and the Gas Group, the latter comprising the American Gas Association, the Compressed Gas Manufacturers Association, and the International Acetylene Association. There are now 17 member organizations joined in the committee, three of which are groups; the total number of individual organizations represented is 24. The committee consists of 47 representatives of these bodies.

Notes from Corps of Engineers

Lieut.-Col. Paul S. Bond has been detailed for duty as inspector-instructor, Engineer Corps, New York National Guard. His headquarters will be in New York City.

Major Ernest Graves has been ordered to appear before a retiring board because of physical disability.

Major James G. Steese, president of the Board of Road Commissioners for Alaska, has been ordered to Washington for temporary duty in connection with the estimates of the work to be done on Alaskan roads during the next fiscal year.

The Chief of Engineers, U. S. Army, has re-established the third New York Engineer District. This district will comprise, among other things, the defensive works at both the eastern and southern entrances of New York harbor. Col. E. E. Winslow has been placed in charge. Col. Winslow has been Corps area engineer for the Second Corps with headquarters at Governors Island.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Washington, D. C., Dec. 13-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City, Jan. 19-20, 1921.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. 25-27.

ENGINEERING INSTITUTE OF CANADA, Montreal; Toronto, Feb. 1-3.

The Providence Engineering Society sponsored a meeting at Brown University, Nov. 16 at which John R. Freeman, consulting engineer, delivered an address describing his recent mission to China to advise the engineers of that country on the improvement of the Grand Canal.

The Nashville Engineering Association, at its meeting Nov. 22, was addressed by Ross W. Harris, consulting engineer, who discussed traffic conditions in Memphis, Tenn.

The Detroit Engineering Society announces the following meetings: Dec. 17, "Acoustics of Large Guns" by Dayton C. Miller; Jan. 21, "American Forestry Situation" by Dr. Filbert Roth.

The Engineers' Club of Dayton, at its meeting Dec. 7, was addressed by E. J. Mehren, editor of *Engineering News-Record*, on "An Engineer's Observations in Europe."

The Cleveland Engineering Society, at its noonday meeting, Dec. 17, will be addressed by Garret A. Bremer on "Art in Industry." At its evening meeting, Dec. 14, "Personal Impressions of the European Iron and Steel Industry" will be given by Arthur G. McKee.

The Rochester Engineering Society, at its Dec. 14 luncheon meeting, will be addressed by H. L. Fairchild, formerly professor of geology, University of Rochester, on "Some Mechanical Problems of the Earth's Crust."

Personal Notes

HARRY C. ANDREWS, formerly resident engineer, Boone County, W. Va., highway department, is now assistant engineer, department of public roads, Raleigh County, W. Va.

F. N. CRONHOLM, formerly general superintendent of the river division, Imperial Irrigation District, has been promoted to general manager of all operations of the district in the United States and Mexico.

HENRY ARTHUR BRAZIER, city engineer, London, Ont., Canada, has sailed for England to investigate the activated-sludge process of sewage disposal.

HOWARD K. IHRIG, formerly chief draughtsman, engineering works department, Dravo Contracting Co., Pittsburgh, Pa., is now in charge of the engineering department of the Heltzel Steel Form & Iron Co., Warren, Ohio.

H. W. COLEMAN, formerly chemical warfare officer on the staff of the commanding general, Second Division, U. S. Army, Camp Travis, Tex., has been appointed superintendent of the water and sewer department, Greenville, Miss.

JAMES W. CHEEVER, formerly a superintendent with the Thompson-Starrett Co., has taken a position with Dwight P. Robinson & Co. as superintendent on the construction of a large power station at Seward, Pa., for the Penn Public Service Corp., Johnstown, Pa.

LAWRENCE W. ROBERT, JR., president of Robert & Co., textile engineers and architects, Atlanta, Ga., has been appointed consulting engineer for all of the textile development projects to be carried on in the United States by Dunlop American, Ltd., the U. S.

organization of the Dunlop Rubber Co., Birmingham, England. This company will construct cotton mills representing an investment of $25,000,000.

O. K. PECK has resigned as assistant bridge engineer, Louisville & Nashville R.R. to accept the position of bridge engineer, Detroit, Toledo & Ironton R.R.

T. J. BIVENS, formerly division engineer, Union Pacific R.R. at Omaha, Neb., has been transferred to Marysville, Kan., as division engineer.

C. C. HAWKEN, formerly instrumentman, has been promoted to assistant engineer, Missouri Pacific R.R., with headquarters at Joplin, Mo.

C. P. HUFFMAN, instrumentman, Eastern Division, Missouri Pacific R.R., Sedalia, Mo., has been promoted to assistant engineer, Omaha Division, with headquarters at Falls City, Neb.

G. W. PAYNE, formerly instrumentman, Arkansas Division, Missouri Pacific R.R., has been appointed assistant engineer, Memphis Division.

HAROLD M. LEWIS, for several years connected with the office of Charles W. Leavitt, landscape engineer, has become a member of the firm of Gibson & Lewis, consulting engineers and entomologists, Washington, D. C. Mr. Lewis spent several months with Dr. Karl Imhoff in Germany in 1914 in the study of Imhoff tanks.

THOMAS W. LESAGE, for thirty-three years in the service of the City of Montreal, and recently consulting engineer to the waterworks department, has resigned, effective Jan. 1, 1921.

W. A. KINGSLAND, assistant general manager, Eastern Lines, Canadian National Rys., has been appointed general manager, with headquarters at Toronto.

L. S. BROWN, superintendent, Canadian National Rys. at Moncton, N. B., Canada, has been appointed assistant general manager of Eastern Lines, with headquarters at Montreal.

R. C. VAUGHN, formerly assistant to the president, has been appointed vice-president, Canadian National Rys., Toronto, Ont., Canada.

OBITUARY

HAROLD TAIT, engineer of sewers, Borough of Queens, New York City, died Nov. 29. He was born in Metuchen, N. J., in 1868 and was graduated from Rutgers College, 1887.

JAMES J. REYNOLDS, consulting railroad engineer, died Nov. 28 in Chicago. At the time of his death he was consultant for the Elgin, Joilet & Eastern Ry. With John Ericson, city engineer, and E. C. Shankland, he was the third engineer on a commission which handled the design and construction of the Chicago municipal pier. Twenty years ago as engineer for the New York Central he built the Chicago, Illinois and Southern R. R.

LIONEL HENRY PEABODY, JR., civil engineer, who was at two different periods in the employ of the Rhode Island State Highway Department, died Nov. 15 at Shawomet, R. I. He was born in Middletown, R. I., in 1878, and was graduated from Brown University, 1903. In 1907 he became associated with O. Perry Sarle on general engineering and problems connected with hydraulics and river and harbor work. In 1916 he took a position in the Rhode Island State Highway Department.

JAMES E. EGAN, member of the firm of Egan, Field & Nowak, civil engineers and surveyors, died Nov. 10 at Minneapolis, Minn. He was 63 years old and a resident of Minneapolis for 40 years. He was a school teacher in early days and then surveyor for Hennepin County for about 4 years. Since 1897 he had been in engineering practice with private firms.

GEORGE S. RICE, formerly chief engineer of the Rapid Transit Commission, which built the first New York City subways, died in Montclair, N. J., Dec. 7, after an illness of several months. He was born in Boston in 1849 and was graduated from Harvard University in 1870. His professional experience, which included a number of years' service as deputy chief engineer of the Croton Aqueduct Commission, New York City, and as chief engineer of the Boston Rapid Transit Commission, will be treated in further detail in next week's issue.

BUSINESS NOTES

WILLIAM H. TAYLOR has resigned as president and general manager of the Iron Age Publishing Co. and has been succeeded by Fritz J. Frank, a publisher of long experience, who has been with the company since 1910.

THE TOLEDO CRANE CO., main office and works Bucyrus, Ohio, will on Jan. 1921, succeed The Toledo Bridge & Crane Co. of Toledo, Ohio, as builders of Toledo cranes. W. F. Billingsley, for the past eleven years with the crane department for the latter company, will be active in the management of the new company.

SCOVELL, WELLINGTON & CO., accountants and engineers, announce that J. Chester Crandell, F. Richmond Fletcher, William A. Schich, Jr., Harold S. Morse, and Horace G. Crockett, who have been associated with this company for many years, have become partners in the firm. Messrs. Fletcher and Crockett will continue to direct the engineering work.

THE J. F. COLEMAN ENGINEERING CO., New Orleans, has been selected by the Board of Commissioners of the Port of New Orleans to serve in an engineering capacity.

FAIRBANKS, MORSE & CO., Chicago, have purchased the business of the Luster Machine Shop & Railway Equipment Co., Philadelphia, and will open a new branch in Philadelphia under the management of D. W. Dunn.

THE BLAW-KNOX CO., Pittsburgh, has established a new sales district in the South with headquarters at Birmingham, Ala. Prescott V. Kelly, formerly connected with the executive sales department at Pittsburgh, is in charge of the office.

THE PORTLAND CEMENT ASSOCIATION announces the opening of a Canadian office in the Birks Building, Vancouver, B. C., in charge of A. E. Foreman as district engineer.

THE AMERICAN WOOD PIPE CO., Tacoma, Wash., manufacturer of wire wound and continuous stave wood pipe, has opened a Chicago office with A. J. Berger, district manager, in charge.

THE NASHVILLE INDUSTRIAL CORP., composed of business men of Nashville, Tenn., has purchased from the U. S. Government the Old Hickory Powder plant at Jacksonville, Tenn. The purpose is to develop the plant into a large manufacturing center.

ROBERT H. MCKINLEY, formerly sales engineer H. Y. Smith Company, Wilwaukee, Wis., has accepted a position as manager and highway engineer for the Indiana Paving Brick Manufacturers' Association, Indianapolis, Ind.

THE CHICAGO PNEUMATIC TOOL CO. announces the removal of its rock drill plant from 864 East 72nd St., Cleveland, Ohio, to the company's Boyer pneumatic hammer plant at 1301 Second Blvd., Detroit, Mich. The location of the company's little giant air drill plant at 1241 East 49th St., Cleveland, remains unchanged.

HUGO V. HERTTING CO., INC., Dempsey Building, Manitowoc, Wis., general contractors for industrial plants, have opened an engineering department to handle all classes of engineering work.

THOMAS CRIMMINS CONTRACTING CO. announces the removal of its New York office to the Crimmins Building, 126 East 59th St.

T. TOWLES & CO, railroad and highway contractors, announce the removal of its general office from Princeton, W. Va., to the Boyce Building, Charleston, W. Va.

THE PROSPECT CONSTRUCTION CO., INC., has opened offices in Philadelphia, Pa., to engage in general architectural, contracting and engineering work.

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—James H. McGraw, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

Volume 85 — NEW YORK, THURSDAY, DECEMBER 16, 1920 — Number 25

Co-ordinated National Transport

NEED FOR more effective co-ordination of the national transportation system to bring the various means of carriage into their greatest usefulness was strikingly brought out in the addresses last week at the transportation session of the American Society of Mechanical Engineers' annual meeting. The program was remarkable for agreement in this fundamental need, so difficult of accomplishment, and the papers presented were of such high quality as to warrant unqualified commendation of the society's enterprise in arranging for them. Abstracts of some of the papers appear elsewhere in this issue, but for lack of space those of the other two will not appear until next week. They are deserving of a thoughtful reading.

Highway "Service"

COMMON sense in highway engineering is epitomized in the article on page 1187 by A. R. Hirst, state highway engineer of Wisconsin. A highway department, it is contended, exists to give transportation service. This is accomplished by building a large mileage of permanent grade, temporarily surfaced, and not a limited mileage of main route brought to high standard by paving. It keeps in mind that improvement is subordinate always to the carrying of traffic. These are the fundamental ideas in an article filled with thought-provoking statements. They represent the trend of practice in the Mississippi Valley states, where great mileages of trunk-line road remain to be permanently graded and provided with drainage structures. "Transportation service," in a phrase, is the highway doctrine of the Middle West. The fact deserves emphasis because it represents a change from the earlier hard-pavement doctrine borrowed from practice in the East where, to a large extent, there remained in the way of improvements only the perfection of permanent grade by hard surfacing.

Service and Road Widths

GRAVEL roads are given high rank by Mr. Hirst as economic highways. Here again he voices a growing conviction of highway engineers in the Middle West. Particularly does he voice the germinating thought that the economic service of a gravel road is greater or less in almost direct proportion to its width. Specifically, if a gravel roadway 16 ft. wide has a serviceable life of three or five years, then 10 ft. added to this width will increase its serviceable life to six or ten years. These figures are not definite; they merely express the comparison which it is sought to emphasize. Moreover this comparison does not hold true, nor is any broad assertion of the worth of gravel roads quite true unless there is continuous maintenance. Wherever gravel roads are giving notable service good maintenance is as much the reason as is good construction.

Unsightly Concrete Surfaces

IN ordinary commercial concrete construction is there any prospect of being able to make exposed surfaces of permanently good appearance without finishing treatment? Considerable economy should result from a successful answer to the question, since it would make possible a large reduction of the use of brick and tile facings now used solely to conceal unsightly concrete surfaces. It would also make it possible to avoid the distressing appearance of concrete structures on which such veneering has been omitted for reasons of economy. On bridges and important structures the exposed surfaces are often given special finishing treatment by washing, grouting and rubbing in order to secure a satisfactory appearance, but the effect thus obtained is sometimes of short life, being soon marred by the characteristic patches and streaks of discoloration. Painting is seldom employed and rarely successful. Cracks in the concrete have not been considered in the foregoing remarks, but in spite of reinforcement there is a frequent occurrence of such defects, which may be of little or no structural significance but are seriously detrimental to the appearance. There is an open field for developing concrete construction that can honestly show its own face without causing pain because of its unsightliness.

Articles for the "Average Engineer"

FOLLOWING the precedent set in the July 22 number of this journal, another "Average Engineer Issue" is herewith presented. Its aim is to give to engineers and contractors engaged in the non-spectacular but important work of the small organization details of field and office practice which will be helpful to them. The term "average engineer" is employed only for want of something better and is not susceptible of any precise definition. He may be the city engineer of some small town, chief of party on a topographical survey, a waterworks superintendent, a county highway engineer, a designer on a structural engineer's staff or a construction superintendent. He may be "going it alone" or be the non-commissioned officer intermediary between the commanding officer—a chief engineer or contractor—and the rank and file on the job or in the office. The interests of the readers of the *Engineering News-Record* are extremely varied. This fact the editors realize and the effort is made to balance the material in each issue, apportioning space to articles on the large as well as on the small project. After the appearance of the first "average engineer" issue last summer, however, letters were received from so many readers endorsing the idea that it was decided to repeat the experiment. The range of articles this week is wide, covering such topics as useful "dodges" in surveying, good and bad practice in making bituminous patches in highways, the checking of drawings, estimating small sewer jobs and the use of

special slide rules in valuation work. It is hoped that from the dozen articles presented this week the "average engineer" will secure information or suggestions of practical use in the day's work.

Our National Parks

THE rapid increase in the use of our National Parks is gratifying. The increase is partly due to the commendable work done by the National Park Service to make the park facilities known. A recent instance of such publicity is a press bulletin outlining the extent to which a number of the National Parks can be readily used and enjoyed in winter—some for distinctly winter sports. The National Parks have a special appeal to outdoor men like engineers; and many engineers, in their travels about the country, have or could readily make opportunities to visit them. Comparatively few people know what national parks exist and how to reach them. Information can be had from the National Park Service for the asking, besides which there are now some four or five books giving handsomely illustrated descriptions of our national parks and monuments.

Gravel Roads

HIGHWAY administration in Maine includes at least two practices which may well be studied by states whose programs do not call for extensive construction of high-type pavements, but whose highway systems demand general improvement. These two practices, fully discussed on page 1177, concern the construction of plain gravel highways and the maintenance of surface-treated gravel. Specifications to be found in most highway handbooks and, in fact, adopted by various state highway departments, which call for the bonding with clay of the top course of plain gravel roads, have been replaced in Maine by those that require the top course to be of the cleanest gravel. Instead of rolling, consolidation of the surface is skillfully avoided. In fact, a loose, or "live," surface course is deemed necessary for success. In surface treatment the economic distribution of bitumen has become an art. "Put the bituminous material only where it is needed" is an old maxim in Maine's maintenance.

Need for Engineering Publicity

INNUENDO and quoted surmises in regard to the works of the engineer may cause a distrust that is entirely unwarranted. One of the latest attacks of this kind is upon the water supply of Duluth. Several newspaper editorials seem calculated to lead water consumers to assume an attitude of suspicion toward it. There is a job waiting for the publicity committee of the local engineering society. The facts, as the *Engineering News-Record* learns them, indicate that the city is blessed with a zero-turbidity water and one which by daily analysis seldom has a bacterial count in excess of 25 per cc. But since slight pollution from the nearest sewer, four miles from the intake, might occasionally be expected chlorine has been used for eight years. *B. coli* are seldom found in the pump discharge but they do occur more or less frequently in samples taken from the city taps. These bacteria may possibly come from surface contamination of one of a number of open-topped reservoirs on the hillsides. The creation of a nuisance in the Duluth-Superior harbor by sewage in the future is quite another question and should stand as a sanitary problem by itself. Simple protection of the surface reservoirs would seem to be about all that is necessary to give Duluth an ideal supply. There being much to be said for and little against the purity of the city's water, the local engineering society should be the first to assure the citizens, through the layman's medium, the newspaper, of the good quality of the water supply.

Bettering Sanitary Conditions

MORE cities should enact *and enforce* ordinances like the one recently passed by Raleigh, N. C., requiring all buildings in which one or more persons live or work to be connected with the local water-works and sewerage systems. Sewer connections have been at least nominally required in a considerable number of cities for many years but there are still hundreds of communities that either lack such rules or fail to enforce them. The Raleigh ordinance prohibits owners and agents from leasing any property not provided with water and sewer connections, and empowers the local court to order the refund of rentals paid where the owners have been convicted of non-compliance with the rules. This and other clauses make the Raleigh ordinance noteworthy. Moreover, there is evidence that the local authorities intend to enforce the ordinance—all of which gives promise of improved health and sanitary conditions at Raleigh.

Why This Feeling?

REPRESENTATIVES of the thirty-five third-class cities of Pennsylvania, with delegations from all the larger cities of the state, if securable, are to march a thousand strong to the State Capitol when the legislature meets in January and demand the repeal of the Public Service Commission law. In the adjoining State of New Jersey the Governor, responding to a similar popular feeling, removed the Public Utility Commission a few weeks ago. In other states there is equally strong feeling against public service commissions, although not always so well organized and so forcibly expressed. Why is this? The fundamental cause lies in the popular conception that the purpose of these commissions is to reduce rates and that to increase them is proof that a commission is false to its trust. War and after-war conditions have resulted in a large number of cases of increased utility rates. This the public, suffering from high prices on every hand and with a confident belief that there is profiteering everywhere, deeply resents. Hence the demand that utility commissions be removed, as in New Jersey, or abolished, as in Pennsylvania. The utility companies feel that the public is unreasonable, to put it mildly, but they should remember that the public service commissions never would have been created if the patrons of the utilities had not believed—too often with good reason—that otherwise good service and fair rates could not be obtained without almost unending litigation and court delay. Consequently, when these commissions were created the people expected them to lower rates, not raise them. What the public needs to learn is that the function of utility commissions is to see that even-handed justice is done to the companies as well as to the consumers. To convince the public of this, especially in these times of high prices, will be a hard, slow task, demanding judicial qualities of the highest order on the part of the commissions and their engineers, and a change of attitude, both before the commissions and towards their customers, on the part of the utilities.

A Fair and Full Trial for the Motor Truck in Terminal Service

EVEN UNDER this year's congestion at railroad freight terminals line-haul freight did eventually get through; the terminals, therefore, from that standpoint, are in general adequate for present tonnage. The complaint comes because the terminals, as the neck of the transportation bottle, cut down the rate of traffic flow demanded by industry. In fact the rate has been cut below present line-haul capacity—resulting in loss of revenue to the carriers themselves. Every year 100,000,000 tons of package or less-than-carload freight must pass through these terminals attended with congestion and delay and absorbing an inordinate share of the railroads' gross revenue. It appears that the terminals themselves are not bad, but that the fault lies in their operation. In Cincinnati there has been developed a system of l.c.l. interchange employing motor trucks with demountable bodies that has resulted in striking economies and speed of operation. With this demonstration of two years of successful service, the motor-truck, tied in effectively with the existing terminal plant, should be given a fair and full trial in increasing traffic capacity, bettering service to shippers, and saving money for the carriers. Engineers have directed their efforts for increasing terminal capacity to tremendously expensive improvements. Is it not their duty as practical economists first to develop to the utmost a method that promises large results with little capital outlay?

As indicated by the operating figures of one railroad entering Cincinnati, about 28 per cent of all l.c.l. freight passing through that terminal area is being handled with fifteen motor-truck chassis, and the indicated 50-per cent decrease in total loss and damage claims on freight so handled alone amounts to more than the railroads are paying for the transfer service. The cost of transfer has been reduced. Freight movement has been advanced 52 hours. Continuous service of 154 trap or ferry cars, 115 heavy horse drays, some 300,000 switch-cut movements annually and a large portion of freight rehandling have been eliminated. Available platform area and station-track capacity have been increased by current movement and freedom from congestion. Doorways previously held for dray service have been released to shippers. If such remarkable economies, carrying capacity and speed of handling, *effected merely by adapting existing facilities to an efficient system of operation at comparatively small capital cost*, have been secured at Cincinnati it is certain that new methods of terminal operation, permitting a higher rate of traffic flow, are needed at most other important terminal points as well. The alternative is large increases of plant, operated by old, slow and wasteful methods.

At present the Cincinnati system is being used only in exclusive railroad service for the interchange of l.c.l. freight between main and substations. It was described and commented upon editorially in the *Engineering News-Record* of March 11, 1920, pages 498 and 508. At the meeting of the Federal Highway Council's committees in New York last week, reported elsewhere in this issue, the extension of the system to even more important uses and its further possibilities were ably presented by Mr. B. F. Fitch, president of The Motor Terminals Company of New York and Cleveland, and chairman of the board of The Cincinnati Motor Terminals Company. The possibilities for extension hold promise of such great advantages that precedents should not stand in the way of a fair and thorough trial. The possibilities are: First, the elimination of the industrial-siding, intra-terminal trap, or ferry, car; second, the operation of zone freight stations without rail connection to permit the development of new industrial districts and to provide centers for store-door delivery; third, line haul of loaded demountable bodies on flat cars without rehandling of freight at stations properly equipped.

Unfortunately there appears to be an immediate obstacle to a trial of such extension. This is the fear of disrupting existing switching tariffs and existing traffic treaties between individual railroads and shippers arising from the connection of manufacturing plants with the rails of one or more carriers. For instance, the Cincinnati motor service can now actually be offered for extension to some manufacturers at much less than present switching tariffs and at one-quarter of the estimated cost to the carrier for industrial intra-terminal trap car service. The reason that the truck service has not already been thus extended is no doubt due to the fear of some of the railroads that traffic now controlled by them for a large share of line-haul tariff might be diverted for line haul over competitive lines. This, in spite of evident economies and better service to shippers, and in spite of the fact that the effect of such a new method of operation would, in the aggregate, if conceded by all railroads in a terminal, be to divert practically as much business to each of the carriers as would be diverted away from them, subject only to the deficiencies and advantages of wastefully competitive transportation. Here is the opportunity for such a body as the Association of Railway Executives to undertake bold initiative in the public good.

Great credit is due Mr. Fitch for his work in the public service and for his exhaustive study of the past five years that led to the adoption of the Cincinnati system which he developed and put into operation. Credit also is due Mr. H. A. Worcester, vice-president of the Big Four, who had the foresight and courage to authorize the original test of the new system.

It is most encouraging to note the increasingly liberal attitude of railroad officers to radically new methods, as instanced by the remarks of Colonel Charles D. Hine and Mr. F. E. Williamson, who represented the American Railway Association at the meeting of the Federal Highway Council transportation committees. Daniel Willard's address last week before the Mechanical Engineers was also significent in this respect, voicing strong sentiment for employing new methods where found economical, with particular emphasis on the motor truck's possibilities. Undoubtedly all of these views were expressed wholly in the interest of better service to the public. However, railroads must realize that private operation and ownership are still on trial and that the public will condemn the managements if they refuse, through the inertia of routine-bound precedent, to investigate thoughtfully the merits of such a system as that at Cincinnati, and to give such a system and also its further applications a fair and full trial. Such a trial should be made regardless of any selfish individual interests.

The railroads should be all the more open-minded on methods of improved terminal operation with present plant, since the capital outlay involved in the only alternative—extensive terminal additions—will run into stupendous figures, a prospect that is forbidding in view of the present financial position of the roads.

Articles for the "AVERAGE ENGINEER"

The issue of July 22 featured a dozen articles for the "average engineer," all of them dealing with details of ordinary field and office work rather than with large, costly projects. In response to the requests of readers who wrote approving the idea we now offer another "Average Engineer Issue."

Of course, the editorial contents of every *number of* Engineering News-Record *are balanced so as to serve the man on the small as well as the large job. This week, however, more than the usual amount of space is given to articles of the "average engineer" type. They deal with a wide variety of topics.*

A Few Useful Dodges in Surveying

By H. L. Thackwell
Civil Engineer, Anaconda, Mont.

The theory of surveying has been so thoroughly covered by many able authors that the practising surveyor need not be at a loss to find a book which will aid him in solving any complex problem. All engineers and surveyors of experience, however, have had recourse to simple dodges or methods which, though sometimes inelegant, are helpful in situations that require resourcefulness and ingenuity. Such matters are not printed in books, but are frequently disclosed by men of experience to those under them. The writer, a sometime government surveyor, can vividly recall situations where the ordinary instructions given in textbooks did not help the instrumentman in finding the backsight when the personnel of the party did not include a backflagman, nor in making an observation on the sun for a meridian when he had thoughtlessly left his watch in camp 5 mi. away.

The following dodges are listed for the benefit of those who may find them useful. The writer has used all of them with one exception, that in No. 3. Most of the ideas have come to him independently, although no doubt others have originated them.

1—How to Get Along Without Back-Flagman

In the West a surveyor is frequently called upon to survey a ranch or homestead and, upon arriving on the ground, finds that, although plenty of assistance had been promised for the work, only the client and his small boy present themselves. They would act as rodman and axeman respectively. How to get along without a backflagman is illustrated in Fig. 1.

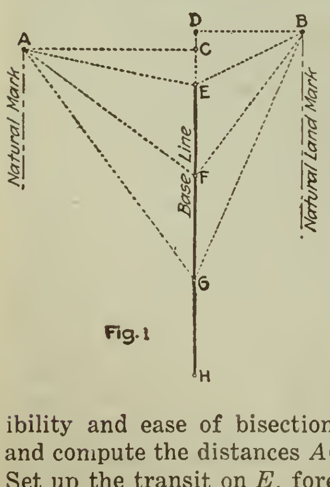


Fig. 1

The point of origin of the survey is at E and the survey is to be run in the direction of EG. Lay off the base line EF. Pick out two conspicuous points in the landscape, A and B, one on either side of the line to be run, and choose them with respect to their visibility and ease of bisection. Triangulate these points and compute the distances AC and BD, also CE and DE. Set up the transit on E, foresight on F, and set a point G on line. Then measure the distance FG. In the notebook keep a column or progressive distances from the point of origin E. Set up the transit on G; since there is no back-flagman recourse can be made to either of the natural monuments A and B, using that one which happens to be visible. Having the distances AC and DB and the progressive distances CG and DG the angle AGC and BGD can be readily computed.

If the landmark A is chosen set the angle AGC off on the plates, backsight to A, turn the plate in the correct direction so that the vernier reads zero, and the instrument is then in line. Proceed in this manner until the sighting points are invisible or the included angles become too small for accurate use, then triangulate two more points and repeat the process.

2—Laying Off True Meridian with Solar Transit

To lay off a true meridian and to find the time with a solar transit the following method may be used:

Guess at the time as nearly as possible by glancing at the sun. With this inaccurate time calculate the declination and make a solar observation. Read the hour-circle and correct the original declination by the new time. Make another solar observation and read the hour-circle again. If there is any appreciable error between the first and second hour-circle readings repeat the process until there is no further error. The resulting meridian and time will be as close as if the correct time had been used in the first observation.

3—When Day of Month is Forgotten

If the day of the month has been forgotten make an equal altitute observation of the sun and establish a true meridian. Measure the angle from the meridian to the sun, also the sun's altitude. Compute the declination of the sun by the formula

$$\text{Cos. } Q = \frac{\text{sin. dec.}}{\text{cos lat.} \times \text{cos. alt.}} - \text{tan. lat.} \times \text{tan. alt.}$$

The sign of the first term of the right hand side of the equation is minus when the declination is south; the second term is plus where the latitude is south. If the algebraic sign of the result is plus, Q is the angle between the sun and the North point, but if it is minus it is the angle between the sun and the South point. Correct the resulting declination by the hourly distance to obtain the declination at Greenwich. If the observation has been made correctly an inspection of the ephemeris will disclose a declination similar to the computed one, and the date corresponding to this declination is the date of the observation.

4—To Avoid High Hill in Line of Survey

In the mountain districts the surveyor is often confronted by a high wooded hill in the line of the survey. In such a situation it is frequently advisable to triangulate to the top of the summit, thus avoiding delay in

clearing the line. To project the line over on to the other side without occupying the summit station go around the hill and triangulate back to the station. Obtain the bearing of the line by solar observation. The original line can then be located by computing the necessary offset from the triangulated station.

5—Tying in Large Objects

When in a topographic survey it is necessary to tie in objects of large diameter, such as smokestacks, monuments, etc., read an angle first to one edge and then to the other. The mean of the two angles will be the angle bisecting the object.

6—Sighting Box for Tunnel Work

In aligning a tunnel under ground a capital sight can be made by using an old powder box, as in Fig. 2. Cut a diamond shaped opening in the box and tack a piece of vellum or tracing cloth over the opening. Take a section of an old level rod about one foot long and nail it across the top of the box. Take a level-rod target and bore a small hole through it near the circumference and on the horizontal line. Slip the target over the rod with the hole downward, then slide in into position over the center of the diamond shaped opening. Hang a plumbline from the hole in the target and place a light inside the box. In the dark the plumbline will show up vividly against the light background. Clamp the target with the set-screw and move the plumbline into the exact alignment by means of the target micrometer-screw. This sight can be used to advantage at night for marking a meridian obtained from a stellar observation.

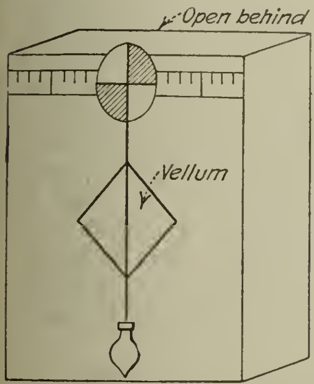


Fig. 2

7—Saving Time by Eliminating Plane Table

In making topographic surveys a great saving in time can be made by doing away with the plane table and using the following method:

The party should consist of an instrumentman, a recorder, and several stadia rodmen. The transitman sets his instrument over a known point and orients it so that the horizontal angles can be taken by azimuth. The recorder, who is provided with a drawing board mounted on an easel, should be seated close to the transitman. The instrumentman reads out the observed angles and stadia distances to the recorder, who immediately plots the points on his drawing board. The plotting is accomplished by the aid of a large semi-circular protractor, which is held in position over the station by a needle stuck through its center into the board. The distances and elevations are computed by a stadia slide rule, and the contours are drawn in in the field before moving on to the next station.

As much as 1,200 acres per day of rolling sagebrush land has been mapped with 5-ft. contours by this method. This system has the advantage in speed over that of the plane-table and the paper can be kept cleaner than would be possible if an alidade were rubbing over its surface. If an accurate angle is required it can be measured directly by the transit plates, whereas the plane-table method would only give approximate angles.

8—Projecting Accurate Lines

When projecting very accurate lines over rough country, such as tunnel alignment surveys, it is of great importance to have as fine fore and backsights as possible. If there are any extra transits at hand, set them up over the points and sight at the plumbline with the aligning transit. The foresight can be set very accurately by this method, even though the observer can not see the head of the tack in the stake.

9—Locating Soundings

In hydrographic surveying of small areas soundings may be taken and their respective locations recorded by the following method:

Construct a suitable raft mounted at one end with sweeps and at the other with a stadia rod set in a vertical position on a swivel and pin so that the rod can revolve in any direction. The raft should have a crew of two men, an oarsman and a soundsman. From the shore an observer with a transit should direct the movements of the raft. The oarsman should propel the craft at a more or less uniform rate along lines crossing the lake at definite intervals apart. The soundsman should stand by the stadia rod and sing out the soundings as fast as he can take them, and at the same time keep the stadia rod constantly turned in the direction of the observer. The instrumentman should read magnetic bearings and stadia distances to each of the sounding points and record them with the soundings in his note book. After a little practice he will find it easy to follow the movements of the raft with the transit, and by watching the soundsman anticipate the moment of sounding. In this manner accurate soundings can be taken without interrupting the rowing of the raft. The notes should be plotted, and if any portion of the lake has not been adequately covered by soundings the oarsman can be directed to the spot by the shore observer and soundings taken as needed.

10—Measuring Excavated Prisms

In measuring up the excavated prisms in small canals much time can be saved by making a template, as in Fig. 3. The template should be constructed of light pine strips, the shape being that of the prism cross-section. The center line of the frame should be provided with slots in which can be placed a standard level rod. Readings can be taken on the rod for grade, and by sliding the template down the rod the size and shape of the prism cross-section can be accurately checked.

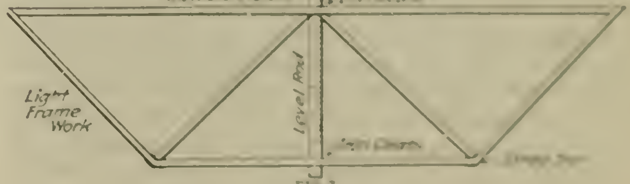


Fig. 3

11—Pipe Line Location on Hillside

In making a location survey for a pipeline along a tortuous hillside it often happens that the distance between two P.I.'s is so short that a reverse curve must

be used. Make both curves of equal radii, so that the pipe will have the least curvature. The following simple formula will solve the curve, Fig. 4:

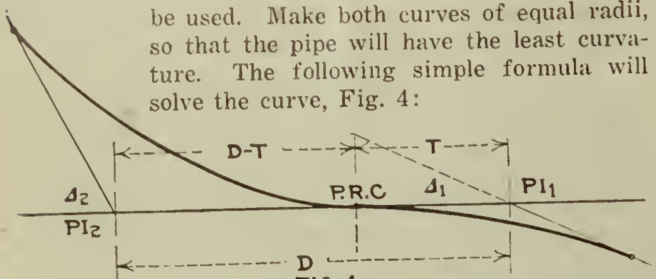


FIG. 4

$$T = \frac{D \cot \frac{1}{2}\Delta_2}{\cot \frac{1}{2}\Delta_1 + \cot \frac{1}{2}\Delta_2} \qquad R = T \cot \tfrac{1}{2}\Delta_1$$

In locating a flume line around a winding hillside it is economical to build the flume as close to the convex hillside as possible, and in extreme cases even cutting the hillside and building the flume on mudsills. Where the contour is concave build the flume well out so as to give the trestle its maximum height.

The average trestle height should be approximately that which will make the total cost of the line the least. Such a procedure will make the flume of such length that any change in the flume location would increase its total cost. To locate such a line measure the external distance from the P.I.'s of the trial line and by level ascertain the height of the trestle at that point. By reference to previously prepared tables of cost for various trestle heights the economic external distance can be computed.

12—Measuring Head of Water on Weir

It is difficult to measure accurately the head of water over a weir which carries a turbulent flow, such as the discharge from a power house tailrace, or from a fall or chute. In such cases place a raft of logs a few feet above the weir, care being taken to cover practically the whole width of the weir pond. Such a baffle will still the water surface so that accurate measurements can be taken of the head. The use of this method will stop all vibrations in self-recording water-stage registers.

13—Gulch Measurement with Tape

To measure with a 300 or 500-ft. tape a distance across a draw or gulch which is less than the length of the tape:

One chainman should brace himself behind a stake marking the station and hold the zero point of the chain on the tack. The other chainman should pull the tape up with a tape grip until the tension is about 60 lb., then release the tension and pull up again, gradually working a swinging motion into the tape. At the moment when the tape is on the upward swing and there is practically no curve throughout its length the chainman should mark the reading on the tape with his thumb, and, after releasing the tension, read the distance on the chain at the point marked.

14—Reading Stadia in Bushy Country

In reading a stadia rod in a bush-covered country have the rodman hold the rod upside down. Set the top stadia hair on the top of the rod, and set a hand target at the intersection of the lower hair on the rod. The rod interval can be read directly by the transitman, or, if the distance is too great, the rodman can read the hand target, which need be nothing more than the lid of a cigar box painted red or white, with a small cleat nailed along one edge like a T-square.

A Dozen Articles for

Engineer and Contractor—Mutual Use, Not Abuse

By S. H. Wright
Hydraulic Engineer, Philadelphia, Pa.

AT THIS time of year, ordinarily, construction work is at its height, and at the same time many colleges are releasing men, of more or less theoretical perfection, prepared to act as inspectors and engineers and general utility field men on work as varied as the personality of the contractors engaged on it.

In these days of welfare work, industrial relations and production efficiency, too little attention has been given to the relations between contract and money, or their representatives, the contractor and the owner or his agent—the engineer. Of course, human nature never changes but human methods do, fortunately, so that while the contractor and his engineer on any particular job may get along together better than they have, there is reason why a little thought may be given to the subject again with a view to calling to the minds of the new engineers and new and old contractors what each may do so that the owner may pay for what he wants as well as for what he gets; and so that the contractor may have a fair chance to get what he makes, and keep it, instead of losing his catch, as it were, because the engineer or his authorized assistant has backlashed.

The fact is that the system of contract letting is, in itself, bad, and will be abandoned for some plan of cost-plus profit at such a time when the parties concerned have implicit confidence in each other, and are represented in the actual performance of the contract by wholesome, fair-minded men.

It is my endeavor here to point out to the uninitiated and others where some of the pitfalls lie and how they may possibly be avoided, or in other words how two ambitious, responsible, reasoning human beings can perform a good economical piece of work by *using* instead of *abusing* each other. The result is the same whether there are involved in controversy the resident engineer and the superintendent or a foreman and an inspector.

How seldom it is that two average minds can meet in understanding on any given point. To our minds we know exactly what we see, hear and say—yet some other mind equally as intelligent is differently impressed by the same things. Is it any wonder then, that some specifications seem irrational? In competitive bidding the contractor must gamble on his prices, on what the author of the specifications believes he wrote, on the contractor's interpretation of them and on the field engineer's interpretation. The engineer's word shall be final, we say. All right, but I pray you use discretion —judgment.

Here is an honest contractor trying to accomplish a difficult piece of foundation work. He is to clean the exposed rock surfaces preparatory to placing bulk concrete. There are mud, débris and gravel—residue from the excavation—to be cleared up. The contractor starts at 7 o'clock in the morning; by 10 a.m. relations are strained. The rock is not suitable to the engineer as the surface is not properly cleaned—it was thought to

the "Average Engineer"

have been all right but the men were careless, and it is ordered done over again. Rain comes, the hole fills with water and sediment collects several inches deep over the "cleaned" surface. Perhaps two or three days delay follow and the profit on the concrete is gone. Whom shall we blame? Not the contractor, because he says he did not understand the rock was to be holystoned like the deck of a battleship. Not the perhaps too conservative resident engineer who wanted a sandpapered job and couldn't tell just where to draw the line, nor how to get what he wanted.

As a matter of fact this is an important illustration. To prepare such a surface for concrete is a very serious matter and a hard job to perform. It is very necessary that it should be well and thoroughly done. But let us not wait until seven o'clock on the day the contractor expects to concrete to tell him what we want and how we want it done.

A lot of work is done on the "give and take" plan. When the engineer can "ease up a bit" he does so with the idea that, on important parts of the work, he will hold the contractor straight to the letter, a rather questionable practice, depending on the men engaged in the work. Such a compromise often leads to misunderstandings from which the engineer extricates himself with difficulty.

There have been in the courts of Pennsylvania and New York alone cases for adjudication involving millions of dollars based primarily on ambiguous specifications, insufficient field investigations and lack of harmony between the contractor and engineer. Would it not be cheaper in the end to be a little more explicit as to what we really want and expect? It is a known fact that many specifications are drawn purposely lacking in detail because it is feared that too much descriptive matter will either scare the contractors away, or cause them to *bid higher prices*.

The young engineer on his first job or two is apt to be over-zealous. He sometimes feels he may be dealing with a crook and a liar and that only by the most assiduous attention and painstaking effort, which the contractor construes to be harassing and nagging interference, can he fulfill the requirements of his chief and the specifications. The latter he may carry in his pocket to produce on the slightest provocation, and when brought forth with a more or less triumphant flourish, the red flag to the bull is nothing, by comparison. Let the engineer do his studying after or before working hours so that he knows his paper line for line, forwards and backwards, and then when the time comes take a fair, definite stand, being sure of his ground, and let the contractor produce the papers.

It seems to me therefore, that there is room for improvement in the personal relations between engineers and contractors. It is a great help under trying conditions to put one's self in the other person's position, whereupon the point of view having changed a smooth way out can often be discovered. Greater effort should be made to do away with mystifying legal and technical phraseology in our specifications that lead us more often into trouble than out of it. Where we have uncertain information acknowledge the fact and let the contractor bid accordingly, if we insist on unit price bids.

Flood-Proof Bridges for Andes Streams

By Donald G. Coombs
Office Engineer, Construction Department, Braden Copper Co., Rancagua, Chile

DURING the construction of a copper smelter and appurtenances in the Chilean Andes the writer had considerable to do with the transportation of material by mule back. This necessitated trail construction and incidentally a number of small stream crossings. Geographically and geologically this section of the Andes is new, the mountain sides are steep and rugged and the streams fall rapidly. Being at an altitude of 5,000 to 7,000 ft. a few degrees difference in temperature would change snow to rain, with consequent floods of short duration but considerable volume.

With the mule loads averaging 300 lb., and often top-heavy, fords were abandoned and light bridges sub-

MULE BRIDGE OVER COYA RIVER, CHILE, BUILT TO WITHSTAND FLOODS

stituted. These were seldom greater than 20 ft. span so 3 x 8-in. fir stringers were about as heavy timbers as were used. At first simply wood sills in the banks were used. As these washed away dry wall abutments were built from the stream bed boulders. Floods carried these away even though the bridges proper were cabled to adjacent rocks so the third design was adopted as shown in the accompanying photograph.

This type of temporary crossing was constructed by hand drilling two holes 4 ft. apart in the rock bottom or large boulders. In these holes were set short pieces of 40 lb. rail with one end forged round for about 2 ft. To the upper ends of the projecting rails were bolted two 3 x 6's. The bridge stringers were then bolted to these cross pieces and the rails grouted in.

This type of crossing has withstood two years of heavy floods and though overtopped several feet a number of times, suffered little—only a few feet of guard rail were lost even though the approach fills have been repeatedly carried away. It is but fair to state, however, that there is very little débris carried by these streams in this immediate locality as the mountain slopes are almost bare of trees.

To the engineering brethren who are headed for south of the equator this is respectfully submitted—the lowly pack mule is the Ford of South America.

A Dozen Articles for

Good and Bad Practice in Making Bituminous Patches

Exhaustive Study of Patching Problems Necessary for Best Results; Mistakes and Their Results Tabulated

By John Stanley Crandell,
Consulting Engineer, General Tarvia Department, The Barrett Company

IN the spring of 1921 a number of roads will be in bad condition. The average foreman will say: "Well, I patched that road good last summer, and now look at it! The patches have all busted up, and the road's as bad as if we hadn't spent a cent on it. That patching stuff is no good, and I don't want to use any more of it. You're throwing away good money when you use it."

His remarks may be aimed at any brand of material; all have failed at some time or other. But in nearly every case it has not been a matter of the bituminous material failing; rather it is a lack of understanding on the part of the engineer or foreman of the nature of patches in particular. Patching is not a simple art: proof of which is that there are comparatively few perfect patches.

The examination of thousands of patches made with bituminous materials leads me to the belief that only a small percentage are made correctly, and that much better results would be obtained if the road men directly interested would make exhaustive studies of their own patching problems. It is only by watching results obtained with many mixes, under varying conditions, that real information may be collected. This information must then be put to practical use.

Cold Patching Materials—Tars and asphalts are used as binders for patching, and when properly used both

FIG. 1. CORRECT WAY OF PREPARING HOLE FOR PATCH

have given good results. Some engineers prefer the heavy grades that require heating; others like the cold patching materials because of ease of handling. Cold patching materials are of two kinds: emulsions and cut-backs. Emulsions are made by combining bitumen with water, soap and caustic soda so that the resulting material is liquid at ordinary temperatures. Asphalts are usually employed in making emulsions, but the material has the drawback that freezing separates the bitumen and renders it unfit for use.

Cut-back materials are made either from tars or asphalts by dissolving a binder in a proper solvent. The tar cut-backs are, however, more generally used. The solvent is inflammable, and care must be taken to keep cut-backs away from open flames. Serious fires may occur, and the materials themselves are spoiled if they are unduly heated. They are manufactured so as to be fluid at ordinary temperatures, and the right amount of solvent is added to make them sufficiently fluid except in extremely cold weather. Heating drives off the solvent and increases the viscosity, or "body," to such an extent that the cut-back may be made unfit for cold patching work.

Since cold patching materials may separate somewhat on long standing it is always well to agitate the cut-back

FIG. 2. HOT PENETRATION PATCH

by either rolling the barrels about before using, or by stirring with a stick or rod.

As a rule hot patches are made quite differently from cold patches, and the methods must not be confused.

Hot Patches (Penetration Method)—The easiest way to patch with hot bitumen is to build up exactly as a penetration macadam pavement is made. Clean out the hole as deep as necessary. Fill with clean hard 1½-in. stone. Tamp or roll well. Apply hot bitumen at the rate of ¾ gal. per inch depth of stone. Spread ¾-in. stone chips over surface, sufficient to fill voids; sweep off excess chips; tamp or roll. Apply a seal coat of bitumen, ½ gal. to the square yard. Cover lightly with ½-in. chips. Roll.

Mistakes:	Results:
Too much bitumen:	A "fat" patch that will wave, roll, and bleed.
Not enough ¾-in. chips:	An open work patch that holds water and soon breaks up. Allows seal coat to run through to bottom where it is lost in the base.
No seal coat:	Patch is never waterproofed and breaks up in spring thaws.
Too much seal coat:	Patch is soft, or "fat," bleeds and pushes into ridges or waves.
No rolling or tamping:	Patch is never solid; settles below level of pavement after a short time.

Hot Patches (Mixed Method)—A hot mixed patch is excellent if skilled workmen are employed for the work, but almost a certain failure otherwise. It cannot be economically made except in cities and towns where there is a mixing plant, and where there is considerable of this work to be done.

Mistakes:	Results:
Poor quality of aggregate	Patch does not wear like surrounding pavement.
Dirty aggregate:	Patch does not hold together.

the "Average Engineer"

Mix chills before laying:	Uniform rolling impossible, hence a wavy patch.
Bitumen burned:	Value of binder destroyed and patch breaks up.
Too much or too little bitumen:	Equally bad; the former makes a "fat" patch, while the latter makes so lean a mix it will not bind together.
Not rolled enough:	Patch settles, and is not waterproof.

Cold Patch (Penetration Method)—This patch is made as just described under "Hot Patch," but results have, on the whole, been discouraging. Therefore this method had better not be used unless success with it has attended your efforts in the past.

FIG. 3. TOP PATCH CONTAINS NO FINE STONE—BOTTOM PATCH IS FAIR

Cold Patch (Mixed Method)—Probably 90 per cent of patching work, exclusive of sheet asphalt patching in large cities, is done this way. The method is simplicity itself, and consequently good results have been obtained despite the mistakes that have been made, and the wilful carelessness often obvious. The procedure in making mixed method cold patches would be: Clean out the hole and sweep it thoroughly. If it is over 2 in. deep, deposit crushed stone in the bottom and bring to within 2 in. of the top, tamping well. Paint the sides of the hole with a light coat of bitumen, using a brush or broom. The proportions of the mix are: Two parts of ¾-in. stone, one part of clean coarse sand or screenings, and just enough bitumen to bind the stone and sand. This amount varies with the materials used. With tar it has been found that about 15 gal. of tar cut-back added to 1 cu.yd. of stone and sand is usually sufficient. A greater amount of asphalt cut-back is necessary. The correct amount must be determined by experiment, and then all mixes should be made alike, if the ingredients are uniform in quality. Mix the stone and the bitumen until the stone is thoroughly coated. Then add the sand. If possible set this mix aside for a few days to season. This permits some of the more volatile fractions to escape, and the mix sets up more quickly when placed in the pavement. Into the hole, prepared as above noted, deposit enough of the mix to slightly more than fill it. Tamp. Cover lightly with screenings. Roll patch with steam or hand roller. If neither of these is to be had use a heavy tamper. Apply a very light seal coat with a brush. Cover with clean chips, sand, or pea gravel. Traffic may be admitted immediately, but it is always better to keep it off the patch for a few days.

Mistakes:	Results:
Large sized stone with no fine material for filler:	A too open mix which has no strength since the stones touch each other at points only and are not embedded in a matrix. An open mix is not waterproof and ice, forming within the patch, breaks it up in winter and spring, if it has not disintegrated under traffic long before.
Too much bitumen:	A patch that will never set up hard and therefore rolls and waves badly.
Too little bitumen:	A weak patch that breaks up as soon as laid.
Dirty stone or sand:	A weak mix is certain. Bitumens will not stick to dirty, greasy, or wet surfaces.
Clay mixed with sand:	May form an emulsion in rainy weather.
No seal coat:	Water may penetrate a poor mix, and break up the patch.
Too much seal coat:	Softens patch and causes it to wave, bunch, or rut.
No cover:	May leave an open surface into which water will find its way.
Too much cover:	Kills binding quality of bitumen, or else makes a dusty patch.
Water in the hole before patch is made:	Patch will usually be a failure, never adhering to sides of hole, even though hole eventually dries out.
Use of wet stone and sand:	Bitumen will not adhere, and patch will be a failure.

Before winter sets in all patches should be examined and such as show a surface similar to that in Fig. 3 should be given a light seal coat of cold patch bitumen and a cover of screenings or pea gravel. The patch will then be waterproof, and will go through the winter and spring without further attention.

Often, attention is directed to patches that do not match the pavement. This is, of course, inevitable when bituminous patches are made in brick, stone block, wood block, asphalt block, concrete, and other such pavements. But when patches are made in bituminous pavements they can be made to match up fairly well. When cold patches are placed in sheet asphalt a very close mix should be made by adding more sand than usual, and the rolled surface should be dusted with portland cement, as is done when the pavement is originally laid. If care be taken in selecting the aggregate, so as to get as nearly as possible the same materials as were used in the construction of the pavement, the patches will not be

FIG. 4. RESULT OF TOO MUCH BITUMEN

obtrusive. A patch made of nothing but large sized stone and bitumen will look out of place in any pavement.

It is becoming more and more the practice to patch holes in brick and in concrete pavements with bituminous materials. Five years ago this was considered a makeshift; today it is acknowledged that the patches are lasting as well as the pavements themselves. But it is only when care is used that such patching is successful. Haphazard workmanship is of no value.

Skin Patching—Breaks in the surface of concrete pavements, bituminous concrete and macadam, and surface-treated plain macadam occur frequently, and repairs must be quickly made if the contiguous surface is not to be broken down rapidly. The usual method is to give the break a thin coat of bitumen, either hot or cold, and then cover with clean chips, or pea gravel.

Mistakes:	Results:
Failure to thoroughly clean the surface of the break:	Bitumen does not stick to dirt or manure, hence the skin coat of new bitumen peels off.
Too thick a coat of bitumen:	A wavy, bumpy surface.
Too much cover:	Kills binding value of bitumen and makes a dead patch that soon breaks up.
Sudden shower immediately after coat is applied: (Cold patch, only.)	May wash off bitumen.

Patches fail because of the use of too large aggregate with not enough "fines"; because of dirty stone, wet aggregate, wet or dirty holes, too much bitumen, too little bitumen, no seal coat, and *no horse sense.*

Patch before winter sets in.

Locating Leaks and Waste in Water Distribution System

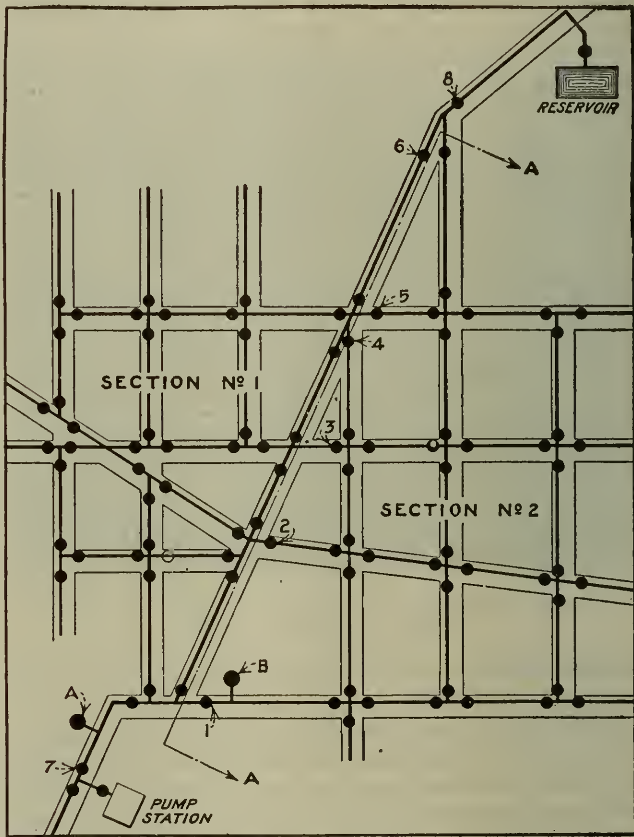
By J. P. Lawyer
Resident Engineer, J. G. White Engineering Corporation, New York City

A COMMON problem which is encountered by the engineer is the determination of whether or not a water-works distribution system leaks and, if it does, how much and where. The most accurate method of determining such leakage is to compare the total reading of all the service meters with the output at the source of supply for a given length of time.

If the services are not metered an estimate of the consumption can be based on the per capita consumption of some similar community, taking into consideration all local features having direct bearing on the use of water.

All distribution systems will show some difference between the amount of water delivered to the system and the amount accounted for. This should not exceed from 15 to 30 gal. per capita per day, depending on the age and condition of the system. Having determined the total difference between the quantity of water deilvered to the system and the quantity accounted for as being consumed and as reasonably "unaccounted-for," the remainder, if any, will represent leakage or wastage which should be located and stopped.

The first step in a simple and satisfactory method of locating leakage or waste is to divide the system into sections which can be segregated by the manipulation of valves. In the accompanying sketch the distribution system has been divided by line A-A′ into two sections. Section No. 1 will first be investigated as follows: Valves 1 to 6 are closed. A standard pressure gauge is attached to Hydrant A and the static pressure observed. Valve 7 is next closed. If the pressure on the gauge attached to Hydrant A falls



DISTRIBUTION SYSTEM DIVIDED INTO SECTIONS

rapidly to zero, it will indicate that there are leaks in Section 1. If the pressure on the gauge remains constant or falls very slowly to 5 or 10 lb. and remains constant at that point for some length of time, it will indicate that Section 1 is free from bad leaks.

In an ordinary distribution system a small static pressure will be maintained by the column of water in the house services for some time after the operating pressure has been dissipated by the loss of a relatively small quantity of water.

Assume that no leaks existed in Section 1 it will be again put in service by opening valve 7. Valves 1 to 6 of this section are left closed and Section 2 is tested in a similar manner, with a pressure gauge at hydrant B, by closing valve 8. If the gauge pressure then drops rapidly to zero we know that there are leaks in Section 2. The next step is to subdivide and continue to subdivide Section 2 until the leaks are bracketed between two valves. As it is necessary that no water be drawn from the mains in the section being investigated while the test is being made, it is advisable to make the tests between 1 and 4 a. m., previously notifying the consumers that no taps are to be opened during that period.

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The ease and speed with which this method can be applied depend largely upon previous preparation of a definite plan, which can conveniently be laid out in advance on a map of the distribution system.

The exact location of the leaks can be determined by any of the methods described by Professor Babbitt in *Engineering News-Record* of May 27, 1920.

How to Check a Drawing

By Samson V. Becker

Architect and Consulting Engineer, New York City

SINCE all drawings are designed to supply information in regard to certain definite objects, the first duty of the checker is to inquire into the "objective" of the drawing. He should obtain this information from one in authority, preferably by first-hand communication or failing in this by checked reference drawings.

General Layout—The checker should not attempt to become familiar with the contents of a drawing during its execution, for he then loses a very valuable "checking" asset; "the first impression." In checking a drawing he should use this asset before it has time to merge into secondary impressions. See that the drawing is laid out in conventional form, that sections of specific parts correspond to their respective plans and elevations and are placed near their relative parts. Make sure that enough sections and explanatory notes are present to sufficiently convey all necessary information. Compare with office standards. See that the location of the object in question is well indicated in respect to base lines, center lines or other conspicuous lines or points. Make sure that these lines or points are readily accessible in the field. Check grades.

Principle—Having verified the general location, next check the principle of the apparatus or construction. If it is constructional, note the particular features of construction; that is, see that doors do not interfere, headroom for stairs, relation between the objects of the construction and the result attained by the methods shown on the drawing. If the drawing is mechanical, check the movements of the apparatus and its parts, capacity, rate of operation, etc. Check for clearances, for strength of construction, for economy, for utility, for material of construction, for practicality and for ease of installation.

Check all detailed parts next. See that parts meet correctly and that dimensions tally with assembly. Clearance for bolts, nuts, etc. Comparison with office standards and with foreign prints and catalogs.

Dimensions and Notes—Endeavor to find the fundamental or starting points of the scheme and check all portional dimensions from this point. From these check all total dimensions.

Notes should cover all obscure and confusing points. In referring to foreign apparatus, etc., use manufacturers' numbers and names and give catalog page and numbers, if available. Avoid all words and phrases not in common use. "Trade" names and descriptions should be used by preference. See that all separate parts have marking letters and the number required noted in obvious reference to same. Avoid labeling two different parts by the same name. All parts of apparatus not "marked" should be named. See that section lines and titles agree.

Check for quantities and material against material list. See that the type and weight of the material conform to the requirements of specifications for the particular job. Make sure that the material listed has not been duplicated on other sheets. Check against requisition. See that the title form and sheet number, scale and client are correctly shown.

General—The checker should obtain a blue-print of the drawing before starting work. He should adopt a uniform system of checking colors. Yellow for approvals and red for errors make a good system. He should mark out all dimensions, notes, etc., with the correct color and make all corrections and additions in ink. Before turning in the print he should mark on it conspicuously his name and the date corrected, so that the print can be returned later. He should keep a list in a record book of his contact with the drawing and state the client, title, date received, date checked, date back checked and number.

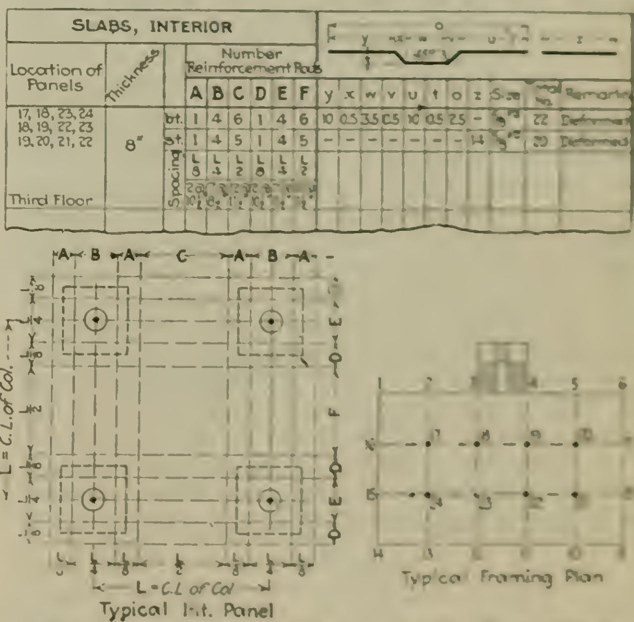
For back checking compare the checking print with the revised tracing. See that all corrections have been made. Check carefully for alterations not listed for revision. Date and sign with initials. Mark all suggestions which have been declined in pencil on the checking print, together with the vetoing authorities' name.

Typical Flat-Slab Working Drawing

By Harold H. Sondheim

Philadelphia, Pa.

DRAWINGS for flat-slab reinforced concrete floors are apt to become complicated and extensive when apt to become quite complicated and extensive when the sizes of floors in one building vary. The accompanying drawings illustrate a typical layout in which



METHOD OF LAYING OUT FLAT SLABS ON WORKING DRAWINGS

simplification is carried to a high degree but which at the same time permits the contractor readily to check up the steel list on the different floors.

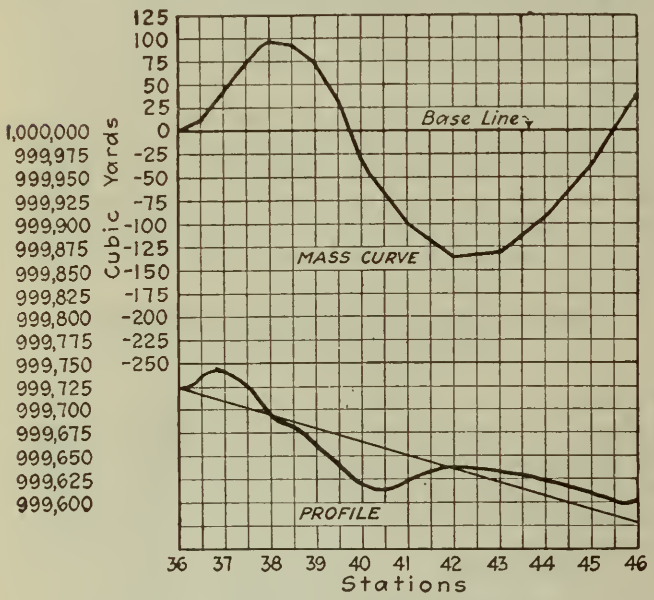
For this example the live-load is 200 lb. per square ft. and the panel 20 ft. square, but provision is made in the blanks for unequal sides. For wall panels the same general arrangement holds, except that the bent bars are hooked at the end.

Mass Curve Ordinates Computed By Aid of Adding Machine

By R. T. Brown
Chief of Surveys, South Carolina State Highway Department

IT IS PROBABLE that many other engineers have had the same experience as had the writer in regard to the use of the mass curve. They have recognized the advantages of using it to aid in balancing quantities and computing overhaul, but on account of the large amount of work required to make the computations, have neglected its use.

In an effort to minimize the work of computing ordinates, by the use of an adding machine the writer



PORTION OF MASS CURVE DIAGRAM

secured results similar to those listed below. Excavation quantities were added, and embankment quantities were subtracted directly on the adding machine. In subtracting, the arithmetic complement of the embankment quantity is listed on the keys and all the nines to the left are depressed as indicated in the table. So long as the ordinate is positive, the subtotal lists the correct ordinate, but when the fill quantities are in excess the sub-total shows the complement of the ordinate with a string of nines to the left. At first these minus ordinates were actually computed and plotted downward from the base line. Later, however, it was found that if the base line were taken as having a value of 1,000,000, the complement of the ordinate can be plotted directly as listed by the adding machine.

EXAMPLE

Sta.	Cut	Fill Increased for Shrinkage	Adding Machine Sub-Totals	Ordinate
36	0.00	......	....	0.00
+50	12.50	......	12.50	12.50
37	28.00	......	40.50	40.50
+40	26.50	0.00	67.00	67.00
+80	32.00	8.00	91.00	91.00
38	18.50	12.50	97.00	97.00
+50	24.00	28.50	92.50	92.50
39	18.00	36.00	74.50	74.50
+50	9.50	52.50	31.50	31.50
40	3.50	67.00	999968.00	— 32.00
+20	0.00	15.00	999953.00	— 47.00
41	0.00	55.00	999898.00	—102.00
42	11.50	46.00	999863.50	—136.50
43	24.00	18.00	999869.50	—130.50
44	38.50	2.50	999905.50	— 94.50
45	56.50	0.00	999962 00	— 38.00
46	78.00	......	40.00	40.00
	381.00	341.00		

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In plotting the ordinates shown in the table below those to 39 + 50, inclusive, would be plotted above the base line, as usual. At Station 40, instead of subtracting 999,968 from 1,000,000 and obtaining 32, which would be plotted downward from the base, the 999,968 will be plotted directly, considering the base as 1,000,000.

By having one person hold the computation sheets and call the quantities and another operate the adding machine the ordinates can be quickly computed by this method.

Since the total for cuts and fills will be shown at the bottom of each sheet, the ordinate on any sheet can be checked by adding algebraically the difference of cuts and fills on that sheet to the ordinate at the bottom of preceding sheet.

Simple Solution of Three Highway Construction Problems

By W. B. Walraven
Assistant Engineer, Department of Public Works and Buildings, Division of Highways, State of Illinois

HEREWITH are presented the solutions to three problems frequently met with in the course of highway engineering work. The first is a theoretical treatment of the perpendicular offsets to a horizontal curve at various points along the transit line. It has usually been the practice to use the formula

$$\text{Offset} = 0.875\, n^2 D$$

where n is the distance in stations along the curve, and D is the degree of the curve. This gives sufficiently accurate results for small values of N and D, but for large ranges it is not even approximate. It also is unhandy for ordinary use in a highway office due to the fact that N is referred to the length of the curve, and not to the tangent.

The writer has sought to find a simple formula which would be absolutely independent of the range of values and which would express N in terms of the distance along the tangent. The first drawing on Fig. 1 illustrates the problem. The formula for the offset is

$$O = R - \sqrt{R^2 - n^2}$$

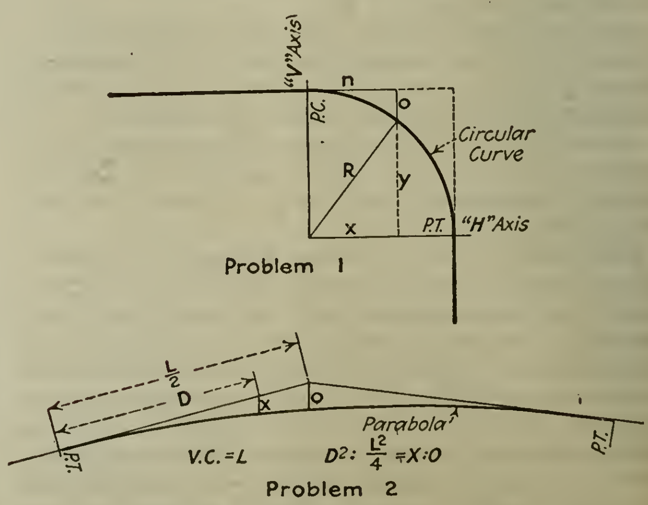


FIG. 1. DEVELOPMENT OF EQUATIONS EXPRESSING CIRCULAR AND VERTICAL CURVES

the "Average Engineer"

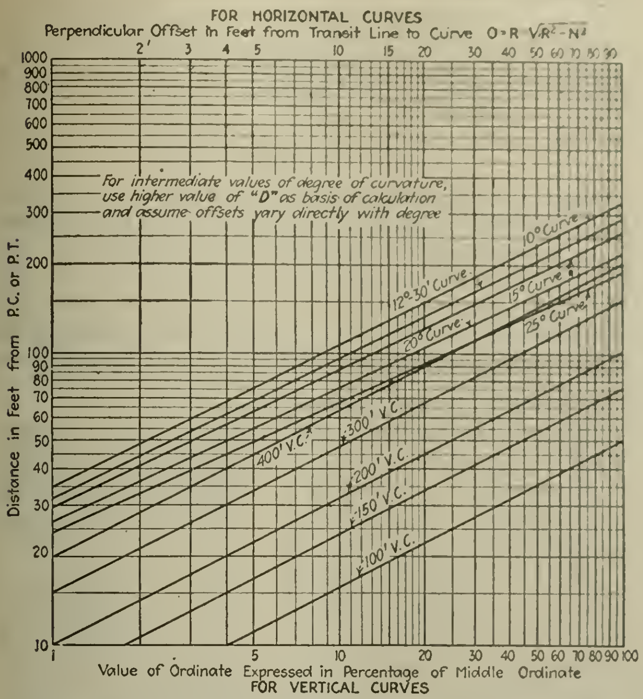


FIG. 2. TABLE GIVES TANGENTIAL OFFSETS TO CIRCULAR CURVES AND RATIO BETWEEN ORDINATES IN VERTICAL CURVES

in which O is the offset to a circular curve in feet, R is the radius of the curve and N is the distance from the point of beginning or ending of the curve.

The derivation of this formula is as follows:

The equation of a circular curve referred to two axes at right angles to each other is

$$X^2 + Y^2 = R^2$$

$$Y^2 = -X^2 + R^2$$

$$Y = \sqrt{R^2 - X^2}$$

$$n = x \text{ and } Y = R - O$$

Substituting these values, transposing and changing signs,

$$O = R - \sqrt{R^2 - n^2}$$

On Fig. 2 will be found curves showing values of the offset for various degrees of curvature, which are, of course, dependent upon the radii. These values are shown for only a few curves, but values covering the entire range from 0 deg. to 25 deg. may be figured very approximately by assuming that the offsets vary directly with the degree of curvature between any two curves plotted. For example, it is desired to find the offset to a curve of 18 deg. at a distance of 75 ft. along the tangent. The value, referred to a 20-deg. curve, is 10 ft. By proportion, the corresponding value for an 18-deg. curve would be 9 ft. The 10-deg. curve may safely be depended upon to serve as the basis of calculation for all values from 0 deg. up to 10 deg., within a range of 250 ft. along the tangent. If absolutely correct values are desired for any specific case, the investigator should solve the equation for the offset and not trust the reading of a graph, but for ordinary work this chart will be found to be reasonably accurate. In solving the formula for an 18-deg. curve it will be seen that the absolute value of the offset 75 ft. along the tangent is 8.93 ft.

The second problem is the solution of the ordinates to vertical curves at various points along the grade line. The relation of the offsets to the ordinate at the center is so well known that it needs no development here, so the writer has plotted the values without mathematical proof.

The first and second problems are combined on Fig. 2 for the sake of convenience. The chart is logarithmic, with the consequent result that the graph appears as a straight line. This is considered advantageous, since the intercepts on a straight line are more clearly defined than on any higher form of curve. Other lines may be plotted by solving for the values of any two points and connecting them by a straight line.

The third problem refers to one solution of superelevation of a pavement on a curve from the resident engineer's point of view. It would be difficult to establish any rule concerning the amount by which the pavement should be superelevated on account of varying conditions, but the formula in general usage seems to be

$$S \times R = 0.067\ WV^2$$

in which S is the total superelevation in feet, R is the radius of the curve, W is the width of the pavement in feet and V is the velocity in miles per hour, usually taken as 25.

Fig. 3 illustrates how the superelevation is gained by means of two reverse, vertical curves, the pavement being rotated about the center line. It is good practice to take up the superelevation in from 100 to 150 ft., but this is, of course, liable to great variation on account of local conditions. The proportional parts by which the outside edge is raised and the inside edge lowered are shown for the sixth and the quarter points. For example, assume that the total superelevation is to be 1.5 ft. and is to be attained in a distance of 120 ft. Stakes every 30 ft. will probably be close enough. Beginning at Sta. 0 as shown on Fig. 3, the superelevation is 0. At Sta. $D/4$, or in this case 30 ft. forward, the outside stake is to be set 1.5/16, or 0.09 ft. above crown grade at that point and the inside stake lowered by the same amount.

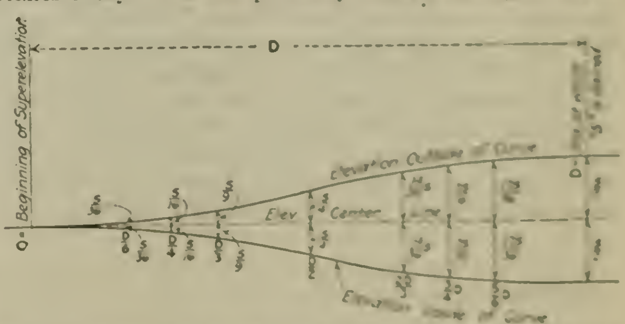


FIG. 3. GRAPHIC REPRESENTATION OF SUPERELEVATION

Attention is called to the fact that these amounts do not take into consideration the crowning of the pavement itself. Naturally, if the pavement were crowned 2 in., both the inside and outside edges would be lowered 2 in. more than would be figured from the diagram. The figures given are applicable only in the case where the superelevation is gained by rotating about the center line. If it is desired to "bank" the outside, and leave the inside unchanged, use the tabular values multiplied by two.

A Dozen Articles for

Special Slide Rules Prove Useful in Valuation Work

By C. S. Meyer
Equipment Branch, Valuation Department, Baltimore & Ohio R.R., Cincinnati, Ohio

In calculation work involving the use and repetition of definite formulae or in which the cost of material such as belting, cold-rolled steel shafting, etc., varies gradually and definitely with the increase in size of the article, the special slide rule finds instant favor. If the variation of cost with size is plotted with size as abscissae and cost as ordinates, the equation of the curve resulting can be derived and when once derived forms the basis for the construction of the special slide rule. In fact, any calculation or series of calculations which can be represented by an equation can be transformed into a special slide rule on which, by the simple process of moving the slider or sliders, the solution of the equation and hence the results sought can be obtained.

The special slide rule, once constructed and checked, obviates the need of the price list in valuation work; minimizes the chances of error in calculation and while not attaining the degree of accuracy obtainable by the slow long-handed method of calculating, is as accurate as our ordinary polyphase slide rule. A special slide rule, then, is a slide rule constructed for the purpose of solving one particular formula which represents a definite curve. Such a rule cannot be used for any other purpose or formula unless adapted to meet the conditions.

The apparently intricate method for the evolution of special slides is not difficult, as the following discussion will show. One case, the description of which follows, is that of a special rule designed to determine quickly and accurately the cost of a piece of two-ply leather belting, when the length and width of the belt are known.

In the first place, the only material available and necessary was a price list of two-ply leather belting of the year 1914, at which time prices are taken in the work of railroad valuation. Using the width of the belt as abscissae and the cost per foot as ordinates, a curve was plotted on rectangular cross-section paper and is shown in Fig. 1. Next, using the same values for abscissae and ordinates but plotting the values on logarithmic paper, a curve is obtained which approximates a straight line as shown in Fig. 2. To anyone familiar with the properties of logarithmic graph paper it is known that, if the curve is a straight line, the value of the slope is the exponent of the variable. By the slope of the curve, as well known, is meant the ratio at any point of the ordinate to the abscissae: In other words, the tangent of the angle made by the curve with the X axis. Since the curve approximates a straight line, it is of the form,

$$y = Kx^s$$

where s is the slope of the line, which, from the curve is,

$$S = \tan^{-1} 45.5^\circ = \frac{1.5}{1.46875} = 1.02$$

The equation then becomes very approximately,

$$y = Kx$$

To find the value of K, substitute values of x and y, that is abscissae and ordinates, from the original curve, Fig. 1. The average value of K is 1.08.

Hence, the equation becomes

$$C' = 1.08W$$

where C′ is the cost per linear foot in dollars and W is the width in inches.

With the equation established, the actual determination of the scales with the proper graduations is the next step. This is a rather long but simple operation which space will not permit to be explained here.

The finished special slide rule is shown in Fig. 3. The method of using the rule is as follows:

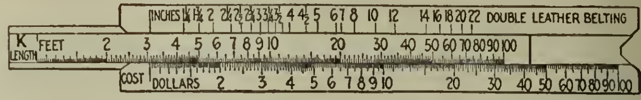
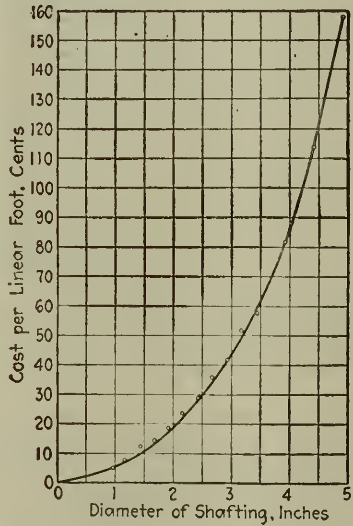
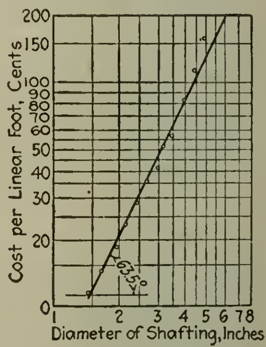
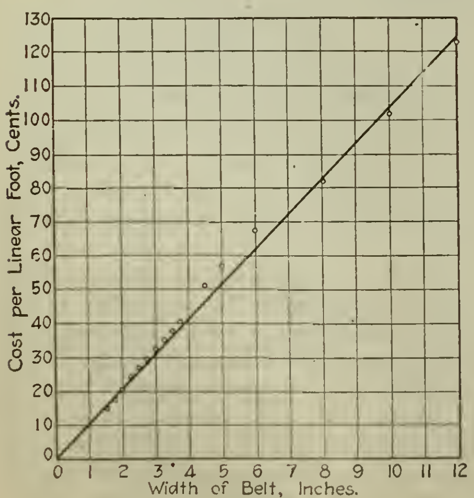


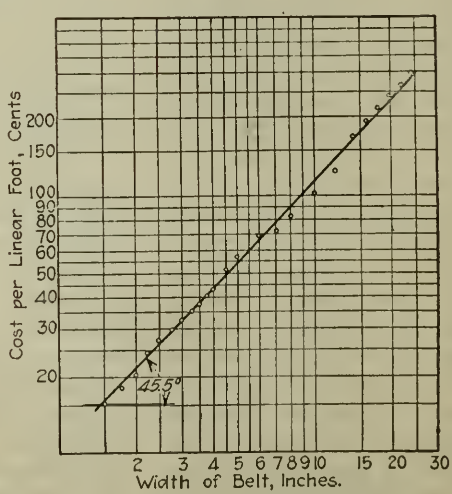
FIG. 3. SPECIAL SLIDE RULE TO DETERMINE COST OF TWO-PLY LEATHER BELTING





FIGS. 4 AND 5. RECTANGULAR CO-ORDINATE AND LOGARITHMIC CURVES OF COST OF COLD ROLLED SHAFTING





FIGS. 1 AND 2. RECTANGULAR CO-ORDINATE AND LOGARITHMIC CURVES OF COST OF BELTING

the "Average Engineer"

Bring the vertical arrow on the K scale to the number on the upper scale (width), and below the length in feet read the corresponding cost in dollars on the lowest scale. Fig. 3 shows the scales of the rule in their proper position to determine the cost of a piece of three-inch two-ply leather belting 30 feet long, which is $9.72.

In like manner a slide rule was constructed to determine the cost of cold-rolled steel shafting which

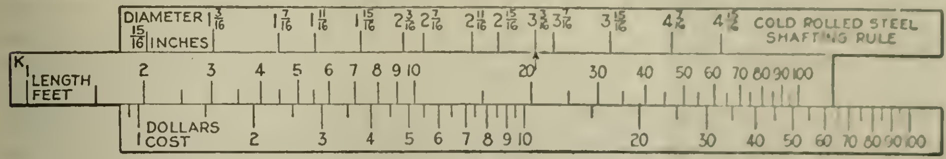


FIG. 6. SPECIAL SLIDE RULE TO DETERMINE COST OF COLD ROLLED SHAFTING

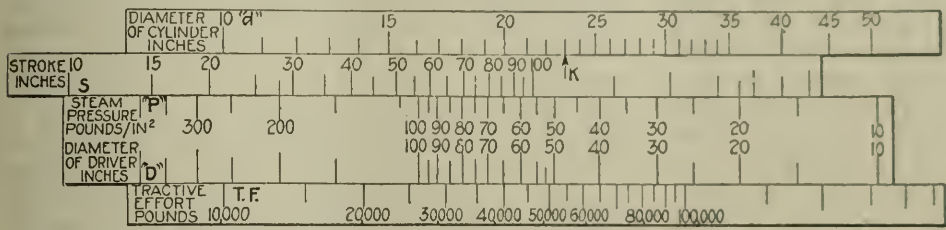


FIG. 7. SPECIAL SLIDE RULE TO DETERMINE TRACTIVE EFFORT OF LOCOMOTIVE

Assumes use of the formula: T.F. = 0.85 Pd²S/D where T.F. equals tractive effort in pounds; d equals diameter of cylinder in inches; P equals steam pressure in pounds per square inch; S equals stroke of piston in inches; D equals diameter of drivers in inches.

curve is plotted on rectangular cross-section paper, Fig. 4, and also on the logarithmic paper, Fig. 5. The equation of the shafting curve, following the same method of procedure, as already given in detail, is that of a parobola of the general form,

$x^2 = Ky$, which, in this case, is, $C = LD^2/K$

where, C is the total cost in dollars, L the length in feet, D the diameter in inches, and K the average constant, which is 20.39.

The equation is consistent with the fact that as steel shafting or any round stock is sold by weight, the weight, and consequently the cost, varies as the length and as the square of the diameter. Hence it follows that this slide rule is adaptable for any round stock material, the use of the correct value of K being the only requisite.

The resulting special slide rule is shown in Fig 6. The scales of the rule are in the proper position to determine the cost of a piece of $3\frac{3}{16}$ in. diameter cold-rolled steel shafting of any length. A piece 30 ft. long, for example, will cost $15.45; 40 ft., $20.60.

The possibilities for the further development of more complicated slide rules are indicated in Fig. 7 showing a rule to determine the tractive effort of a locomotive from the formula:

$$T. F. = 0.85\, P\, d^2\, S/D$$

This rule is a good example of the solution of formula involving several variables.

The sketch shows the rule set to determine the tractive effort of a locomotive with cylinders 23 x 28 in., boiler pressure 200 lb., diameter of drivers 52 in., giving the result as 48,400 lb. The scales representing the stroke, steam pressure and driver diameter slide between fixed scales representing diameter of cylinder and tractive effort.

Estimating Small Sewer Jobs

By W. Earl Weller

City Engineer, Binghamton, N. Y.

BECAUSE of the tendency of the engineer to underestimate the cost of construction work the preliminary estimate has become a source of friction between supervising engineers and contractors. Many an engineer as well as many a contractor has had cause to rue bitterly a carelessly considered or a too optimistically computed preliminary estimate. Especially is this true in municipal work where the penalty of a high preliminary estimate is the unpleasant experience of seeing a short-sighted legislative body refuse the funds for necessary construction. Perhaps an over-anxiety to make a project appear in its best light to a group of aldermen is the impelling reason for the chronic underestimating by municipal engineers. Whatever the cause, engineers should bring themselves to realize that the preliminary estimate is a most important part to any plan for construction work and that it is not a feature that may be neglected up to the very last minute and then rushed through in a haphazard manner. A moment's consideration will prove that a low preliminary estimate encourages inexperienced contractors to underbid a job to the detriment of the job itself and of all concerned and that it places the experienced contractors before the public in a most unfavorable light.

In connection with the more important and more costly work there is usually time, if the engineer will take it, to estimate most carefully the probable cost of the construction, but with the smaller jobs, more or less routine in their manner, time may actually be lacking for preparing a proper estimate. Two methods are then open to the engineer for arriving at a probable estimate of the cost. Either he may make a guess based on his personal experience or he may trust to the ability of one of his subordinates. In the ordinary office either course is dangerous and in a majority of cases will lead to embarrassing situations. A method of estimating the ubiquitous "V. T." sewer has been in use by the Bureau of Engineering of Binghamton, New York, for the past three years and has proved so satisfactory from the standpoints both of time and of accuracy that a brief description may not be amiss.

At the end of each construction season a careful analysis is made of the unit prices bid by the various successful contractors for the small sewers. These prices are tabulated as shown in the accompanying table, the second column giving the total number of units and the last column the total cost of each item for the season. From these figures are derived the average price to the city of the various items. The maximum and the minimum bid prices of successful contractors for the various items are also recorded in the table. These figures multiplied by the ratio between the cost of 8-in. pipe at the time the estimate is being made

and the average cost of 8-in. pipe during the season covered by the table are used as the unit prices for the preliminary estimate during the following season. Minimum, average or maximum prices are used depending on the nature of the soil to be encountered.

SEWER COST (1919), BINGHAMTON, N. Y.

Item	No.	Unit	Price Max.	Price Min.	Price Avg.	Cost
8-in. sewer 0- 6 deep...	659 7	lin.ft.	1.20	0 93	1.08	717.36
8-in. sewer 6- 8 deep...	5,633.9	lin.ft.	1 26	1 10	1 22	6,871.83
8-in. sewer 8-10 deep...	1,236 0	lin.ft.	1 45	1.20	1.37	1,698.45
10-in. sewer 6- 8 deep...	121.0	lin.ft.	1 45	1.45	1.45	175.45
10-in. sewer 8-10 deep...	802.0	lin.ft.	1.65	1.50	1.58	1,235.40
10-in. sewer 10-12 deep..	260.0	lin.ft.	3.12	1.92	2.15	559.20
10-in. sewer 12-14 deep..	156 0	lin.ft.	4.00	2 25	2.31	361.50
10-in. sewer 18-20 deep..	42 0	lin.ft.	6.00	6.00	6 00	252.00
12-in. sewer 0- 6 deep..	1,155.0	lin.ft.	1 20	1 20	1.20	1,386 00
12-in. sewer 6- 8 deep..	98 0	lin.ft.	2 00	2.00	2.00	196 00
15-in. sewer 6- 8 deep..	101.0	lin.ft.	2.10	2.10	2.10	212.10
15-in. sewer 8-10 deep..	59.0	lin.ft.	2 90	2 90	2.90	171 10
15-in. sewer 10-12 deep..	121.0	lin.ft.	4.00	4 00	4 00	484.00
30-in. sewer 0- 6 deep..	662.0	lin.ft.	5.35	5.35	5 35	3,541.70
30-in. sewer 6- 8 deep..	581.3	lin.ft.	6.00	6.00	6.00	3,487 80
30-in. sewer 8-10 deep..	524 0	lin.ft.	7 06	7.06	7 06	3,699 44
30-in. sewer 10-12 deep..	28.0	lin.ft.	8 50	8 50	8.50	238.00
Laterals..................	6,268.0	lin.ft.	1.00	0.62	0.69	4,378.76
Branches..............	338 0	each	2.20	1.02	1 86	630.18
Manholes..............	48.0	each	60.00	48 00	52 50	2,520.00
Manholes (ex. depth)....	73.4	lin.ft.	7 00	4 25	5 45	399.75
Catch basins............	21.0	each	130 00	115.00	125.71	2,640.00
Inlets..................	6.0	each	35.00	35 00	35.00	210.00
10-in. connections.......	126.0	lin.ft.	1 70	1.70	1 70	214 20
Replacing pavement.....	36.3	sq.yds.	3.40	3.40	3.40	123 42
Concrete..............	15.5	cu.yd.	10 42	10.42	10 42	161.51
Removing catch basins...	6.0	each	25.00	25.00	25.00	150.00
Extra work.............	......	.....	......	......	......	1,878.45
Inspection.............	......	.....	......	......	......	660.00

Total length of sewers	12,239.90 feet
Total cost	$39,253.60
Total cost without appurtenances	25,287.33
Cost per foot	3.21
Cost per foot without appurtenances	2.06
Percentages of cost:	
Sewer proper	64.42%
Laterals	12.76%
Appurtenances, excluding laterals	14.70%
Extra work (cost plus)	4 78%
Special work (bid prices)	1.65%
Inspection	1.69%

The method has proved exceptionally satisfactory during its three seasons of use. It is practically automatic and yet is flexible enough to meet varying conditions. For instance, it is possible in any particular case to judge how sharp competition for the work will be and to modify the unit figures by a ratio to meet this condition. The accuracy of the estimates so derived is surprising. The method is further extended for the purpose of furnishing snap figures for committees and boards that must have some fairly accurate estimate of the cost of these small sewers before even the survey is authorized. For this purpose a composite price per foot of the previous season's work is derived and this figure multiplied by the ratio stated above and the resulting product multiplied by the probable length of the sewer. The cost of a group of small sewers thus estimated will usually be from 90 to 95 per cent of the estimated cost, a most satisfactory condition. The method has been a saver of time and an avoider of those petty heart-burnings that are bound to follow a poor preliminary estimate. It is possible to apply similar methods to a large percentage of ordinary municipal construction.

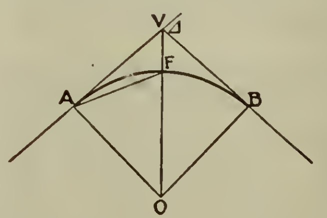
Salt River Bridge Completed

Completion of the bridge over the Salt River, on the Salt River-Pleasant Valley road in the Tonto National Forest, Gila county, Arizona, has been announced by T. W. Norcross, chief engineer of the U. S. Forest Service. This bridge makes unnecessary the operation of the dangerous ferry across Roosevelt Lake.

A Method of Setting Out Curves

By Walter H. Drane
Chief Engineer, Smith County Highway Commission, Carthage, Tenn.

In staking out curves in railroad and highway location work, much time is often consumed in selecting the proper curves and in fitting them to the ground.



In the accompanying figure, the usual problem presented after locating V and measuring delta, is to determine D and the PC of a curve to run through some selected point F, the curve being then figured from fieldbook tables. In brushy country, besides the labor of figuring, this often necessitates several settings of the instrument, with loss of time, and the method suggested below may prove useful.

Suppose the V and delta have been determined in the usual way and that the degree is figured from the tables as usual by selecting arbitrarily the point F in the secant through which it is desired that the curve shall pass. Locate F carefully by turning off an angle $\frac{1}{2}$ $(180 - \Delta)$. Move the instrument to F, orient on V and turn off the angle $VFA = 90° + \frac{1}{4}\ \Delta$. Now $FA = 2Rs$ in $\frac{1}{2}\ \Delta$. This locates A and the curve can be staked in by the usual method of deflections from F. If a check is desired, T may be computed from the tables and compared with the measured T $(A\ V)$.

There is nothing new in this as to geometry. Its possible advantage is that very often the entire curve can be staked easily in both ways from V, while obstacles would require several settings for the ordinary procedure. Another advantage is that F is usually much nearer V than either A or B, so that the instrumentman has much less distance to walk.

Making Macadam Surfaces Durable Type Bases

At the 26th annual convention of the American Society of Municipal Improvements held in St. Louis, George C. Warren, of Warren Bros. Co., set forth the value of conserving old macadam as a foundation for durable bituminous surfaces. Some of the points upon which he laid emphasis are given herewith:

1. The macadam must be real macadam of either stone or gravel of substantial strength, or must be reinforced with additional stone.

2. Make test holes across the road at intervals of about 100 ft. immediately in advance of construction for deciding the necessity of a depth of new metal.

3. Such reinforcements required to be paid for by the ton or cubic yard and bids should be taken on that basis, due to the impracticability of determining in advance exact quantities needed.

4. Do not disturb the old macadam for grade or contour changes unless absolutely necessary.

5. In every case where there is any road metal on the road or street, however thin or weak it may be, it is better to conserve it than to remove it.

6. If the test excavation develops that six inches or more of solid metal are present in which the coarse aggregate—above one-quarter inch in size—is more than one-half the total metal, no treatment is necessary or advisable except to smooth out irregularities in grade.

7. If the above condition does not exist and fine particles predominate less labor and cost will be necessary to increase the depth of the old surface after regulating the grade whatever depth of new metal intelligent consideration indicates to be best.

Trend of Highway Development —A Survey

THIS IS THE SIXTH of a series of staff articles on the highway situation. It discusses Maine's construction and maintenance of plain and surface-treated gravel roads, and the legislative measures that have given the towns in the state opportunity of initiating construction on connecting systems.

The seventh article in the series will appear in next week's issue.—EDITOR.

Maine's Practice

ATTENTION to the details with which Maine has so successfully built and maintained an extensive system of plain and surface-treated gravel roads is liable to eclipse other important considerations of her highway practice. Yet no inquiry into Maine's highway development can justly ignore the various highway measures that have induced almost every town in the state to assist in the construction of either state or state-aid roads.

Several factors contributed toward the extensive use of gravel surfaces on not only third-class roads but on the state and state-aid highways as well. In the first place, the large mileage of roads and the sparse population precluded the possibility of securing money with which to construct an elaborate system of any so-called durable types. Then, there is locally available pit gravel at a maximum haul of five miles. That distance has been exceeded at times in maintenance work but seldom on construction, and most projects have been completed with an average haul of from two to three miles. With these conditions existing, Maine has developed a system of plain gravel and surface-treated gravel roads that comprise approximately three-fourths of its 4,300 miles of state and state-aid roads, and which in some cases, carry during a four-months summer season as high a daily average as 3,500 vehicles of all types.

Deep Frost Penetration

One of the first facts to be noted in highway work in Maine is that there is a frost penetration of from 4½ to 6 ft., and in at least one case a penetration of 7 ft. has been noted. It is apparent, then, that the drainage must be carefully planned. In this connection it may be said that Maine does not believe in snow removal, and for two reasons: Because taking the snow from the highways would endanger their integrity through the removal of the protecting blanket against the most excessive frost penetration; and, because those who make winter use of the highways are, with few exceptions, prepared for the deepest snow.

Twelve different types of gravel road have been developed, so that every variation in subgrade is overcome and a surface secured with has successfully withstood heavy traffic. In general, upon the graded subgrade are placed from 2 to 4 in. of pit gravel. Upon that is laid one or several courses of quarry or field stone not more than 8 in. in largest dimension. This stone base is sometimes laid to a depth of 24 in., rarely 30 in., and usually about 10 in. This foundation course is hand laid and then filled with clean gravel, broomed, and rolled intensively, the aim being to fill to as great an extent as possible the voids in the stone base and to compact it thoroughly. A screened gravel surface of a depth varying between 6 and 11 in. is then laid.

For an 8-in. top surface, which is the usual depth, the gravel is laid in three courses. The first course is composed of 1-in. to 3½-in. gravel of a compacted thickness of 4 in.; the second course of ½-in. to 2-in. gravel of a compacted thickness of 3 in.; and the top course of ¼-in. to ½-in. gravel, of a thickness of 1 in. The first two courses of this top layer are clay bound, the pit gravel usually containing enough clay to secure a thorough bond.

Keeping Cushion Alive

Practically the entire success of gravel roads in Maine depends upon the laying and maintaining of the top 1 in. of the 8-in. gravel surface. Only the cleanest gravel is used. It is not rolled but kept continuously alive, that is, never allowed to become consolidated, thus always serving as a cushion coat to protect the bonded courses beneath it from the action of traffic. Were consolidation of the top allowed to occur it is pointed out that the whole road might soon shred or break up under traffic. Evidently careful selection of gravel and well-nigh perfect patrol maintenance are necessary.

Variation from the general method of construction is made where the vertical, natural drainage is good. In that case the stone base may be omitted. Again, drainage may be secured best through either a V-drain under the metaled surface or by a stone-filled side drain. In the former case the stone base attains a depth of 24 in. In the latter case a trench is dug, 10 ft. from the road center line, to a total depth of 4½ ft. below the finished grade. The bottom width of this trench is 18 in. and its top width 24 in. It is filled with stone uniformly graded from 6 in. at the bottom to 1 in. at the top course. Other variations from the general type of construction include the use of gravel containing large stones for foundations, sometimes to a depth of 11 in. where the subgrade does not need a stone base yet indicates that an 8-in. surface of fine gravel will not be sufficient. Gravel is also laid either with a feather edge, providing a 2½-ft. shoulder, or laid only to an 18-ft. width. Up to last year a uniform metaled width of 16 ft. was standard, a width that has been increased during this year to 18 ft.

It is considered good practice to gravel a road and leave it for from three to four years, even though hard surfacing is contemplated, so that, should there have been sections of road overlooked in the original design of drainage or foundation structures, weak spots may be eliminated before any costly surfacing is put down. When a road demands improvement through the laying of one of the so-called modern types of pavement, the gravel remains as the base for the new topping. Bituminous macadam, concrete and stone block have all been laid upon gravel roads with excellent results. Bituminous macadam is the most frequently used of the so-called durable types.

Organization

The state highway commission has jurisdiction over the maintenance of all state and state-aid improved and unimproved highways. The commission is so organized that the construction of state roads is accomplished by one division. Another has the construction of state-aid highways, and these two, together with the bridge, maintenance and accounting sections, form the five divisions of which the highway commission is composed. State-aid construction and maintenance are

more or less correlated inasmuch as the same supervisors who superintend specific state-aid jobs, have supervision over the maintenance work within the twenty-three supervisory districts.

The first maintenance operation upon gravel roads in the spring is shaping and blade-grading, accomplished as soon as the weather permits. After the road has been shaped, from 1½ to 2½ in. of clean, fine gravel is placed upon the road crown. This work is accomplished usually by fifteen-man gangs operating from four to six trucks, gravel loaders, gravel spreaders, etc. Usually from eight to ten of these gangs operate in the early spring. When this work has been finished, the same gangs put into stockpiles along the roadside the clean gravel which is to be used for maintenance during the rest of the season by the patrolmen, of which the state has approximately five hundred operating under the direction of the twenty-three supervisors. All but ten patrolmen operate single teams. Those ten form the nucleus of motor-truck-patrol gangs used on the maintenance of surface-treated gravel roads. Though the amount of territory covered by each patrolman varies greatly at times, the average length of improved and unimproved state and state-aid roads that each covers is eight miles.

Surface-Treated Gravel

Surface treatment of gravel roads is usually begun when a road takes a traffic of from 400 to 600 vehicles per day. The surface treatment is done on state roads only. The treatment begins during May, June or July, depending upon the weather and the place in the state in which the road is situated. Cold bituminous material is almost invariably used. Preliminary to the treatment of the road the surface is swept with horse-sweepers and then hand broomed, and thoroughly bonded. The first treatment is of approximately ½ gal. of bitumen to the square yard, upon which is spread sand, 40 to 50 cu.yd. per mile being used. With some patching that single application will usually carry a road through the first season. During the second season an average of 0.3 to 0.4 gal. of bitumen per square yard and the same quantity of sand as is used in the first treatment, are applied. Such treatments continue for four or five years. It has found that this repeated seasonal bituminous treatment unavoidably leaves, after a time, lumps of bonded material that make the road uneven. Therefore it is considered best to scarify the road and remove the surface to a depth of 3 to 4 in. These pieces of bitumen and gravel are carried to the roadside with a road machine and the road is again smoothed, planed and crowned. A small quantity of this scarified material is first brought back to the crown and allowed to consolidate under traffic. This process goes on throughout the entire season until all of the scarified material is again on the road. If traffic does not thoroughly consolidate it, it is rolled, and if it needs to be bonded, a little clay is added. When all of this material has been brought back upon the road surface from 0.2 to 0.3 gal. per square yard of bituminous material is applied, then covered with sand, 40 cu.yd. to the mile being used. Sand for this purpose is placed at the roadside in piles approximately 30 ft. apart, and the bituminous material is applied with truck distributors. At times it has been found necessary to heat the bitumen but never is it heated in excess of 100 deg. F. When the temperature is between 70 and 80 deg. F., or thereabouts, the bituminous material is always applied cold. The patching of bituminous surface-treated gravel roads is accomplished by truck patrol, team patrol being used upon plain gravel roads.

In the maintenance of surface-treated gravel roads particular attention is given the amount of bitumen applied. Application of a uniform quantity over any great length of road is rare. On the other hand, the bitumen applied may vary from ⅙ gal. to ½ gal. per sq.yd. within short distances and from one side of the road to the other. Spots may be encountered that need no treatment, then again more than the average application is necessary. *The practice is not to apply uniform quantities but to put the bitumen where it is needed*, and the superintendent of maintenance has exercised the greatest patience in instilling into his maintenance gangs the economy and efficiency of such practice.

To indicate the care with which gravel-treated roads are maintained, practical examples are given, which indicate to those in charge of the treatment the necessity of putting the bituminous material where it is needed. For instance, the superintendent of maintenance has frequently followed surface-application gangs. If he finds that puddles of bituminous material are being left, he stops the distributor and in each of these puddles of bitumen he throws a ten-cent piece. He then calls the man who is applying the bitumen and shows him the puddles and the ten-cent pieces, telling him that each puddle of bitumen means practically a ten-cent loss. In other words, he is throwing money away through injudicious application of bitumen and such a practical lesson need be given, in most cases, but once.

Close Scrutiny Given Surfaces

The superintendent of maintenance has, frequently, in going over roads which have been surface treated, used a magnifying glass to discover whether the road needed re-treatment. If any hair lines appear around protruding stones he knows re-treatment will soon be necessary and that if such spots are allowed to go until any appreciable moisture comes to the road surface, the integrity of the bond is endangered.

It is a rule in Maine that no bituminous material shall run to the sides of the road. If the bitumen distributor gets too far ahead of those doing the sand covering the first operation stops until the shovelers and rakers catch up. Then, better than put too much bitumen on, it is thought better to put too little on and make a re-treatment if necessary. However, practice in Maine has reached such an art that almost invariably the exact amount of surface treatment is done upon the first application. If, when treatment is begun, the road surface shows a hard stone, it is thought best to use less bitumen and sand and let the hard points of the stone take the wear of the traffic; whereas in the case of soft stone it is better to cover it up and let the bituminous mat take the traffic.

Maine began its construction of state roads (now state-aid roads) in 1901. Full control of the roads to be improved and the sort of construction to be followed lay with the sixteen county organizations. In 1908 these state-aid roads were put under the control of a single commissioner though the state itself did not begin the construction of roads until the formation of the present commission in 1913. In that year when the commission was organized a constitutional

amendment was also passed authorizing $2,000,000 of road bonds, the funds to be spent in four years—$500,000 per annum. That money was for construction of state highways solely, maintenance money being secured from the motor-vehicle license tax. After the $2,000,000 bond issue was expended the state highway fund was provided by a tax of one mill on each dollar of valuation in the state. With the prospect of increased Federal aid in 1919 another constitutional amendment was passed, allowing for an increase in highway indebtedness of $10,000,000. Bonds were to be carried by, and retired from, motor-vehicle tax fees. At the same time the mill-tax highway fund, excepting a small fraction, was diverted to other uses, such as third-class highway improvement, and to certain special jobs that the legislature might direct. The remainder of the vehicle tax left after providing for bond interest and sinking fund, is used for maintenance purposes, and the residue of the mill tax for either construction or maintenance.

Two recently enacted highway acts have tended to stimulate widespread construction upon state and state-aid highways through the initiative of the towns. The first of these is what is termed the third-class highway law. Through its provisions any town whose individual appropriations for road work have, during a period of five years, been an average of four mills, may, if the sixth year, the year in which money is applied for, equal the five-year average, apply for money made available by the state for such purposes. A sum of $10 per mile is procured through a six-year average expenditure of four mills, and for every mill above four an additional $1 per mile is given. The other act is the three-town highway law. When any three towns agree to the improvement of a highway connecting them, they can avail themselves of state aid through an appropriation of a sum equal to that named in the law, a sum which varies with the valuation of the town. If the towns make twice that base appropriation they receive twice the sum from the state plus a 25 per cent bonus; if three times, three times the amount from the state with a 50 per cent bonus; if four times, four times the amount and a 75 per cent bonus; and if five times, five times the amount plus a 100 per cent bonus.

Stimulus Given Towns

The first of these laws designates that the money may be used either upon third-class roads or upon state-aid roads, and the second law allows the expenditure to be made upon any class, including state roads. Both of the laws, and particularly the three-town law, have greatly stimulated road building throughout the entire state, and not only are the taxpayers at large carrying a comparatively heavy tax burden in the state bond issue, but they are vying with each other to secure the available appropriations from these two aid laws. The construction work executed under these laws is supervised by the highway commission. The laws have stimulated widespread construction upon state and state-aid connecting systems by towns, for the great part of all three-town-highway money is being expended upon such construction.

Maine is apt to be regarded as one of the small New England states, a fact which would perhaps minimize the importance of her success in building and maintaining a large mileage of gravel roads. One statement will suffice to place Maine as to size: From Fort Kent near the Canadian border to Kittery, at the New Hampshire line, running through the center of the state is a trunk-line highway which forms the backbone of the highway system. That road is of the same length as the most direct route from Kittery to Baltimore, Md. Therefore Maine's problem is the problem of the large, sparsely-populated Middle-Western state, but her treatment of the problem is distinctly her own.

Relation of Reservoir Storage to Conduit Capacity

By F. B. Marsh
Water Supply Board, Providence, R. I.

THE article in *Engineering News-Record*, July 22, p. 153, by Frederic H. Hapgood on the "Estimation of Conduit Capacity in Relation to Storage" calls to mind a similar problem of the Catskill water system for New York City which arose in 1906 in connection with the determination of whether it would be more economical to develop storage for the Schoharie watershed locally or increase the size of the tunnel to carry this water to the Esopus watershed and provide the requisite storage capacity by raising the flow line of the Ashokan reservoir.

This question of relative economy was solved by what was called, at the time, the "parallel tangent theorem." Having determined the total storage needed to develop the watershed there was prepared a curve showing the total cost of the so-called Schoharie reservoir for various capacities up to this total and similarly a curve of the cost of raising the flow line of Ashokan reservoir so as to obtain equal amounts of storage was prepared. In addition a curve of total cost of the Schoharie tunnel was plotted showing its increase in size, and therefore in cost as the amount of storage in Schoharie reservoir was decreased and the amount of storage in Ashokan reservoir increased, the total of the two always remaining the same. This curve of cost of the tunnel was then added to the curve of cost of storage in Ashokan reservoir. The most economical amount of storage to develop locally in the Schoharie reservoir was determined by finding the points on this combined curve and the curve of Schoharie storage, the tangents to which were parallel at the same time that the total storage was the amount necessary properly to develop the watershed.

This made a very neat solution of an otherwise tedious problem. This work was done under the direction of the writer as designing engineer of the New York Board of Water Supply but I am not sure who was the author of the "parallel tangent theorem." In any case the patents on it have probably expired long since.

Unemployment on the Job

Dr. Royal Meeker, until recently chief of the Bureau of Labor Statistics, has applied to indifferent service on the part of labor the term "unemployment on the job." He classifies unemployment in three groups:

1. Seasonal unemployment, due to the seasonal characteristics of industry or business. (Many of the construction industries would be typical examples of this sort.)

2. Sporadic unemployment, due to various causes occurring at irregular and unforeseen intervals, and

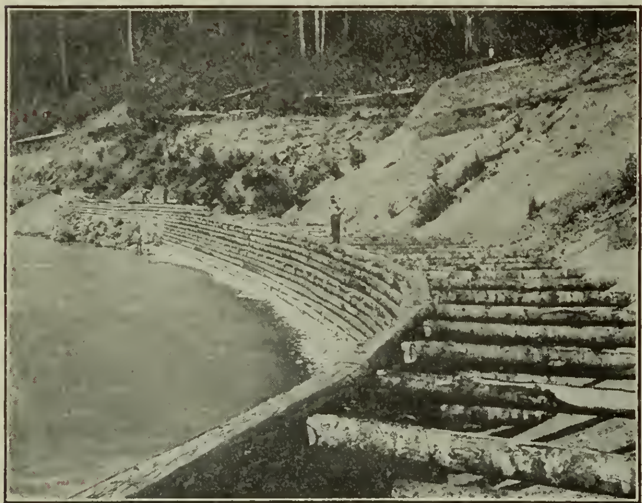
3. Unemployment of hard-times.

Observations on a Pacific Coast Trip

By Frank C. Wight
Associate Editor, *Engineering News-Record*

Seattle's Post-War Problems

SEATTLE is depressed but not downhearted. The depression is economic, partly a reflection of the general condition of the country and partly a local reaction following the cessation of war activity. The uplift of heart is spiritual and is part of the genius of the city, a spirit born in Alaska's boom of the nineties which transformed a frontier town to a city with visions of world greatness. It is more than mere poetic fancy to personify a city. They all have distinct personalities—in the older ones, perhaps, not so marked but in these great cities of the West quite inescapable. In Seattle the common aim toward growth is so obvious as to lend its flavor to the whole community. The vision is unconcealed—to become by virtue of its harbor, its proximity to Alaska and its slight time advantage



TIMBER CRIB SIDE HILL WORK ON SKAGIT RAILWAY

across the Pacific the great port on the east shores of that ocean. In fact, the common vaudeville joke in the competing neighbors to the south is to call New York "the Seattle of the East."

During the war Seattle was one of the busiest centers in the country. Great shipyards set records in construction far ahead of cities where shipbuilding had been a trade for decades. From it as a center went out the efforts of the spruce production army for aircraft. Just to the south of it lay the one big cantonment of the West; and to and from its crowded wharves came and went a large part of the enormous war traffic of the Orient. Boom times beyond the wildest dreams of even Seattle were upon it.

Shipyards Idle

Now the shipyards lie idle, workmen and their families to the number of 50,000 have left town, aircraft is no longer required, the soldiers have put on "civies" and the Orient is, for the time being, dead. Where once the Smith's Cove piers were crowded and packed with oils coming in and steel and munitions going out, now a lone steamer unloads rattan alongside half a dozen of its fellows tied up awaiting business. Because people must eat, good times or bad, the great fish trade of the Northwest continues to flourish and the enormous fish wharves with their thousands of boxes of canned salmon and their, one would almost say, millions of huge frozen halibut and salmon are crowded to capacity. In this one staple the port is very busy.

But Seattle is not discouraged. It counts the letdown of war business an expected sequel of peace and it looks forward with characteristic optimism to an early development of its natural resources. Two fields are particularly encouraging—besides the field of irrigation common to all the West, which, while discussed in engineering circles in Seattle, is not so prominent there as in Spokane and Portland. These two fields are water-power and paper-pulp production.

The latter is especially promising because of the great quantities of standing timber in the country, mainly in the peninsula across Puget Sound and on the lower Alaskan coast line. Near Port Angeles, for instance, small mills are already being enlarged and great projects are under way involving the use of the railway built but never used for the production of wood for airplanes. Near Juneau, much of the Alaska-Gastineau mining equipment is being transformed into paper-pulp mills because the ore is running out and gold mining no longer pays. Anyone familiar with the talk in Montreal and Quebec, to say nothing of our own northern New York cities, knows that with the present price of print and book paper, the Texas oil fields have nothing on a pulp-wood country for wild rumors and easy money, so some of the Seattle paper talk may be discounted. But the material is there and the Pacific Coast ought to be a sufficient market even against the competition British Columbia will undoubtedly give, so engineers are justified in looking forward to a development in which they have a direct interest.

The Skagit River Project

In water-power development the city's Skagit River project is the most talked about. Seattle has had some recent unfortunate experiences in municipal ownership. During the war transit congestion became so great, especially around the shipyard district, as to be intolerable and the usual controversy between city and street-railway company resulted. Finally, for a variety of reasons, most of which are now enveloped in the customary haze of politics—the city bought the street railways. Now the citizens are paying 10c. a ride (two together for 15c. or four tokens for a quarter, with a prospect of only three for a quarter) and the administration is going through all the motions of a boy who, exploring the inside of a basket, has connected with the business end of a large and tenacious crab. In addition to this, the familiar behavior of the city's Cedar River reservoir, whose natural banks continue to leak despite the quarter million dollars spent in an attempt to seal them, is still fresh in the minds of the people.

These two experiences have been unfortunate because they will be used—are being used, in fact—to cast doubts on the city water-power scheme in the Skagit district, regardless of the real merits or defects of that project. Engineering arguments are used in technical discussions, of course, but the common people—who will in the end control the issue—are apt to be more influenced by generalities of municipal inefficiency,

whether those generalities be true or not, than by cold engineering and finance. So far the completed estimate of cost and profit of the Skagit enterprise has not been made public, but about $5,500,000 has been appropriated and the city is going right ahead on the scheme outlined by C. F. Uhden in *Engineering News-Record*, Nov. 18, p. 994. The opposition to the project is divided among those frankly against public ownership, either by conviction or association, and those who think that the construction of a new dam at the head of Cedar River lake—below the porous formation—and the construction of a tunnel to a power house near the present one, would generate enough power for all present needs. There is some prospect that the opponents will prove strong enough to cause the city to abandon the Skagit plan.

As to Seattle's port plans nothing but gooa can be said. The commission is far-sighted and well advised in a technical way. Thanks to its good business in the war years it is entirely self-supporting and with any fair prospect will continue to be so. The new Smith's Cove terminals with their wide piers and sheds, their effective railway tracks, high-capacity and quick-moving handling machines and busy fleet of trucks and trailers, are a revelation to one accustomed to the slow and backward methods of New York. The pity grows with every new and modern port seen that other cities have the equipment but New York gets the business. A firm belief in the ultimate triumph of right thinking is the only bulwark against pessimism in this phase of port engineering. Seattle, however, is alive to its possibilities. It realizes that mere transfer of freight does not make a port, but that industrial activity must be cultivated and to that end the Port Commission is working with a committee of business men to induce manufacturers to bring their factories into or near the port area. With financial conditions bettered in Japan, and Russia restored to activity, Seattle is the logical center for the northern oriental trade.

Road Bonds Defeated

In both Spokane and Seattle one hears a lot about the Carlyon bill, which proposed bonding the state for $30,000,000 for paved roads and which was defeated by a seven to four vote in November. Many engineers, the majority it seemed, were against it and some of the engineering societies, notably the A. A. E. chapter at Seattle and the Associated Engineers at Spokane, actively fought it. The difficulty seemed to be that the proposal was for a trunk-line system of paved roads—though some clauses of the bill seem to provide for a variation from the program, but by a cumbrous and possibly unworkable method The opponents felt that Washington is more in need of radial highways from its smaller centers than for through lines and that it is more necessary to have some kind of passable highway—which means grading and subgrading—than to build first-class automobile roads. There was, too, much talk of the "cement trust" because the bill specifically favors concrete. It is significant, however, that in the West the recent highway bond proposals failed in those states where the new farmer-labor element is powerful. Unless they control the state, these people prefer the counties to run highway work.

Nothing is more evident in Seattle than the resentment against notoriety it achieved nearly two years ago when Ole Hanson "put down the rebillion." The

RUBY DAM SITE ON SKAGIT RIVER POWER PROJECT

publicity-loving Ole has now left the city and is getting more newspaper space writing despatches on the labor conditions abroad. Time softens most things, so perhaps reports today do not rightly mirror the conditions of the Seattle strike, but if what one hears now is true, there never was any danger of trouble in Seattle that could not have been readily allayed by less spectacular methods than were used. The skillful distribution of press matter swallowed whole by most of the newspapers in the country has left in the minds of the people at large an untrue idea of what Seattle overcame. Its citizens for the most part were right-thinking and quite capable of handling the violent tendencies of these among the laborers who made some gestures toward revolution.

Seattle is thoroughly American and her spirit of progress will not down. Because of the intensity of her war activity, the reaction, now that the war is over, is somewhat greater than in those cities that went more the even tenor of their ways from 1917 to 1919. But she is coming back.

Growth of American Merchant Marine

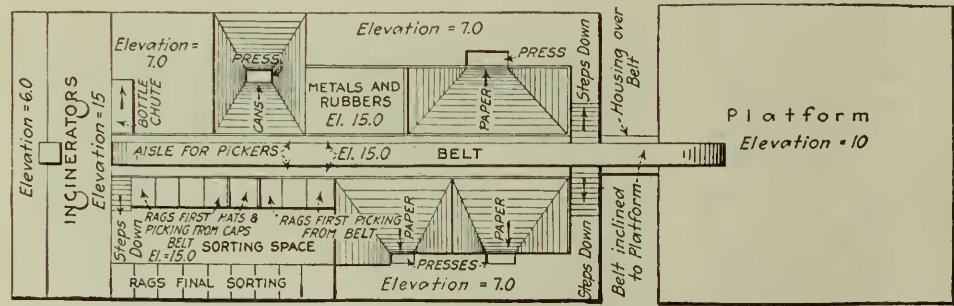
During September, for the first month since the armistice, according to returns of the Bureau of Navigation, Department of Commerce, the increase in the American seagoing merchant marine owned by American shipowners has exceeded the increase in the Government-owned ships built with appropriations by Congress. At the last session Congress, in the appropriation bills, changed the war policy and directed the Shipping Board to maintain itself by sales of ships and shore property without further appropriations. During September the fleet of seagoing ships of 500 gross tons or over of American shipowners rose to 1,829 of 4,625,324 gross tons, an increase during the month of 25 ships of 116,335 gross tons, while the Government-owned tonnage during the month increased only 20 ships of 88,855 gross tons, giving a Shipping Board total of 1,698 ships of 7,288,208 gross tons on Oct. 1. Since Jan. 1, 1920, however, the Government-owned tonnage has increased by 233 ships of 1,347,466 gross tons, while the commercial marine of American shipowners has increased only 129 ships of 536,926 gross tons.

Rubbish Collection and Disposal, District of Columbia

Work Taken Over From Contractor by District—Trash Sorted for Salable Materials; Tailings Burned—Salvage Pays 75 Per Cent of Cost of Collection and Disposal Operating Expenses

By Major F. S. Besson
Assistant to the Engineer Commissioner, District of Columbia

THE collection and disposal of the various classes of municipal refuse in the District of Columbia were for many years past accomplished only by contract. As the city grew larger and larger, more or less dissatisfaction developed with the contractual method, particularly as to the collections. On June 30, 1918, five separate contracts, each covering a distinct class of refuse, expired. Much difficulty was experienced in obtaining satisfactory new contracts. Emergency legislation was quickly obtained from Congress in order to take care of the garbage situation with District forces and efforts were made to obtain general Congressional enabling action authorizing the collection and disposal of all classes of city refuse as municipal functions.



PLAN OF TRASH OR RUBBISH SORTING AND SALVAGE PLANT, DISTRICT OF COLUMBIA

In 1919 the desired action was obtained and the Commissioners were authorized, "If in their opinion such action shall be to the best interests of the District of Columbia, to hereafter conduct any or all of the operations involved in the collection and disposal of city refuse of every kind as municipal functions: Provided, that any or all operations herein authorized to be conducted as municipal functions may be put into effect as such upon the expiration of any of the existing contracts for the collection and disposal of city refuse or upon the failure of any of the present contractors to properly perform the work covered by their contracts." Today the four major operations—street cleaning, collection and disposal of garbage, ashes, and trash [rubbish], are conducted by municipal forces, the last named having been taken over upon the failure of the contractor on Nov. 6, 1919.

For the trash collection and disposal contract, bids were received in 1918, as follows:

Period	Bid 1	Bid 2	Bid 3	Bid 4
July 1, 1918 to July 1, 1921	$45,000 per annum	$48,748 per annum	1st year $54,000 2nd year 35,400 3rd year 15,000	$107,400 per annum

The amounts stipulated in the bids were those to be paid to the bidders by the District. Bid 4, $107,400 per annum, was submitted by the contractor who had been collecting and disposing of the trash since the year 1910 and had available the plant used in his former contracts. The lowest bid was accepted by the Commissioners. The amounts to be paid the contractor—$54,000 for the first year, $35,400 for the second, and $15,000 for the third—indicate that the bidder had expectations that the amounts would suffice for plant cost and maintenance, and that receipts from salvage would compensate for collection and disposal expenditures and allow sufficient balance for profit.

Due to a combination of mishaps during the summer and fall of 1919, the contractor was finally forced to report that he was unable to continue longer with his contract, and on Nov. 6, 1919, the Commissioners took over the plant and equipment of the contractor for operation under the terms of the contract as protected by the surety bond. The work will be done with municipal forces until the end of the contract period, July 1, 1921, at which time a final settlement will be made, and from then on, the District will have to make other arrangements for its own plant and equipment.

Now that the District, upon the failure of the contractor, has been operating the plant and equipment of the latter for a period of eight months, to July 1, the end of the fiscal year 1920, sufficient data are at hand to permit a correct analysis of the situation. The population of the District of Columbia is 437,500 and the land area 60 square miles. Trash is not collected from outlying thinly populated sections, nor from business houses nor large apartment houses. The area of the city from which collections are made totals 36 square miles, having an estimated population of 375,000, less those persons living in large apartment houses, etc., which it is estimated amounts to 45,000, so that collection is actually made from about 330,000 people. The average haul to the present disposal plant is three miles.

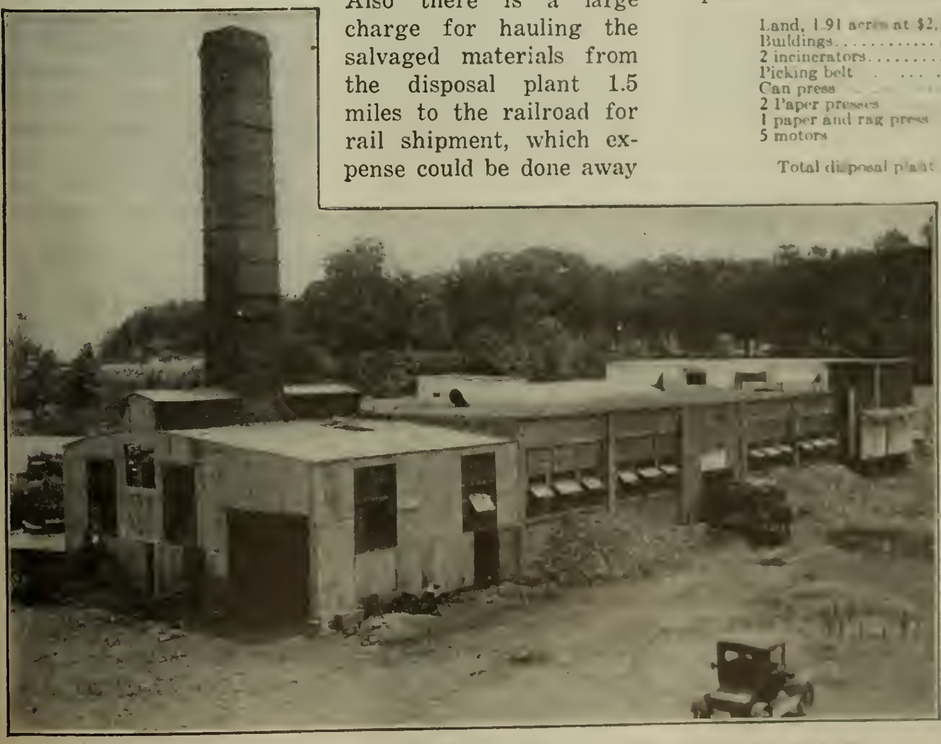
The disposal plant is in a building located at Mount Olivet Road and West Virginia Ave., N. E., where the trash is received, and sorted, the material with a salable value being salvaged, and the remainder burned, with the exception of a few large articles usually received, such as bed springs, furniture, large pots and cans. Strict enforcement of regulations governing the separation of refuse is maintained by the District and seldom or never does the householder put garbage or other forbidden refuse in with his trash. There are collected on an average 1,300 wagon loads of trash per month, each load averaging 11 cu.yd. This gives a total of 14,300 cu.yd. or a per capita collection of 0.043 cu.yd. per month based upon the 330,000 population from whom collections are made. The trash is collected in wagons with slat sides, the largest holding 14 cu.yd. and drawn by two horses. Two trucks are also used for special long distance collections. On the floor of

each wagon body and up the front is a chain and bar sling. Upon arrival at the disposal plant the front upper end of the sling is attached to a winch and the load dragged from the wagon. It is then run over a picking belt, and all that is not picked off as of value passes into the incinerators. The amount burned is but 7 per cent of the trash collected, and consists mostly of house sweepings, old flowers, pieces of wood, etc., but never of anything that in the burning would create a nuisance.

The material salvaged averages the following per month Paper, 1,000,000 lb.; books and magazines, 20,000 lb.; rags, 50,000 lb.; cans, 300,000 lb.; metals and rubbers, 4,600 lb.; 60,000 bottles; cullet (broken glass) 78,000 lb.

This salvage, in its loose mixed state, weighs approximately 120 lb. to the cubic yard and totals 12,600 cu.yd. The unsalable non-combustible large articles, such as bed springs, etc., which are not sent over the picking, belt weigh about 1,000 lb. per cubic yard and amount to 700 cu.yd. per month. The material burned amounts to 1,000 cu.yd., weighing 600 lb. per cubic yard. The ash remaining from the burning of this 1,000 cu.yd. amounts to 150 cu.yd. The material salvaged, non-salable, and burned totals 14,300 cu.yd., which in the wagons, as collected, weighs 200 lb. per cubic yard.

There are certain expenses in connection with trash collection and disposal that would vary, due to the conditions that may exist in various cities. As to collections, much depends upon the service rendered the people. It is the aim of the District's City Refuse Division to take immediate remedial action on the least complaint telephoned or addressed to it at the District Building. Expenses of collection could be cut down materially if the average haul of three miles to the present plant could by a relocation be shortened, but there is difficulty in obtaining such a new location. Also there is a large charge for hauling the salvaged materials from the disposal plant 1.5 miles to the railroad for rail shipment, which expense could be done away with if a satisfactory location abutting a railroad could be obtained. Some cities attempt economy by passing the heat developed in the incinerators through boilers in order to generate steam for operating the equipment in the disposal plant. There is no such provision in the District plant. In fact it is considered that the calorific value of Washington's trash remaining after salvage operations is so small that no attempt should be made for such utilization.



EXTERIOR VIEW OF DISTRICT OF COLUMBIA TRASH DISPOSAL PLANT

(The unloading platform is at the far end, the picking belt and presses are in central or brick portion of the building and the incinerators at the left. The material piled against the building is broken glass awaiting shipment.)

Many additions and betterments have been made to the plant and equipment as originally taken over from the contractor in order to render proper service to the city. Equipment and plant necessary for satisfactory collection, under Washington conditions with an average haul of three miles to the disposal plant, consists of:

Land, ½ acre at $2,500	$1,250
Stable and shops	[illegible]
37 horses at $250	9,250
25 wagons at $250	6,250
25 sets harness at $80	2,000
2 trucks	5,7[illegible]
Sundry equipment	1,475
Total equipment and plant	$27,925

Yearly depreciation and taxes on the collection equipment and plant, as listed above, is estimated at 15 per cent or $4,189. Interest at 6 per cent amounts to $1,675, giving a total yearly charge of $5,864.

Collection operation and maintenance may be itemized per year as follows:

1 Foreman	$1,800
37 Men, drivers and collectors	42,[illegible]
4 Inspectors	5,7[illegible]
7 Men, stable and shops	13,4[illegible]
Forage	8,735
Wagon parts	7[illegible]
Horse and harness maintenance	3,[illegible]
Truck maintenance	1,750
Miscellaneous supplies	750
Total collection operation and maintenance per year	$79,335

With additions and betterments to the contractor's disposal arrangements in order to properly salvage and dispose of the collections, the plant is as follows:

Land, 1.91 acres at $2,500	$4,775
Buildings	1[illegible],000
2 incinerators	7,000
Picking belt	2,026
Can press	4,000
2 Paper presses	6,[illegible]00
1 paper and rag press	2,500
5 motors	2,000
Total disposal plant	$47,3[illegible]1

Taxes and yearly depreciation on the disposal plant are estimated at 7 per cent or $3,311. Interest at 6 per cent amounts to $2,838, giving a total yearly charge of $6,149.

Disposal operation and maintenance may be itemized per year as follows:

1 Foreman	$1,[illegible]
40 Women pickers	[illegible]
40 Men pickers and operators	[illegible]
[illegible] power for operation	[illegible]
[illegible]	[illegible]
General maintenance	[illegible]
[illegible] and ventilation	[illegible]
Hauling	[illegible]
Miscellaneous expenses	[illegible]
Total disposal operation and maintenance	$[illegible]

Overhead expenses for collection and disposal are:

1 Superintendent	$[illegible]
Administration	[illegible]
Salvage [illegible]	[illegible]
Hauling to the railroad	[illegible]
Total overhead	$16,500

FOURTEEN-YARD RUBBISH WAGON, DISTRICT OF COLUMBIA

A winch in the rear of the shed pulls the load from the wagon.

Receipts from the sale of salvage vary widely from month to month due to great fluctuation in the market for materials of this nature. During the eight months' operation by the District the maximum and minimum prices received have been as shown below. For comparison there are also set forth the prices that were prevalent early in 1918 just prior to the submission of the contractor's bid.

Items	Maximum	Minimum	1918
Paper, cwt.	$1.70	$0.40	$0.20
Books and magazines, cwt.	1.80	.90	.75
Rags, lb.	.045	.022	.015
Cans, ton	6.75	4.50	1.75
Metals, rubber, etc., lb.	.07	.035	.05
Bottles, each	.009	.007	.008
Cullet (broken glass), ton	4.50	4.50	...

For the eight months of District operation the receipts averaged $12,750 per month. For the month of July the receipts reached $22,000. Based upon the early 1918 prices the monthly receipts would total but $3,872.

A recapitulation covering a period of three years, the term of the contract, and using the average of the receipts during District operation as a basis, is as follows:

Items—Three Years	Credits	Debits
Contract payments	$104,400	....
Collection, depreciation, etc.	....	$17,592
Collection, operation	....	238,005
Disposal, depreciation, etc.	....	18,447
Disposal, operation	....	289,170
Overhead	....	49,500
Sale of salvage	459,000	....
Total	$563,400	$612,714

The detailed data show that based on prices of equipment, materials and supplies, labor, and other expenses as current during the eight months' experience of the District, an average monthly receipt from salvage of $12,750 is not sufficient to show a profit. Though it is true that prices being received at the present moment for salvaged materials are such as would show a profit, it is considered that they are abnormally high. A fall in the market must be expected, and without a corresponding drop in labor and other operating expenses. Putting to one side capital expenses and contract payments, it may be stated that for the eight-month period in question, salvage sufficed to pay 75 per cent of the expenses of doing business, both collection and disposal. What proportion of the expense would be covered by salvage for the remainder of the three-year contractual period is largely a matter of guess-work.

Surveying From the Air

Tests Indicate Great Possibilities in Expediting Mapping of Waterways and Interior Surveys

By Colonel E. Lester Jones
Director, U. S. Coast and Geodetic Survey, Washington, D. C.

THE great possibilities of airplane photography in connection with the water and land work of the U. S. Coast and Geodetic Survey are looming up as a potential factor in expediting the mapping of our waterways and interior surveys. This important subject has been the object of careful study and experiments by officers of the survey, in collaboration with the other branches of the government, during the past year and the rapid advance in aërial photography, first seriously undertaken during the war, now promises, with proper development, a method of surveying that will probably far exceed expectations in rapidity, economy and minuteness of detail. Stress should be laid on the fact that not only are the possibilities good for an early and complete revision of our shore topography, but the opportunities that present themselves for assisting materially in our hydrographic work should not be underestimated.

FIG. 1. SECTION OF CHART SHOWING STONE HARBOR, N. J., AS SURVEYED IN 1899

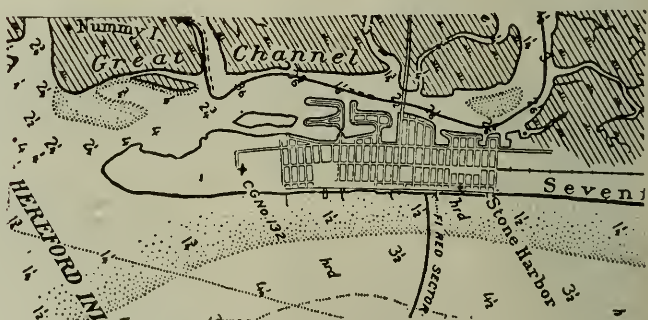


FIG. 2. SECTION OF CHART SHOWN IN FIG. 1 AS REVISED FROM AIRPLANE PHOTOGRAPH MADE IN MARCH, 1920

With the necessary facilities and co-operation supplied by the Army and Navy Aviation Corps to the

FIG. 3. MOSAIC OF STONE HARBOR, N. J., FROM PHOTOS BY ARMY AIR SERVICE
K-1—Mapping camera used: altitude 10,000 ft., approximately. Scale of original 1:10,000. Data reduced directly from the mosaic to scale of chart by means of pantograph.

Coast and Geodetic Survey, experience has already proved the value of aërial photography over the old method of surveying in revision surveys of our coast lines. This work, so far, is divided into two branches: (1) Aërial photography and (2) aërial photo-hydrography. The results are shown in the following recent practical demonstrations.

Aerial Photo-Topography

In July, 1919, experiments were made at Atlantic City, N. J., to ascertain the adaptability of airplane photographs for use in topographic mapping. The area in the vicinity of Atlantic City was chosen as it is characteristic of so much of the coastal plain territory of the Atlantic coast. This project was essentially experimental in character, but developed into one of practical value, as the photographs are being used in a revision of the charts of the New Jersey coast.

The work was done in co-operation with the Air Services of the Army and Navy. Both land and seaplanes were used, and in addition several photographs were made from a dirigible. Three types of mapping cameras were tried out, the "L" type, K-1 and Trilens. An officer of the survey kept in close touch with the work and furnished the ground control, constructing special targets in some cases.

A mosaic was constructed by members of the Air Service of the Army, using the photographs made with the K-1 mapping camera. These were taken at an altitude of 7,000 ft., using a lens of 10-in. focal length, with a resulting scale of about 1:8,000. A rough control scheme was first laid out and the mosaic constructed over it.

The most important point brought out from the study of the results of the work at Atlantic City was the possibilities in revision work, especially along those sections of the Atlantic coast where the shoreline is subject to frequent changes owing to the action of the sea.

Aerial Photo-Hydrography

At the same time that the experiments at Atlantic City were being made, at Key West, Fla., photographs were taken by the Naval Air Service to determine the possible use of aërial photographs in connection with hydrographic surveys. The primary object in view was the elimination of wire-drag work, especially in the clear waters of the Florida coast. An attempt was made to photograph small coral heads and pinnacle rocks, as it is the existence of these needle-like dangers to navigation that requires the use of the wire-drag. Photographs were made at altitudes of from 200 ft. up to 4,000 ft. and under various light conditions.

The problem of control was solved by including in each photograph two vessels of the survey. The photographs could not be corrected for tilt with only two known points as a base, but the control, as furnished by the positions of the two vessels, was found to be sufficient for experiments.

A well-surveyed area near Key West was chosen, and the vessels proceeded on parallel courses over this area at full speed, the plane flying forth and back above the course. The courses and position of the vessels were recorded as in ordinary sounding work. The photographer in the plane recorded the exact time that each exposure was made, with other data such as altitude, exposure, plate, filter, etc. Each photograph was later oriented by plotting the positions of the vessels on the chart at the instant the exposure was made.

Conclusions

These experiments proved conclusively that photographs from the air, using present-day equipment, are of little practical value to the hydrographer. When any of the underwater features did appear in the photographs, contrast in color was the most prominent, with no indication as to whether the contrast indicated shoal or deep water. Vari-colored bottom of uniform depth appears in the photograph as apparent difference in depth. Many charted shoals are not indicated in the photographs while adjacent ones show clearly. Taken altogether, the results are so uncertain that the chances of eliminating field work in hydrography are remote. Developments in the art of photography may change this viewpoint.

In March, 1920, the Army Air Service photographed the coast line of New Jersey from Cape May to Seabright. A single flight was made using the K-1 camera. The plane flew at an altitude of 10,000 ft. and under very good air conditions. The camera was mounted in gimbals, with a lead weight at the lowest point to assist in maintaining the optical axis of camera in a vertical position. Level bubbles aided in keeping the

camera in the proper position. This is the most satisfactory way to suspend the camera and control its verticality. The photographs are being used for a revision of the charts of the coast of New Jersey. The individual photographs are 18 x 24 cm. in size and the approximate scale is 1:10,000. The photographs are mounted in strip mosaics for convenience sake, not over 4-ft. in length. The length is generally determined by the position of control points. This composite photograph is compared with the topographic sheet of the same area and control points identified. The scale of the photographic mosaic is determined, and by means of the pantograph the data are reduced to the scale of the chart and transferred from the photographs to tracing paper.

The photographing of this 120 miles of coast line took less than 2 hr. time in an airplane. The development of the films and printing took two days' time of one man. Two rolls of film were used, a total of 183 photographs. The work of interpreting the photographs, assembling mosaics, comparison with topographic sheet and reduction to the scale of the chart of the outside shore line required 15 days of office work by one engineer.

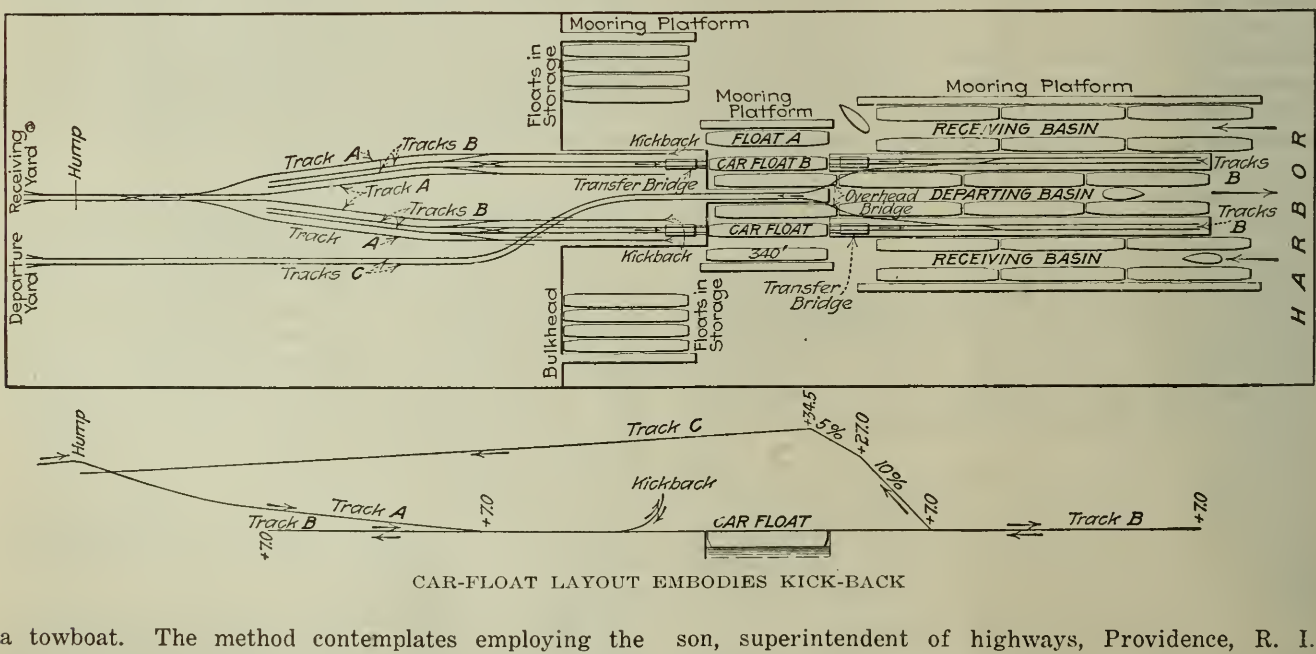
Proposed Method for Handling Car-Float Transfer Movement

By J. Jervis Vail
Assistant Engineer of Construction, Pennsylvania R.R., Rahway, N. J.

Departure from present methods of loading and unloading car floats is suggested in the accompanying drawing, the purpose of which is to attain something of the economy and speed reached at coal car dumping layouts and to moor floats so that they can be moved in and out of the bridges quickly without a towboat. The method contemplates employing the kickback track and the principle of loading cars at one end of a float and unloading them at the other, originated by A. T. Luehman, assistant to engineer maintenance-of-way Pennsylvania R.R.

Cars to be loaded onto the floats, represented in the drawing, will be pushed over the hump from the receiving yard and cut off in bands of eight, equivalent to the capacity of each track on the floats. From the hump the cars run down by gravity from one of the four tracks marked *A* to the kickback, which reverses their direction and throws them back on one of the tracks marked *B*. On this track a small electric locomotive, geared to a rack between the rails, will couple up to the train and push the cars onto the float. At the same time a similar locomotive on the outshore end of track *B* will pull off the cars arriving on the float push them up the steep grade at the outshore end of one of the two tracks marked *C*, and drop them over the hump so that they will run by gravity to be classified in the departure yard.

Cars will be pushed onto both tracks of the float at one time and would be unloaded from both tracks at the same time in order to eliminate strain on the bridge and float due to unbalanced loading. The movement of arriving floats will be into either of the two receiving basins. Float *A* has been moved from the receiving basin and is tied up to the mooring platform ready to go into the bridge berth. Float *B* is at the bridges ready to be unloaded and then loaded. From here it will go into the departing basin, where towboats make fast to the floats for convoy. Floats requiring special movements can enter the bridges through the inshore openings and be taken out the same way. The floats should be of standard length, or otherwise it would be necessary to move them longitudinally in the slip after unloading before cars could be loaded at the opposite end. Floats in the basins would be moved by electric winches without the use of a towboat.



CAR-FLOAT LAYOUT EMBODIES KICK-BACK

Asphalt Pavement Laid at Fast Rate

What is believed to be a record hard to equal in laying asphalt pavement was recently accomplished by city forces working under the supervision of J. H. Johnson, superintendent of highways, Providence, R. I. According to Mr. Johnson twelve men laid a 2-in. asphalt top on a 4-in. sand-filled, compacted stone base penetrated with 2½ gal. of asphalt per square yard, on a Providence street 2,000 ft. long and 24 ft. wide, the entire job from subsoil to surface being done in 18 successive working days. The street so surfaced is Alverson Ave., from Plainfield to Hartford Aves.

Relative Service Value of Pavement Types

Paper (Slightly Condensed) Read by A. R. Hirst, State Highway Engineer of Wisconsin, at Annual Meeting of American Association of State Highway Officials, Washington, D. C., Dec. 13-16

IF, IN a discussion of the relative service value of different types of rural pavements, any one expects specific rules and well-buttressed conclusions, he is doomed to disappointment. It is my opinion that nothing of the kind is justified from the information now available. The term "relative service value" is, itself, open to various interpretations. It might be held to cover only the potential power of a pavement to bear traffic of various amounts regardless of cost or economics, or it might be held to include the two latter factors. The author prefers to include the latter, and hopes that he will be excused of a possible overlap due to this interpretation.

Among the characteristics usually listed as important in determining the service value of pavements, are: (1) Freedom from dust; (2) appearance; (3) character of foothold; (4) ability to clean; (5) freedom from sanitary objection; (6) character as regards noise; (7) freedom from slipperiness, and (8) low tractive resistance.

Important Points in Mr. Hirst's Discussion

1. The prime factor in determining the relative service value of highways is whether they serve traffic effectively and inexpensively.

2. Preliminary traffic censuses are valueless as aids in pavement type selection.

3. Traffic counts have value only in giving information upon traffic changes, and operation costs over varying pavement surfaces.

4. What has been is no indication of what will be.

5. States must adopt uniform loads to be borne by roads of varying classes of importance.

6. All highways cannot be made 15-ton highways every day in the year.

7. Expressed in terms of real service value, type means little unless selection of it is supplemented by proper design and layout.

8. The road problem is not to build a few boulevards but a transportation system.

9. We have thought too little about the basic function of highways—the offering of facilities for travel.

10. A striking feature of highway construction, reconstruction and maintenance has been an almost total disregard of comfort, convenience and economy of operation in the interests of the traveling public.

11. The one permanent thing about road work is proper grading on correct locations.

12. The highway user knows little about pavement economics; but he does know where and when he broke the last spring.

13. We have used too much mathematics and too little common sense.

14. Car owners demand service and service they must be given.

15. Maintenance is the keystone of the entire structure of pavement service.

Almost without exception the characteristics cited above are among the least important of the matters to be considered in determining the service value of rural pavements. The predominant factor in determining the relative service value of pavements is whether they serve the traffic effectively and cheaply. It may be given as a truism that given effective construction and proper width, almost any one of a dozen different pavements will give good service. The question to be determined by the highway engineer is whether they have given, or will give, good service cheaply.

Traffic

Highway traffic is, of course, the first factor to be seriously considered in connection with pavement economics. Traffic is the thing which makes highway surfacings worth while, and the thing which wears them out. Its amount and its characteristics are important and should always be taken into account.

We are going to shock a good many of our more theoretical brethren by saying that a preliminary traffic census is absolutely valueless in helping to determine the type of surfacing to be used. An inspection of the location of a road on the map, a knowledge of its relation to other roads and to the general highway system, and to business centers; together with a consideration of the business tributary to it and probably to be tributary to it, will tell a highway engineer, who knows his business, whether the construction in question should be first, second, or third class. The traffic on a road last year or last month has absolutely no value in this connection, because when a highway becomes a part of a superior highway system, or when one highway is paved with a surface superior to that on the adjacent and competing highways, traffic is so concentrated on that highway that what has been is no indication of what will be.

Any assumption of what traffic will be is merely an assumption and the presence on a certain past day of one hundred automobiles, ten trucks, eight farmers or their wives in single buggies, and three babies in their perambulators, has really no bearing on the future situation.

Traffic counts have value only as serving to give accurate information as to the constantly occurring changes in traffic conditions, and in determining the relative cost of service per unit given by various pavements. The unit cost per ton of carrying traffic is the important consideration and, unfortunately, we have little or no information on this point.

The fact that this type of pavement was maintained for so much per annum and that type for so much per annum means little, unless we know the amount and weight of the traffic served and that it was served adequately. Even then the information would not be conclusive, because the pavement which gave this unit cost under the prevailing soil and climatic conditions might give an entirely different unit cost under different soil and climatic conditions. We have been too prone to assume from the results of experience with a limited number of stretches of a certain type of pavement, built and maintained under certain conditions, that the same results will ensue from the use of the same pavement wherever it may be built. This is not the case. Climatic, soil, and rainfall conditions must be considered as well as traffic and general performance.

Weight of Traffic

Among the important circumstances affecting the service of pavements is the weight of the traffic which the pavement bears.

American highway engineers have been condemned by the unthinking for having built roads which have not stood up under the intense motor traffic of recent years. It would be just as sensible to condemn a railroad engineering department for the failure of railroad bridges under engines

weighing 200 tons, when the bridges were designed for engines weighing 20 tons. Before new and heavier loads are allowed on any length of railroad all parts of the construction are examined and, if necessary, strengthened or rebuilt before the new traffic is allowed to pass over them. There has been nothing of this in highway practice. Loads almost without limit have been placed upon highways designed for conditions existing and anticipated a decade ago, and condemnation has resulted when the inevitable failure of the road structure ensued.

It would seem that it would be clear to even the feeblest-minded that it is not going to be possible for the designers of vehicles using highways to turn loose upon highways any behemoth their ingenuity may design at any time they feel like doing so. It isn't possible to reconstruct the highway system of America every few months, or even every few years.

It is imperative that the several states adopt uniform standards for the loads to be borne by roads of the different classes of importance. It is going to be difficult to do this, because when a motor vehicle is once started toward its destination its operator will wish it to carry its full load for the whole trip, but it seems inevitable that we must classify highways as to the allowable loads upon them, and that traffic on highways must be made to conform to these loads. All roads cannot be made 15-ton roads every day in the year.

It is undoubtedly going to be possible for the states between their congested centers and on certain through highways to finance ultimately the construction of roads which will every day in the year permit loads of twelve to fifteen tons or, if the economics of transportation really justify it, even more. But just as certainly it is going to be impossible for the states to finance the construction of any great percentage of their roads so that they will stand such loads every day in the year, and I believe that on the secondary roads and roads of the lower classes, much lower load limits must be insisted upon, especially at certain seasons.

Continuous Travelability

One of the intangible factors in the service value of types of pavement is the factor of continuous travelability. It goes without saying that given two pavements of equal annual cost, one of which is out of service for several days each year and probably for two or three months at several times during the assumed pavement life, the other one allowing the passage of traffic during its life with practically no inconvenience and no detouring, the choice would immediately fall upon the one which gives the superior travelability. Furthermore, if the maintenance of one type demands annually, semi-annually or periodically, the application of such materials that traffic cannot be accommodated during the application or, if accommodated, is subject to possibility of accident from slipperiness and to defacement of vehicles and clothes, it is a serious impairment of the service value of the pavement.

One of the strikingly characteristic things about American highway practice has been the almost total disregard for the comfort, convenience, and economy of the traveling public during construction, maintenance and reconstruction. A public-be-damned policy has been quite generaly practiced. The traveling public has been considered as an interloper, with no possible business save to pay the bills.

The economic loss to traffic through detouring has been tremendous. For example: A road carrying a traffic of 1,000 vehicles a day is closed for a length of five miles due to construction or reconstruction, for a period of four months, the detour being eight miles in length, a loss to traffic of three miles. The total traffic loss is therefore 360,000 miles, which, at 12c. a mile, is $43,200, a figure which may well have a material bearing upon the type of pavement which one should select. Similarly derived figures will illustrate the importance of speed in construction and reconstruction and demonstrates that it is usually worth paying for.

We have been too prone to select types of pavement on the say-so of others without very material consideration of the matter of cost. The minute we commence to discuss the relative cost of pavements we are thrown into the ocean of economic discussion at a point far beyond our depths.

We are immediately brought in contact with the question: "Should an engineer in weighing the merits of two or more types of pavement consider the factor of interest on the original investment?" Many good authorities say "Yes"; many good authorities say "No." I do not pretend to be good authority, but I am sure that the answer is "Yes." The statement that the value of the pavement in increased comfort, convenience, saving in hauling, saving in gasoline, tires, etc., far offsets the interest on the investment, sounds very nice; but what is one going to do about it when one is considering two types of pavement, both of which do all of these things, but the costs of which are very dissimilar?

In addition to this difficulty with the basic economics of the situation, we have the further trouble that in comparing the unit annual cost of various pavements, we must make assumptions as to the lives of pavements, and we have little or no information on which to base these assumptions.

It might be of some value to cite the factors entering into an economic comparison and to show just how far one can get in his figuring:

1. *First cost of the pavement.*—This is readily determinable within the limits of estimating and causes no trouble.
2. *The interest charge on the pavement investment.*—This charge should be compounded annually and is, of course, readily determinable.
3. *The annual cost of maintenance of the pavement.*—This is only moderately guessable because no one can tell what the cost of the materials and labor entering into repairs will be next year or in succeeding years. Furthermore, no one can guess what unexpected development of traffic may entirely upset the conditions under which the surface exists.
4. *Interest on the maintenance cost.*—This should be added to the cost of the pavement and should be compounded annually.
5. *The assumption of the life of the pavement before total reconstruction is necessary.*—Again we are in the field of theory, because the life of the pavement depends upon the traffic which it will carry through a series of years. Furthermore, on many of the pavements which are now being widely used, enough information is not available to determine what the life may be, and even on some of the older types of pavement, built under supposed to be standard and fool-proof specifications, a variation in life of several hundred per cent has been noted.

Total Pavement Cost

The summation of items 1, 2, 3 and 4, divided by the number of years of expected life of the pavement gives the annual cost to the public of the pavement so far as the mere outlay of money is concerned.

Before the division by the number of years of expected life is made, however, there should be subtracted from the total cost the value of the old pavement for use in the new pavement. Here again we are in the realms of guesswork. Assuming that a certain type of pavement can be preserved for twenty years and will then need resurfacing or replacement by another type, we are making a grave assumption if we value the base at anything very material, because the change in traffic on rural highways is so rapid that it is very hard for one to say that the alignment, grade, culverts or structures that we are building today, or the widths that we are using, will be of any great value twenty years from now.

At the end of this series of guesses and assumptions upon assumptions, one will have some basis, better than no basis, for comparing the annual cost of the types under consideration.

Highway engineers have been designing pavements of too narrow widths, and have multiplied their troubles of maintenance by confining traffic to one or two very restricted lines. *The conduct of all pavements, especially of the so-called inferior pavements, such as waterbound macadams, gravels, and the lesser non-rigid types, is good or bad in almost direct proportion to whether they have been built wide or narrow.*

I am not going to develop this thought in detail, but I believe that highway engineers will find that, if they will design the so-called non-rigid roads wider and flatter much of the trouble incident to the present use of these structures will be avoided.

A supposed-to-be two-track concrete or other rigid surface road built 14, 15 or even 16 ft. wide on a main-traveled highway has its service value greatly reduced by its inadequate width because it breeds disastrous accidents and causes worry at all times. The shoulder maintenance is also a constant source of worry and grave expense if traffic is at all heavy. Furthermore, the concentration of traffic and the crowding to the extreme edges brought about by such widths reduces the effective life of the pavement very materially. It is our opinion that even the rigid types of pavement must provide for a moderate distribution of traffic if they are to hold. The minimum two-track highway is 18 ft., and 20 ft. is better on principal highways. If municipalities cannot finance these widths they had better build part of their lengths of a cheaper type, pending the securing of more money. Plastic or viscous surfaces of all kinds must have width to allow for traffic distribution, especially if built in a climate of wide total temperature variation. On these types especially traffic must be distributed so that it will heal its own marks and not deepen them in heated periods.

On primary highways, unless convenient detours are available, all pavements which from their nature require frequent surface attention embarrassing to traffic should be constructed wide enough so that they can be maintained and repaired one half at a time.

Design and Service Value

The service value of any kind of pavement depends largely upon proper design. It is not only necessary that the pavement be well drained, that it be built of the right depth and width, but the materials in it must be properly sized and prepared. For instance: A gravel road built of uncrushed and unscreened gravel, varying in size from sand to cobble stones as large as one's head, has practically no service value today, because it is impossible to maintain such a road so as to give satisfactory service. On the other hand, a road built of the same width and depth and of the same gravel properly crushed and sized may give most economical service. In Wisconsin we have reached the point where we don't want any gravel within 4 in. of the surface larger than 1 in. and we prefer to have no gravel in the whole structure larger than 1 in.

The service value of any highway may be seriously impaired by the use of sharp and dangerous curves, poor alignment, narrow bridges and culverts, heavy grades, and unnecessary lengths. *A well laid out highway of inferior surface will many times give better service value than a poorly located highway built with the best surface. Expressed in terms of real service value, type means little unless the selection of a proper type is supplemented by proper design and proper layout.*

We believe that maintenance is the keystone of the entire structure of pavement service. Proper selection, design, layout and construction must be immediately followed by intense maintenance if the potential service value of a pavement is to be secured. *Any discussion of the service value of any type of pavement has no basis unless the assumption is made that good maintenance protects the pavement and gives it a chance to serve.* Types seemingly unsuited for the traffic may, when properly maintained, give better service than a much more suitable surface left to care for itself.

Traffic Distribution

I am going to interject just a word or two on the important topic of traffic distribution. We are prone to view future traffic development entirely upon the assumption that one road between two points is going to serve all traffic between these points for all time. I doubt that this is true. Alternate routes will be developed and traffic thus distributed. This will be good from many standpoints. It will prevent traffic congestion, allow the use of cheaper surfacings, accommodate more local traffic, provide a choice of routes, and allow for repairs and reconstruction without closing all available routes. *The road problem of America is not to build a few boulevards; it is to build, maintain, and keep always open, a transportation system.*

Wisconsin has now maintained her 5,000-mile state trunk highway system for three years, and over 2,000 additional miles for one year, and we have gained some idea of the maintenance cost of various types. The condition of the several sections varied so much when they were taken over, and the relative service given is so dissimilar that very little can be determined from an inspection of our figures on maintenance costs.

In 1919 the average cost of maintenance per mile of all types, surfaced and unsurfaced, was $254. The average cost of maintenance per mile by types (taken from a large number of sections) was as follows: Earth, $[illegible]; gravel, $[illegible]; waterbound macadam, $516; penetration macadam, $[illegible]; concrete, $337. Qualifying these figures, it would be only fair to say that the earthroad maintenance included much heavy blade grader reconstruction; that the waterbound macadams had been allowed to get badly out of repair; and that all but $62 of the $337 for concrete was used in shoulder and ditch maintenance and in applying gravel to shoulders on the too narrow 16-ft. surfaces.

As indicating the possible value of well maintained gravel roads we segregated nine very satisfactory patrol sections of gravel road and tabulated at least two separate traffic counts on each. The average count on these roads was 1,059 automobiles, 44 trucks, 21 motorcycles and 45 horse-drawn vehicles per day. Weight was not taken. No effort was made to get maximum day counts. The roads in question gave excellent service every day in the year. The average cost per mile per section of maintaining these nine patrol sections was $263. These roads were not surface treated.

Our experience with gravel roads indicates that when well built of adequate widths with fine crushed materials and well maintained, their traffic limit is far higher than has been hitherto assumed.

Traffic Problem

In considering the relative service value of pavements one cannot disregard the matter of expediency. There are, when considering a road problem and when determining an economical type to be used, always these factors to be considered: (1) The expected traffic, (2) the materials locally available; (3) the funds available; (4) the whole financial, traffic and highway situation in the unit of government to be served. This last factor is far the most important one, and too often has been totally disregarded.

We have thought too little about the basic function of highways which is of course to offer facilities for travel. We have been too prone to concentrate upon a specific length of highway and economic design, rather than to concern ourselves with the more important traffic situation in the unit of government in which we operate. We have been content to design and build a few miles of highway each year and to look forward with the hope that some day the contemplated system would be completed and traffic would be free to come and go as it pleased. We have closed our eyes to the fact that in the meantime we had on our hands scores or hundreds or thousands of miles of highways which are difficult of travel at all times and impassable at some.

Far more important than the mere selection of a truly economical type of construction for assumed conditions on a specific highway is the importance of determining what program of improvement will be of the most benefit to the traffic in a designated area.

The schoolman has so obsessed us with his ideas of so-called true economics in pavement construction that we have been inclined to lose sight of the much more important economics of the traffic situation as it exists and as it may be expected to develop. We have been so impressed with the importance of economic design of specific stretches that many of us have entirely lost sight of economic design for

a traffic situation. If unlimited funds, labor, and materials were always available it might be possible that the schoolman is right, and that we should never build anything but the truly economical surface, but there is always a limit to the funds which can be made available, or which can be expended in a specific term of years. The true economics of pavement design is to find the solution which gives the least cost, not only of the construction and maintenance of the pavement, but in the carrying of traffic in the designated area within the designed period.

As an illustration of this point, Normal County has 200 miles of road of the most importance, 200 miles of secondary highways, important from the county standpoint, and 400 miles of strictly local highways, cared for by the local units of government. Outside of the funds which can be made available for the general maintenance of these 800 miles, it can be foreseen that in the next five years the total funds available for highway improvement in Normal County will be $4,000,000. Of the 200 miles of first class highway, 50 miles have been surfaced in the past and are still maintainable, and 150 miles are earth, without hope of redemption. Of the 200 miles of less importance, 20 miles have been surfaced and 180 miles are earth. Of the 400 miles of local roads, all are earth. Traffic conditions are at present intolerable in the county. Each rain means a blockade; each spring and rainy season an absolute cessation of traffic except by team, and that traffic is almost blocked.

The $4,000,000 available in the five years will, it is estimated, build 100 miles of the schoolman's economically correct highway. If the public officials determine to build this type of highway, at the end of five years there will be 230 miles of the first and second class highways (over 50 per cent of the whole) still unsurfaced. Isn't it plain that this answer cannot be correct, regardless of the so-called economics of the specific instance? Isn't it plain that the public body controlling the money should consider most carefully the whole situation, and spend the $4,000,000 in an effort to make passable at least all of the 400 miles of principal highways?

Economic Construction

The schoolman will say that some of the money is wasted because a portion of the types built are not going to exist for twenty or fifty years, but the economic waste incident to the use of uneconomic types is not a marker to the economic waste incident to the continued use of a largely unimproved system of highways. In other words, the loss to traffic by the prolongation of such a situation is usually infinitely more than the loss to the public due to the construction and maintenance of types requiring renewal after a term of years.

Carried to a logical conclusion, some one will say, *this plan means building largely temporary surfacings, and later on building again. It does! And why not, if that is the true economic solution?* Most of our railroads have been rebuilt more than once. I believe we must proceed along exactly similar lines. First accommodate traffic, building to the money which can be made available, expecting that after the traffic is gotten through and the adjacent territory reaches fuller development, the necessary betterments will follow.

There has been considerable criticism to the effect that a large proportion of the Federal-aid construction is going into low-class structures and that therefore the funds are being wasted. Ninety per cent of these critics never designed or built a highway, nor have they ever tackled a legislative body to get it to finance one.

In Wisconsin about 19 per cent of our total mileage of Federal-aid construction will be concrete, 2 per cent macadam, 42 per cent gravel, and 37 per cent earth, with modifying surfacings to make them passable. Expressed in terms of money, about 40 per cent will go into concrete, the remainder into grading and other types. Every project solved a traffic problem and freed a community from impassability or danger. No one can tell me nor can he tell the communities in which the work was done, that the money was wasted. Our critics themselves, if faced with the same problems, would have come to the same decisions.

We hope that all states will hold to safe ground and serve traffic now. Deviation from this policy is more apt to waste money than is adherence to it. Probably more federal and state money has been wasted in prematurely building unnecessarily expensive types of surfacing than has been wasted in grading and building the lesser surfacings. *After all, the one thing that is permanent about road work—the one thing that cannot be done too well or too soon, is proper grading on correct locations.* Those states that are feeling their way by doing much of this kind of work at places where traffic has been previously stalled by grades or drainage conditions are not wasting money—they are investing it with profit.

It may be inferred from this paper that it would take the brain of a Demosthenes, the genius of an Edison, and the engineering skill of a demigod to determine what pavements should be built, given a condition, these theories, and a sum of money. Such is not the case. In four cases out of five a decision can be readily and quickly made when all pertinent facts and circumstances are known. It takes, largely, common sense and business judgment sufficient to grasp relative values. It is a matter of experience and judgment, rather than of the slide rule and arithmetic. We have used too much higher mathematics and too little common sense. We have sought to set ourselves upon a pedestal of economic perfection and have closed our eyes to many of the surrounding circumstances, until many of us cannot recognize a real economic fact when we meet it. The people are commencing to demand results rather than higher economics. *They don't know much about pavement economics or relative economy of types, but they do know when and where they were stuck in the mud and where they broke that last spring.*

Service Must Be Given

There are too many hundreds of millions of dollars invested in means of motor transportation, and too much pleasure, comfort, convenience, economy and time saving depends upon their immediate, economical and safe use for us to trifle with the facts as they exist. The owners of these vehicles demand service. They must be given it. This despite the fact that many manufacturers of motor vehicles persist in pursuing the *ignis fatuus* of highly centralized highway systems and of highly concentrated construction. Automobiles and motor trucks are owned on almost every square mile of territory and use every main highway. They cannot serve or attain complete efficiency unless they can get through everywhere—now! Why their producers should deliberately work to limit their use offers to me an enigma impossible of solution.

It could be nice indeed if we could serve traffic always and immediately with the ultimate, but it is mechanically impossible. Until we can so serve it we must meet the situation which exists and get the best result we can with the means at hand.

Let's not worry so much about our predecessors or our successors; let's do our best for our contemporaries. Service value doesn't necessarily mean the ideal for the next decade, it may better mean service value right now.

A county or state highway department should not exist merely to design and build a few miles of highway and a few culverts and bridges. It should exist to give transportation service to its clients. We should be purveyors of transportation to his majesty, the American people. Traffic must be served!

Ex-Service Men in Engineering Schools

Of the 1,949 disabled ex-service men who are taking engineering courses under the vocational education statute, 291 are pursuing civil engineering courses. In addition, 68 are taking architectural engineering. This instruction is being given under the auspices of the Federal Board for Vocational Education. The work in civil engineering is divided among seventy-eight schools, of which nine are in New England, twenty-one in the East, ten in the South, eighteen in the Middle West and twenty in the West.

Salaries and Qualifications for Manitoba Engineers

Classification Based on Society Membership Grades —Duties, Requirements and Salary for Each Grade Specified

DIRECT action toward improving the recognition and remuneration of the engineer has been taken by the Manitoba branch of the Engineering Institute of Canada in adopting salary schedules, urging employers to follow these schedules and requesting its members to pledge themselves not to accept positions at salaries below the schedule rates. The following particulars, amplifying the news note which appeared in *Engineering News-Record* Nov. 18, p. 1013, are taken from the report of the salary committee; it will be understood that the schedules relate only to engineers within the province of Manitoba.

Classification

The classification of engineers was based on four factors: (1) Education; (2) experience and ability; (3) responsibility to be borne; (4) character and scope of work. The first three are sufficient to determine the class and the fourth determines the salary within that class. A general classification was based upon the grading of the membership of the Institute, since it would be an extension of an existing system and would define accurately the qualifications for the different grades of membership. Further, engineering activities were subdivided as follows: (1) Railway; (2) public works and utilities; (3) municipal; (4) industrial. The main classification is shown in Table I.

TABLE I. CLASSIFICATION FOR ENGINEERS IN MANITOBA

	Institute Membership	Grades and Basic Minimum Monthly Salaries
1. Professional engineers......	Member	A, \$600; B, \$450
	Associate member	C, \$350; D, \$275
2. Sub-professional service.....	Junior	E, \$175
3. Non-professional service....	Student	F, \$200; G, \$100; H, \$90

Duties and Qualifications

Definitions of the several grades as drafted in the report are given herewith, somewhat condensed:

1. Professional Engineers.—Grade A: Chief administrative charge of a technical organization or a main division thereof; to determine general policies; to have final responsibility for reports, estimates, designs, and specifications, and for construction, maintenance or operation; to have full charge of valuation proceedings; to conduct or direct the most comprehensive lines of engineering research.

The qualifications are along lines of work similar to those of the position to be occupied, and of at least twelve years' duration, of which at least four years shall have been spent in duties of engineer, or their equivalent, and at least five years in responsible charge of important work or projects. Fundamental training must be equivalent to that represented by a professional degree granted upon the completion of a standard course of engineering instruction in an institution of recognized standing, or, in absence of such degree, at least four years of additional experience. The completion of each full year of such standard course is considered equivalent to one year of additional experience.

Grade B: Under general administrative direction to have responsible charge of and to initiate and determine policies for a major subdivision of an organization; to prepare reports, estimates, designs, specifications and valuation studies; to have immediate charge of construction, maintenance or operation of works of major importance; to conduct or direct major lines of engineering research; or to furnish for executive action advice on engineering works, projects or policies.

The qualifications cover active professional practice or executive charge of work for at least eight years, of a character to demonstrate a high degree of initiative and of ability in administration, design or construction of work of major importance, of which at least three years have been spent in duties of senior assistant engineer, or their equivalent, and at least three years in responsible charge of work. Fundamental training similar to that of Grade A.

Grade C: Under general administrative and technical direction to be in responsible charge of an intermediate division of an organization; to exercise independent engineering judgment and assume responsibility in studies and computations necessary for the preparation of reports, estimates, designs, specifications or valuations; to have immediate charge of construction, maintenance or operation of important works or projects; or to conduct or direct important lines of engineering research.

The qualifications include active professional practice or executive charge of work for at least five years, of which at least three years shall have been spent in duties of assistant engineer, or their equivalent, with at least one year in responsible charge of work. Fundamental training as for Grade A.

Grade D: Under specific administrative and technical direction to be responsible for the work of a minor subdivision of an organization; to collect and compile data for special items of engineering studies; to take immediate charge of field survey projects and of the design and construction of minor engineering work; to lay out and develop work from specifications and to supervise the work of a drafting or computing force; or to conduct specific tests or investigations of apparatus, materials or processes.

The qualifications include an experience of at least two years in duties of junior assistant engineer or their equivalent. Fundamental training as for Grade A.

2. Sub-Professional Engineering Service.—Grade E: Under immediate supervision to perform work involving the use of surveying, measuring and drafting instruments; to take charge of parties on survey or construction work; to design details from sketches or specifications; to compute and compile data for reports or records; to inspect or investigate minor details of engineering work.

No experience required other than that involved in securing a professional degree. In the absence of such a degree a high school education or its equivalent is required and at least four years' experience in the use of surveying, measuring or drafting instruments, or the computation and compilation of engineering data, together with evidence of a knowledge of the fundamentals of engineering science sufficient, with further experience, to qualify for the higher professional grades. Each full year of standard course of engineering instruction is equivalent to one year of experience.

3. Non-Professional Engineering Service—Grade F: To supervise the plotting of notes and maps; to direct the work of a drafting or computing squad; to direct work of field party on surveys or construction; to keep survey notes and engineering records; to supervise construction or repair work; to direct the work of computing surveys and estimates; to direct the making of minor engineering computations.

Experience required is at least five years in tracing, lettering, drafting and computing, with at least three years in the duties of draftsman. Or experience for at least five years in the use and care of surveying instruments, with at least three years as instrumentman. Education equivalent to graduation from high school. Each year of a standard course of engineering instruction is the equivalent of the experience otherwise required, with the provision, however, that at least one year shall have been spent as draftsman or instrumentman.

Grade G: To prepare general working drawings where design is furnished; to plot notes and prepare maps; to design simple structures; to make computations and compile data for reports and records; to check plans, surveys and

other engineering data; to use and adjust surveying instruments; to compute surveys and estimates; to make minor engineering computations; to inspect incidentally construction or repair work.

Experience is required for at least two years in tracing, lettering, drafting and computing, or two years as rodman. Education equivalent to graduation from high school and familiarity with the use of the slide rule, and of logarithmic and other simple mathematical tables; or familiarity with the construction, operation and care of surveying instruments. Each year of a standard course of engineering is equivalent to the experience otherwise required.

Grade H: To trace and letter maps and plans; to make simple drawings from sketches and data; to make minor calculations; to run tape or leveling rod; to perform other miscellaneous subordinate duties in survey party in field or office. Education equivalent to graduation from high school.

TABLE II. SCHEDULE OF SALARIES FOR ENGINEERS IN MANITOBA, CANADA

Grade	Positions	Monthly Salary Min. $	Max. $
	1. Railways		
A	Chief engineer	875	Up
	Asst. chief engineer	600	725
B	Principal asst. engineer	550	700
	Bridge, maintenance, construction, electrical and mechanical engineers	525	675
C	District, first assistant, assistant bridge, building, reconnoissance, water supply, combustion, signal, harbor, valuation and locating engineer	400	550
D	Division, right of way, second assistant, designing and assistant district engineers, and chief draftsman	300	425
E	Third assistant, resident and record engineers; inspector A, signal supervisor, rail inspector	200	325
F	Draftsman, levelman, transitman, inspector B, topographer	150	225
G	Junior draftsman, rodman, head chainman	100	150
H	Tracer, chainman, axman, blueprinter, asst. record engineer	90	125
	2. Public Works and Utilities		
A	Deputy minister and chief engineer of public works; highway, power and drainage commissioners; commissioners of any department of public works	650	Up
B	Chief engineer of highway, power or drainage departments; chief engineer of mechanical service; chief engineer of any dept. of public works, or public utility	500	Up
C	District, bridge, mechanical, electrical, construction and office engineers; engineer of urban municipality; surveyor	375	500
D	Assistant engineer, engineer of rural municipality, chief draftsman	300	375
E	Instrumentman	175	250
F	Draftsman, levelman, transitman, inspector	150	250
G	Rodman, junior draftsman	100	175
H	Tracer, chainman	90	150
	3. Municipal		
A	City engineer, deputy city engineer	600	Up
B	(No classification)	.....	.....
C	Superintendents of water, streets, sewers and refuse disposal, chemical superintendent (tests)	350	450
D	Assistant engineer, water works chief engineer (mechanical)	300	400
E	Instrumentman	175	250
F	Draftsman, inspector	150	250
G	Rodman, junior draftsman	100	200
H	Tracer, chairman	90	150
	4. Industrial and Commercial		
A	Chief engineer	600	Up
B	Head of major engineering division	450	Up
C	Designing engineer	350	450
D	Chief draftsman, estimating engineer	300	350
E	Squad boss, checker	250	300
F	Senior detailer, draftsman	200	250
G	Detailer, junior draftsman, inspector	150	200
H	Tracer, blueprinter	90	150

The basic minimum and maximum salaries adopted for the several grades in the four main departments of engineering work are given in Table II above.

Twenty-Four Ton Truck Standard for Bridges

Wayne County, Mich., designs all its new highway bridges for 24-ton trucks, with a view to making full provision for future requirements. The standard minimum roadway width on bridges is 24 ft.

Engineer Schools Show Increase in Student Registration

WHETHER the war increased the demand for engineers or merely made the profession of engineering seem more attractive, returns from 65 engineering colleges to the Institute for Public Service, New York City, show that the increase in register during the three years after the war was nearly ten times that of the three years before the war. During the school year 1916-17, which had practically its full register before the war broke out, there were but 1,276 more engineering students in 65 technical schools than in 1914. In 1920, with a total of 35,132, there were 12,437 more than in 1917, and 13,713 more than in 1914.

In the six-year period 5 colleges lost where 17 lost from 1914 to 1917. After 1917 the register dropped in 6 colleges. Of 65 schools 9 added over 500 students each and 19 added over 300 each. Of 42 publicly supported engineering schools none had fewer students than in 1914 and only 1 had lost, Nevada, three students. Between 1914 and 1917 6 lost. Of 23 privately supported engineering schools 11 lost between 1914 and 1917 and 5 showed a net loss between 1914 and 1920. Of 20 largest schools not one showed a decrease between 1914 and 1920. California, Wisconsin, Pennsylvania, Cornell and Case had fewer students in 1917 than in 1914. Columbia reports a decrease from 675 in 1914 to 136 in 1920.

The twenty largest engineering schools reporting follow, with their gains since 1914 and their gains or losses in graduate training schools for teaching and research:

Institution	Size in 1920	Gained Since 1914	Gain or Loss in Graduate School
Cornell	2,115	726	264
Michigan	2,038	583	42
Illinois	1,768	566	49
Minnesota	1,547	897	391
Ohio State	1,488	600	75
Iowa State	1,372	700	206
California	1,358	544	267
Wisconsin	1,104	384	770
Rensselaer	1,017	391	...
Pennsylvania State	1,016	375	22
Oregon State Agricultural	971	675	23
Kansas State Agricultural	916	629	Dec. 20
Washington	887	398	Dec. 27
Lehigh	847	306	38
Cincinnati	824	413	Dec. 1
Case	810	261	...
Kansas	742	243	Dec. 7
Texas	727	317	47
Penn	696	96	179
North Carolina Agricultural	692	312	...

With Minnesota, Iowa, Oregon State Agricultural, Kansas State Agricultural, Cincinnati, the following engineering schools more than doubled in six years:

Oklahoma	from 91 to 534	Utah Agricultural	from 95 to 265
Geo. Washington	from 204 to 530	Alabama	from 101 to 210
Missouri	from 145 to 444	Tufts	from 197 to 210
Cal. Inst. Tech.	from 58 to 365	Montana	from 64 to 190
West Virginia	from 118 to 330	Florida	from 51 to 150
Utah	from 174 to 327	South Carolina	from 28 to 58
Johns Hopkins	from 95 to 315		

Kansas County and Township Road Fund

Exclusive of Federal aid, Kansas raised $12,628,-502.55 for county and township road and bridge work for 1919, according to a recent statement issued by W. C. Markham, secretary of the state highway commission. This is approximately 25 per cent more than was raised during 1918. About half of the total amount went into the county road and bridge fund; taxes for the township road and bridge fund raised another $4,000,000 in round numbers; and the automobile owners, through the motor vehicle license law, contributed $1,304,735.71.

Coördinated National Transport System Advanced

Addresses Before Annual Meeting of Am. Soc. M. E. Show Need for Correlating of Functions and Methods—Railroads, Terminals, Branch Lines, Highway, and Waterways—Abstracts of Papers

The Railroads and a Unified National Transportation System

By Daniel Willard
President, Baltimore & Ohio Railroad Co.

FOR the purpose of outlining my own views concerning the larger problem I will repeat a portion of my report submitted to the Council of National Defense in November, 1917:

> A nation should have a national transportation system and such a system should embrace and make proper use of all available and suitable agencies. The fullest possible economic co-operation should be encouraged and required between all such agencies. Inasmuch as the business of transportation for hire partakes of a monopolistic character, all agencies so used should be subject to governmental regulation in the public interest. . . The co-ordinated transportation system of a nation should be so adjusted that each agency will perform the particular function for which it is best adapted, and, speaking broadly, that country which is provided with the most efficient transportation system—other things being equal—ought to be the most prosperous.

If we are to have a complete and well-articulated national transportation system it can only be had, as things are now, by the co-ordination of a number of different transportation agencies, including the steam and electric railways, the utilization of coastwise and inland waterways, the full economic use of highways, improved and unimproved, and the use of the motor truck. Of all of the transportation agencies at this time available, particularly for interior service, the steam railroad is undoubtedly the most important.

If this country were fully developed and if we had already reached the peak load which the railroads would be expected to carry, the railroad problem would be a much simpler one than it is under conditions as they actually do exist. At least $1,000,000,000 per annum must be provided as a minimum for capital expenditure to keep the railroads abreast of transportation requirements. The country cannot afford to experiment with any system of ownership or control of railroads unless it can provide, as needed, the necessary additional facilities. Personally, I believe the new Transportation Act will enable the railroads to do this. If it does not the law must be amended or some other method adopted. The only alternative would be ownership and operation by the government.

The carriers realizing that they were inadequately equipped decided last April that they must make the best use possible of available facilities. A campaign to increase car mileage and loading was initiated and I am confident that its aims will ultimately be reached and exceeded. In spite, however, of all that the carriers may be able to do with existing plants they will not be able to handle all of the business that this country is even now capable of producing. The productive capacity of the country has been greatly increased, but railroad facilities were not increased at all. The railroads were able to cope with the war situation, but in times of peace the people are not willing to accept the character of service given during the war nor is it in the interests of the people as a whole that they should be required to accept such service. In order that the carriers may be able properly to handle future business they must make very large expenditures not only for additional cars and engines, but for additional running tracks and particularly for additional terminals.

It is in the larger public interest that in developing a transportation system adequate to meet the requirements of growing commerce that each suitable agency of transportation should be used to the extent economically desirable. Where a given expenditure, if applied to water transportation, will provide for the movement of the traffic offered at a lower economic cost than an equal investment in any other transportation agency then water transportation should be developed; also if the use of the motor truck and improved highways in certain localities and for certain distances is shown to be cheaper, including all factors of cost, it should be used.

I do not believe that the motor truck can compete in long-haul traffic, but I do believe that for short-distance traffic in sparsely settled communities the motor truck not only on the improved highway but even on the ordinary dirt highway may be used in conjunction with the railway and thus afford the cheapest form of transportation. The same may be said of our inland waterways.

At various instances in the past railroads have taken business at a loss. The country would be better off if such business could be handled in such a way as would give a profit. There was a time when railway managers were believed to be opposed to the development of other means of transportation which might become competitive. But whatever may have been the attitude of the railway managers in the past that is not their attitude at the present time and I am certain that they will be glad collectively or individually to co-operate with all other transportation agencies in such a way as will inure to the greatest public good.

Terminals and Terminal Yards

By William Barclay Parsons
Consulting Engineer, New York City

TERMINALS form the largest item in railway construction cost and the most expensive item of cost in railway operation. Does it seem unlikely that at least 30 per cent of the physical valuation of the railways would be found in the terminals? To make a similar estimate of terminal operation cost would be more difficult since there is no segregation of cost figures. But terminal operating costs form so great a part of the total transportation expense that it is filled full of hope, if not of promise, for finding substantial economies.

If the shipper would avoid further raises in rates he can aid by focusing public attention on the unnecessary burdens of legislation, on failure of transportation companies to make the best use of their properties, or on the failure of public authorities to co-operate with the companies. Is there not great waste in duplication of service and in the use of badly located facilities? In the old competitive days it was necessary for each company to have its own complete terminals, and to prevent competitors from obtaining facilities as ample or as well located. If all the railways in any large American city had been combined would the previous methods of duplicated service have been maintained? The Chicago Terminal Commission has already answered this question by saying that "there are decided advantages in co-operative operation." Would there not be really great saving if all the terminal facilities in all large cities could be pooled and duplications avoided; the badly located facilities abandoned?

How can terminals be more economically operated is another question. What can the railways do and what can the shippers do? A few years ago shippers used both railway freight houses and cars as places of free storage and perhaps the only way in which this can be entirely stopped is by having the railway companies do all the unloading and delivery, either by their own agencies or by some authorized single agent acting for them. At London at about 3 a.m. incoming freight arrives at each station and by 7 a.m. the freight house and delivery tracks are full. An army of railway drays attacks the ordered pile of merchandise and by noon everything has been removed and de-

livered to consignees. At 4 p.m. outgoing freight begins to arrive by drays; by 8 p.m. the freight houses are full again, and by midnight the contents have been loaded into cars. In this country much of the terminal expense is caused by the shippers themselves doing their own trucking. With storedoor delivery trucks would carry full loads with the consequent minium of truck miles.

In New York no less than 25 per cent of Manhattan dock front is occupied by railway terminals or landing places where no one does business, but to which and from which the city's incoming and outgoing merchandise must be trucked daily. If the principle of storedoor delivery be adopted in New York there seems to be no necessity for waterfront terminals in New York and waterfront yards in New Jersey. New yards with switching connections at both ends can be constructed, with modern freight houses, and unloading tracks equipped with freight-handling, labor-saving machinery, located in any convenient place, even on the Jersey meadows. To them motor trucks with trailers carrying not part but full loads would transport merchandise between cars and points of origin or destination in any part of the metropolitan district. In such a system would there not be economy in handling, time saved in trans-terminal shipment, and relief to street congestion through diminished number of trucks? Besides, such large area of waterfront property, now held for local freight purposes only, would render available a site for the finest kind of ocean steamship terminals to relieve present congestion and overflow to other ports.

The two great things to be overcome if any radical improvement in the New York terminal situation is to be made are: First, the financial difficulty in the large amount of capital required; second, the political difficulty of two states, one on each side of the Hudson River. In addition there stands the difficulty of no less than eight municipalities on the Jersey shore. But there is needed a plan that will provide the much sought for economy in terminal operation, a plan that will consider the needs of the railways, the interest of the shipping public and the taxpayers, the development of that portion of New Jersey lying east of Newark and west of the City and State of New York and the serving of the country at large.

Motor Truck Transportation

By Francis W. Davis
Engineer, Pierce-Arrow Motor Car Co.

IN THE short period of twenty years motor highway transportation in capital invested and diversified fields of application has reached the point where it is warranted in seeking counsel with its elder brothers. Except for certain specialized services the motor truck will never replace waterway and railway transportation, nor act in other than a supplemental capacity to these two. Three principal aspects of the problem are here considered: The field of truck transportation, the present status of truck transportation, the improvement of truck transportation.

It is in the short haul and at terminal points that the railways are at the greatest disadvantage, both as to service rendered and to their own earnings, and it is here that motor transportation comes as a help and releases cars for the long hauls where they are most efficient.

COMPARISON OF THE COST OF DOOR-TO-DOOR DELIVERY OF FIRST CLASS L.CL. FREIGHT FROM BUFFALO TO VARIOUS POINTS.

Buffalo to	Miles	Flat Freight Rate	Total Cost by rail per 100 lb.*	Time by Freight (days)	Truck Rate per 100 lb.[1]	Time by Truck (hours)[2]
Tonawanda....	10	.25	.83	2	.25	2
Niagara Falls.	26	28	.87	2	.35	4
Batavia......	37	.31	.90	2	.60	5
Rochester....	72	.38	.99	3	.80	9
Jamestown...	77	.54	1.17	2	.90	9
Erie.........	92	.59	1.23	2	1.00	10
Ashtabula....	129	.67	1.32	3	1.30	14
Elmira.......	145	.61	1.25	4	1.40	15
Syracuse.....	154	.56	1.20	2	1.50	16
Utica........	203	.66	1.31	3	2.00	21
Binghamton..	204	.70	1.36	3	2.00	21
Pittsburgh.....	241	.84	1.52	5	2.50	26
Albany.......	308	.72	1.38	4	3.00	31

*Total cost by rail per 100 lb. equals freight rate plus teaming charges, both ends, (.30), plus cost of extra boxing (.24) plus extra freight charge on increased weight of boxing (17 per cent of freght rate.) [1]Trucking Association figures (1920). [2]Loading and Unloading time of 1 hr. plus running time at 10 m.p.h.

The foregoing table shows the relative cost of shipping by rail and by truck for various lengths of haul. The figures for the railway include freight charge, teaming between terminal points and the increased cost and freight on boxing for railroad shipment.

If the express companies could save by using motor trucks in short haul, suburban service of the character, for instance, as between Germantown and Philadelphia, the practice is uneconomic that express companies, as I have been informed, are not allowed by their contracts with the railroads to ship to any point where they maintain an office and advertise tariffs by any other means than by rail irrespective of the distance.

The Truck in Terminal Work

With the proper co-ordination the motor truck can aid materially in lowering terminal and transfer charges. The results obtained in Cincinnati in the use of motor trucks with demountable bodies show the possibility in the solution of terminal problems. Sixteen motor truck chassis with 225 unit-container interchangeable bodies were put in operation and have averaged 4.55 tons per load. Walker D. Hines, previously Director General of Railroads, has reported in connection with this installation in addition to quickness of dispatch a "saving of two handlings; 50 per cent decrease in damage to freight in loading and unloading, and decrease of about 15 per cent per ton in cost of handling." B. F. Fitch, president, Motor Terminals Co., New York and Cleveland [who developed the system of operation at Cincinnati] estimates that the installation of a terminal system in New York similar to that at Cincinnati would save $45,000,000 in freight costs yearly.

In the carrying of passengers the motor truck or bus is taking its place as a feeder to the street railway. In 1918 the General Omnibus Co. in London carried a total of 682,000,000 passengers against 699,000,000 on the underground and 992,000,000 on the street railways—more passengers by bus than all the *surface* railway lines of the boroughs of Manhattan and the Bronx in New York City. Bus advocates do not look for the elimination of the street railway but for its use as an auxiliary and a feeder.

Possibly the most interesting phase in the development of the motor truck opening new fields in each new application is in "combination service," for which the truck engine is used for other purposes than driving the truck. It is available for auxiliary purposes, such as the driving of winches, cranes, pumps and for miscellaneous power requirements. As an instance of this, this winter New York City will have a fleet of caterpillar tractors operating snow plows for use in snow removal. Now, approximately 50 per cent of the larger trucks are equipped for some form of auxiliary device utilizing the power of the engine.

In the present status of truck transportation we find 800,000 trucks in operation, and if each of these average 5 tons per day for 300 working days per year the total tons moved by truck would be about 1,200,000,000. In 1918 about 2,504,000,000 tons of freight were moved by the railroads. Estimates of the Firestone Co. covering cost analysis of a number of fleets of from one to forty trucks, all of 5-ton capacity, show a daily mileage of each truck of 40.5 miles with labor approximately 37 per cent of the total cost. The motor truck owner is confronted with the less-than-carload shipment, which in his case is the less-than-truckload shipment, and due to the extremely short haul of the motor truck, loading and unloading time becomes of very great consequence. For one-mile haul, with 60 min. loading plus unloading time, the truck accomplishes nine trips per day; with a 5-min. time, sixty trips; with 1-min. time, ninety trips, or an increase of 1,000 per cent.

The question of possible increase in size of motor trucks is an economic one with respect to present carrying capacity of many highways and bridges and the unmanageability of vehicles over five or six tons capacity. The development

is intimately related to the rubber tire. The pneumatic tire promises betterment in increasing traction, absorbing road shocks and protecting highways.

In the improvement of truck transportation the improvement of highways is of paramount importance. Proper surfacing and foundations are the greatest need. Grades are of very little importance if the roadbed is right, but it will be necessary to have bridges of ample capacity to take maximum load. The ideal highway development is a comprehensive system of national highway under Federal control.

In conclusion, railway transportation should and will hold its place for long hauls and for carload shipments where there is direct railway connection to the factory or warehouse of the shipper. Motor transportation will relieve the railways of the expensive short haul; serve them at terminals and act as a feeder. It will supplement the street railways and spread in the field for utilizing the engine for auxiliary purposes. With the improvement of devices for shortening loading and unloading time there will be a reduction in the use of horses for heavy freight haulage. The economic limit of the size of motor trucks will probably not increase, although the use of trailers will increase tons hauled.

Feeders for Railroads

By Charles A. Morse
Chief Engineer, Chicago, Rock Island & Pacific Ry.

IN THE past, due to unrestricted competition, many railroad facilities have been duplicated, such as tracks from two or more lines into the same industry, branches of two or more railroads running side by side where one line would do double the business done by all. Under the Transportation Act the Interstate Commerce Commission is required to permit rates to the railroads, in addition to paying operating expenses, including a fair amount for depreciation, to yield a return of 6 per cent on a fair value of the property devoted to transportation purposes either on the railroads as a whole or divided into groups. The public should not have to pay the cost of maintenance and upkeep, the cost of operation and interest on the investment in duplicate property. There are many branch lines less than 50 miles in length that are built to control the territory on either side of a main line. Such lines were built as a rule when there were only ordinary dirt wagon roads and all teaming was done with animals. Today with the advent of the automobile and the motor truck have come the "good roads." A careful study should be made of branch lines of railroads, and where there are "good roads" of the hard-surfaced class, over which the business now handled by the railroad can be handled by motor trucks and buses, the matter of dismantling the branch line of the railroad should be given serious consideration.

Where Feeders Are Necessary

On the other hand, there are railroads that have undeveloped territory adjacent to their lines which will warrant the construction of feed lines and increase their main-line business, and these railroads should apply to the Interstate Commerce Commission for authority to construct such lines and for a freight and passenger rate over the new line that will pay a proper return on the investment and the cost of maintenance and operation of the line. Some of the more prosperous railroads have systematically constructed feeder lines and their prosperity under adverse conditions has been due largely to this policy where it has been carried out in developing new territory. Some of the more prosperous railroads have systematically constructed feeder lines and their prosperity under adverse conditions has been due largely to this policy where it has been carried out in developing new territory.

Branch lines were formerly cheaply built, at from $12,000 to $15,000 per mile; they had narrow roadbeds, light rail, light bridges and less ties per rail than main lines; they were equipped with locomotives that had become too light for main line traffic, but handled the short branch line trains.

In the development of traction—both steam and electric—locomotives have become so heavy as to require strengthening of the roadbed and tracks, and since provision must be made on branch lines as well as main lines for carrying heavy power, the former become almost as expensive as the latter. It can readily be seen that with the introduction of a class of locomotive—the motor truck—that requires no rails but which can be used by the public at large that the use of the railroad within the limits of the practical use of a single unit of transportation must become less and less as good roads are constructed. The public is paying for the good roads and the motor cars and now under the Transportation Act they must pay for the maintenance and operation and also the interest on the value of the branch lines of railroads. If the public were required, as it should be, to pay a rate on the branch line that would pay the cost of upkeep, operation and interest on investment, it would pay as much in many cases as it costs to haul the freight to the main line by motor trucks. If many of these branch lines that are tributary to a territory within the limits of auto-bus and auto-truck service could be taken up and abandoned it would mean a reduction in cost of main-line service.

Where branch lines are long enough and they cannot be replaced with motor service and do not connect with or cross other railroads there should be a rate that would yield an amount sufficient to cover all operating, including capital costs. Present practice in this respect is the discrimination of the few against the many.

Abandonment of Branch Lines

In considering the question of abandoning a branch line a careful study of the situation on each railroad should be made and the useless branch lines should be listed and a program made up to cover a period of five to seven years, at the end of which period they would all be up and charged to operation and capital account on which the public must pay a return which would be reduced that much and in addition the public would be relieved of the operating cost. With the completion of such a program there would be such a reduction in investment as would go far toward providing for new construction to develop new territory. Branch lines are a necessity, but in abandoning them the railroads must deliver more freight at main-line stations resulting in an increased use of cars from time saved in movement between main-line and branch-line stations. L.C.L. freight should be collected for all railroads at the various stations in the city and should be taken to a central point by one railroad or terminal company and there made up into carloads and billed over the railroads to which it is assigned and the cost of the service kept separate. Those desiring to deliver l.c.l. freight to the point of consolidation by motor truck would save this special charge for collecting the l.c.l. freight.

In order to permit the Interstate Commerce Commission to handle the question of new lines and abandonment of old lines it is going to be necessary to have all railroad charters issued as national rather than state charters. There would have to be a campaign of education which would show the public that the changes advocated would be for the good of the great majority of the people. People on branch lines will object to their abandonment, but, while we are rearranging our transportation facilities we should weed out all special privileges and make every one pay for what he gets.

The railroads are going to be able to make many changes in maintenance and operation that will tend to decrease the cost to the public if the Interstate Commerce Commission takes a broad view of the transportation situation and handles its regulation along economic lines as a national rather than a local matter and does not let local interests interfere with the carrying out of broad national policies.

[For lack of space in this issue, the report of the addresses of Gen. Frank T. Hines, on waterways, and of Gustav Lindenthal, on the Hudson River bridge project, will appear next week.—Editor.]

Construction Revival—When?

Price Stabilization Must Come First—Public Waiting for Lower Materials Prices

By Owen M. Fox
Construction News Department, *Engineering News-Record*

TO INSURE a busy year in 1921 and to make possible the progress of needed housing and public-works construction definite action on price revision seems necessary. Only stable prices will encourage building. Buying is always at a minimum when prices are on a decline and at its best on the upward trend.

There is a lack of confidence in the stability of present-day costs, or, stated differently, a conviction that construction cost will soon be much lower. No industrial company cares to put a million dollars in the erection of a plant which six months hence may possibly be built for $600,000. No financial institution can risk financing such a project. No public official dares spend public moneys except for urgent work under such conditions.

The necessity of stabilizing costs, not only in fact but also in the public mind, is therefore apparent. Labor has already taken long strides in this direction. In Chicago, for instance, the building trades have agreed that there shall be no wage or working-condition agitation for eighteen months. At no time in recent years have there been so few strikes and lockouts and it has been a long time since labor has been so plentiful. Efficiency, by common agreement, ranks from 12½ to 30 per cent higher than during the silk-shirt days, but labor is almost the only construction element that shows cost decline.

Materials Reductions Lagging

Reductions in building-materials prices during the past ten weeks have been remarkably few in comparison with those of other commodities. Much has been made over a drop of from 30 to 40 per cent in lumber costs, but lumber cost, after all, is such a small portion of the whole expense of general construction that the influence of this movement is almost negligible. The general public from whom, in the last analysis, all buying movements come, whether of cotton cloth or concrete warehouses, seems intuitively aware of the facts indicated by the weighted index figure of prices issued by the Bureau of Labor Statistics at Washington. This shows a decline of about 53 points, or 23 per cent, since May 1, but shows also that during this time building materials in the aggregate have shown but 8 per cent decline.

People recall that while building-material prices have been receding 8 per cent textiles have gone back 35 per cent; farm products, 30 per cent; metal products, 29 per cent, and that all commodities, including building material, have dropped the 23 per cent mentioned in the foregoing paragraph. They recall that the 8-per cent decline in building materials has been confined almost exclusively to lumber and sheet and structural steel, and are asking why brick, cement, sand, gravel, lime, reinforcing metal, etc., do not do their share.

Would-be investors cannot help but note that in most lines in which but slight reductions have occurred the reason is offered that the price increases were less than the average during the period from 1913 to May, 1920. Such is not true of building material. Again citing the Bureau of Labor Statistics, we find that farm products advanced during that period 146 per cent; foodstuffs, 187 per cent; metal products, 157 per cent; chemicals, 152 per cent, and that building materials advanced 241 per cent, being exceeded only by textiles, 256 per cent, and house furnishings, 271 per cent.

The above recital is given to point out the frame of mind of the public, and to indicate the necessary steps that must be taken to change that attitude, which is apparently so determined as to make impossible any immediate improvement in construction.

In other industries reductions by manufacturers and first hands have compelled cuts all along the line and have caused holders of intermediate stocks to stand losses in shrunken inventories. In the building field such losses are not necessary as dealers and jobbers have no vast supplies stored. It is more nearly a direct producer-to-user business.

Effect on Volume of Work

Apparently the opinion of "the man in the street" is going to have a great deal to do with the immediate future of construction. Any great private construction movement will come largely from the erection of individual homes and small flat buildings and the owners of such projects are governed largely by their opinion of conditions in general rather than by any knowledge of conditions in the building industry. It seems probable that the growth of industrial plants in America in 1918 and 1919 has discounted the need for a large additional amount of factory space at present. The present trend of financial venture seems to be toward either long-time, non-speculative investment or short-time, high-return, speculative investment, which would preclude an unusual volume of apartment or office-building construction.

In public statements, in testimony before the Senate committee and in private conversations, producers of materials are a unit in stating that reductions at the present time are not justified by lowered costs. Opinion seems to be about as unanimous that cuts will be justified in the course of a few months—possibly by March first, though Eastern opinion has inclined to expect earlier reduction. Decisions as regards construction next year are being made now. Every engineer and architect in the country is busy on plans which will either be postponed or advanced in the next few weeks. Bond issues for public works are coming to a vote or being offered for sale.

The longer the coming readjustment of price is delayed the less new work will be undertaken in the coming year. It seems that the wise thing to do is to make immediate surveys in every line, to determine the level at which the price should be maintained next year. These surveys should take into consideration every factor which goes to reduce costs—improved transportation, cheaper coal, reduced labor cost due to wage reductions (if any) or increased efficiency and lowered interest rates on investment. The price, when determined, should be put into immediate effect, even at the cost of a temporary loss.

This is not a matter of charity to would-be builders. It is purely a problem in merchandising. That which will work to the ultimate benefit of a trade in general is a wise thing to do even if it involves a present sacrifice on the part of the seller and permits particularly advantageous buying, for the time being, on the part of the consumer. Such a movement, at the present

time, holds promise of greater benefit to the construction industry during the next year than has ever seemed possible at a similar period.

Sufficient plans for construction are now "on the boards" to insure, should the major portion of them go ahead, a banner year in 1921. Reports from every city of the country show millions and even hundreds of millions of dollars worth of construction scheduled to go ahead *as soon as conditions permit.*

Present Conditions

Current tendencies in the industrial and financial world are encouraging, not for the outlook they give for the next few weeks, but for the promise of a good year in 1921. The process of descending from the perilous peak of inflation, which existed at the beginning of this year, is well under way and seems certain of accomplishment without the morale destroying shock that was feared.

Nearly all sections report decreased volume of construction, the Pacific Coast region being the exception. Building is going on there at a high rate, Los Angeles and vicinity showing particular activity.

Throughout the Mississippi Valley construction is standing still. The steel-producing section reports a plentiful supply of ore stored, pending the close of Lakes navigation, to insure any needed steel production this winter, and coal supplies are also assured in all sections. Lessened demand is noted for steel products and is being reflected in reduced output, several plants having shut down a portion of their furnaces. The tendency of farmers in the West to withhold fall crops from market on account of falling prices is being defeated by the forced calling of loans by the banks.

While the buying power of the nation seems to be reduced on account of the fall in agricultural prices, lessened sales are attributed chiefly to a spirit of economy and uncertainty as to the future. Necessary liquidation of inflated values, both in materials and securities, is proceeding systematically and in a manner which should render all elements sound and provide a basis for real prosperity in all lines when once the new level of buying power of the dollar has been established.

Utility of Liquid Oxygen as Explosive

At a series of addresses given recently before engineer organizations in the principal Western cities George S. Rice, chief mining engineer of the Bureau of Mines, called attention to the advantages of liquid oxygen as a substitute for dynamite in certain types of blasting operations.

At the request of the Bureau of Mines Dr. C. L. Parsons, the secretary of the American Chemical Society, looked into the use being made of liquid oxygen explosives in Germany. Dr. Parsons recently returned from Europe and in his report he expresses the opinion that liquid oxygen can be used to great advantage in this country. He bases this opinion on the successful way in which that explosive is being used in Germany. Its use is by no means confined to mines, he states, but extend to all types of work where blasting is required. The Germans have developed machines, he says, for the making of liquid oxygen which can be placed on motor trucks and operated by the truck's engine. Machines of this character are made as small as seven liters an hour capacity.

Minnesota Creates State Trunk-Line Highway System

A SYSTEM of trunk-line state highways aggregating 6,900 miles was created in Minnesota by an amendment to the state constitution at the general election Nov. 2. This amendment is peculiar, in comparison with the highway amendments submitted to vote in other states, in that it definitely prescribes the 70 trunk-line routes composing the system, and specifies the manner in which the improvements of these highways shall be financed.

Briefly, the 70 trunk-line roads aggregate 6,900 miles which are to be improved and maintained by the state. In case of the creation of new counties or the relocation of county seats the legislature may add to this mileage the new routes necessary to connect the new county seats with the main system. The legislature may also create additional routes whenever 75 per cent of the present mileage has been permanently improved. To finance the improvement a trunk-highway sinking fund, realized by taxes on motor vehicles, is to be created by the legislature. With the creation of this fund, which can be used only to pay interest on and to retire highway improvement bonds, the legislature can authorize bond issues not to exceed $10,000,000 annually nor a total of $75,000,000.

Use of Funds

It is to be noted that the new trunk-line highway system will be constructed and maintained by independent funds. No money now raised by state aid, or county or township levies, will be used on this system. These funds in the last two years have averaged about $16,000,000 a year. Previously, the roads included in the new trunk-line system have absorbed about 75 per cent of this money. By the present plan it will all be expended on the secondary county and township roads. It is estimated that in 1921 the aggregate of all funds available in Minnesota for highway improvement will be $27,000,000.

In general the policy of improvement will be as follows: The state will use gravel surfacing, concrete, brick, and all other materials as conditions require and as the counties and towns are now doing and will continue to do. Contrary to impressions, the amendment makes no reference to the kinds of roads which may be built. Hard-surfaced or gravel roads will be built according to traffic and other actual conditions and every road will be improved as judgment and economy demand. Where heavy traffic pounds and pulverizes the gravel, paving will be necessary, and will be laid as rapidly as conditions require and funds will permit. Much gravel surfacing, where it meets present traffic requirements, will be used as the state extends the system of permanent roads. But every road will be improved, graded and drained to insure the best possible service throughout the entire year.

Automobile Fatalities in 1919

According to a bulletin recently issued by the Department of Commerce, Bureau of the Census, automobile fatalities reached a high figure of 3,808 during 1919. This represents a ratio of 14.1 per 100,000 of population. Of this number, fatal automobile accidents in Greater New York alone totaled 780. The automobile fatality rate in 1915 was 8 per 100,000 of population.

ENGINEERING LITERATURE

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Structural Steelwork from British and American Viewpoints

Sir—An appraisal of the relative merits of British and American technical literature was suggested in R. Fleming's review of a British textbook on structural steelwork by E. G. Beck, published in *Engineering News-Record*, Sept. 16, 1920, p. 568. Such an appraisal would necessitate much work in comparison with its ultimate value, but a brief discussion on the general subject may be of interest.

A search through the best London libraries containing up-to-date books of both countries fails to reveal any British work which can compare with American monuments to the subject, such as Johnson, Bryan and Turneaure, Ketchum and others of similar merit. From discussion with British engineers it appears that those whose methods and designs are up to date have, almost without exception, studied American or German literature, while those who have confined themselves to the work of their own country reveal the fact in the results they obtain, and the cost of the work for which they are responsible.

Generally speaking, British books may be roughly divided into two classes, theoretical and practical. The works of theory are frequently little more than studies in higher mathematics, having considerable merit if the student desires mental exercises, but being of little use to those who have to design a bridge and need a book of reference. Their failings are a lack of practical suggestion as to the suitable dead and live loads to apply, and little advice as to what are the most suitable and economical sections and details to use after the stresses have been determined. In other words, they start on the assumption that the load is known and that the design is simple if the stresses are known. Economic spans and depths are rarely discussed.

The so-called practical books frequently make a parade of the fact that no calculation involves the calculus. As the subject cannot be covered without at least an elementary knowledge of the calculus, they thus fail to interest the more ambitious students. This class of work does make some attempt to indicate loads to be allowed for, and after indicating an empirical method of obtaining the stress, proceeds to questions of sections and details. It is here that they generally fail. Sizes are suggested that are costly and difficult to obtain, and details are shown which would not be tolerated in America and are undesirable for the majority of British structures.

Most English books devote much unnecessary space to stresses in roof trusses due to wind loads normal to the surface. It seems to be overlooked that at best such stress allowances are only an approximation and that equal results could be obtained for ordinary cases with a fraction of the labor by an assumed vertical load. These books give scant attention to rolling loads. Critical positions of wheels and the use of influence lines are not generally known.

In dealing with columns and struts, American books pay less attention than British to the condition of the ends. It would seem advisable in both textbooks and specifications to state clearly to what conditions of ends the formulae suggested are intended to apply. The British student of American books very reasonably doubts the justice of using the same formulae for pin-connected struts as for those with riveted ends.

The book reviews which appear in the English technical press are no guide. It is to be feared that they are written to aid sales. They rarely contain candid criticism, as would be the case if they were written by an engineer who needed a reference book.

The educational facilities in the two countries appear to differ considerably. The young British structural engineer just out of college is not capable of designing anything but the simplest structures, and has all his details to learn so far as commercial work is concerned. The American is better equipped in this respect, but on the other hand the Briton seems to have a much better general knowledge of engineering, and will know something of electrical and mechanical work, foundry, smithing and machine shop practice. In the United States, highly specialized structural engineers with an appalling ignorance on general subject are frequently met—men who do not know the difference between D.C. and A.C., and who have little conception of mechanical work. They also seem to know less of general conditions which affect the sale of the work they handle, particularly in countries outside the United States. This may be due to the fact that more men go abroad from the older country to places where they may have to tackle all kinds of work and be many miles from help or even advice.

The differences between the practice in the two countries is due to the difference in fundamental conditions which prevailed before the war. In Europe, labor was cheap, and, therefore, no effort was made to design economical details. The expensive labor in the United States necessitated simple details. The quantity of structural steel used in the United States is so far in excess of that used in Great Britain that American designers have had more opportunity of investigating economic designs; consequently, it is now usual to find American bridges lighter than British—loads and stresses being the same in both cases. There are some fearful examples of structural atrocities in Great Britain, and one does not need to go outside London to find many of them. There are many spans with shallow trusses and multiple web systems without lateral bracing to the top chords. One wonders what length the designer assumed in figuring these members as struts. The only conclusion is that these freak structures have never carried anything like the load the designer thought he was providing for. Such structures give the impression that they might be strengthened simultaneously with a considerable reduction in weight and saving in cost. In showing an American visitor these structures, one must be apologetic.

The bridge carrying the Northeastern Railway over the Wear at Sunderland is a curious design. It is a

through-truss span with parabolic top chord, and evidently figured on the basis that such a span has no web stresses for it has no diagonals. The partly loaded span does not appear to have been considered but as the result apparently did not "look right" the spaces between the verticals were completely filled in by huge plate gussets with one large oval hole in the center proportional to the size of the panel. A student of secondary stresses due to deformation under partial loading could have no finer example than this.

The difference between American and British building work is much less marked than is the case with bridgework.

Aesthetically, America has something to learn from Britain, where one rarely sees a beautiful landscape spoiled by an ugly steel bridge which, with only a little extra cost, might be made to look more in harmony with its surroundings.

There is no doubt that structural steel engineering has made but little progress in Britain for many years, especially when compared with that made in other branches. This is probably due to the following facts: The railroads do their own designing by engineers trained in their own office, and who have, therefore, little opportunity of acquiring modern ideas. Most other work is designed by consulting engineers or architects who have little qualification for the work and treat it as an unimportant side line. The manufacturing units are small, and, therefore, have no chance of specializing in any particular class of work.

There *are* good British designers, but they are mostly attached to the manufacturing concerns, and, therefore, only get a small proportion of important work to design.

As an Englishman it is naturally unpleasant to have so little to say in favor of British work, but if adverse criticism will help to rouse more interest in this subject, it will be for the benefit of both users and manufacturers.

H. R. WHITE,
Resident Engineer, U. S. Steel Products Co.,
London, England.

Sir—The letter by P. L. Pratley in the Engineering Literature section of your issue of Nov. 18, contains some statements that call for comment from American engineers. Mr. Pratley seems to favor strongly European or English practice of designing largely by judgment. He would commend a plan of designing without strain sheets, even for enormous structures such as the Forth Bridge. Would he fabricate without any detail drawing? It would be a logical step from the premise just stated. He discredits analysis and the taking care of details—proportioning them for their load and each part for its own load. He says, "There is no structural argument against bent angles." Such statements can only serve to confuse the unwary.

If analysis is useless, books should be burned, engineering periodicals suppressed, and engineering schools abolished. No book nor paper nor school can teach judgment nor even impart experience, the thing Mr. Pratley so exalts.

There is indeed the soundest of structural argument against bent angles, particularly as used in the flying buttress end stiffeners in plate girders which Mr. Pratley defends.

Some years ago a paper of mine was read before the Western Society of Engineers on a comparison between European and American practice in railroad bridge design (very fully reprinted in *Engineering Record*, March 1, 1913, p. 241). I condemned just such things as the wide spreading bearing plates on girders and slender bent angles to stiffen them—a detail that could not possibly distribute the load of the girder on the bottom area of the bearing plate. Compression members with wide, thin outstanding flanges were also condemned—a common style of compression members used where analysis of stress and study of test results are ignored. One European bridge failure occurred as a result of this style of design.

Mr. Pratley would have us believe that Europe's engineering practices are being adopted in America because, forsooth, pin-connected bridges are not as common here now as they used to be. It is a far cry from the growing preference in America for riveted trusses to the adoption of the European practice of building a structure by "experience" and then nursing that structure for its lifetime by frequent inspection and watching, as European practice seems to require. American bridges need no nursing,—only occasional painting—if designed on the principles and analysis set forth in American books and periodicals.

I wrote a paper on common practice in structural designing which was published in *Engineering News*, April 11, 1907, p. 394. This paper condemned many details of bridge design which showed lack of analysis. Prof. W. C. Kernot, of the University of Melbourne, Australia, an authority on structural engineering, wrote me commending this paper and sent me a book of his written along similar lines. So it is not exclusively an American trait to design bridges by scientific rule.

Pittsburgh, Dec. 4. EDWARD GODFREY.

Specification for Steel Railway Bridges

STANDARD SPECIFICATION FOR STEEL RAILWAY BRIDGES: Canadian Engineering Standards Association—Ottawa, Can.: The Association. Paper; 6 x 9 in., pp. 79.

This specification applies to steel railway bridges up to 500 ft. span and movable bridges, except suspension bridges and locomotive turntables. It is based on the specification of the Engineering Institute of Canada, originally issued (by the Canadian Society of Civil Engineers) in 1912 and revised under date of 1919. As the council of the Institute subsequently approved the proposal of the newly formed Canadian Engineering Standards Association to deal with the specification as final authority, and as the membership of the association's subcommittee responsible for the present specification is identical with that of the Engineering Institute's committee by which the 1919 specification was prepared, the present may be regarded as the successor of the 1919 specification.

It will prove interesting and instructive to American bridge engineers in many ways, both through its general form and through details. Being relatively short and compact it contrasts with the latest specification of the American Railway Engineering Association, as it does also in including movable bridges and in using a parabolic column formula. No standard loading is specified. Braking force is varied with the span, decreasing from 22 to 10 per cent. The preface states: "It is believed that the specification in its present form, while not in absolute agreement with the American specifications on all points, will be found to be in substantial agreement therewith, the principal points of difference being such as are found desirable in order to comply with Canadian conditions."

Foundation and Substructure Problems

Reviewed by A. W. Buel
Consulting Engineer, New York City

ENGINEERING AND BUILDING FOUNDATIONS: Including Sub-Aqueous Foundations—By Charles Evan Fowler, C. E., M. Am. Soc. C. E.; Member Engineering Institute of Canada, etc., Vol. 1: Ordinary Foundations. Fourth Edition Revised and Enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6 x 9 in.; pp. 531: illustrated. $5.

A revision and amplification of earlier books by the author presents itself here as the first of three volumes which together are to deal with the subject of foundations. A fair appraisal of one volume of a three-volume work without seeing the other two is obviously difficult, especially when there is room for questioning the particular division of the field among the three volumes. Yet it may be said at the outset that the volume under review, standing alone, should find ready welcome to the intimate book shelves of all engineers and constructors who are concerned with foundation and substructure problems. If Vols. II and III measure up to the standard set by, and supply what is lacking in, Vol. I, the complete work may claim to be ranked as an exceptional and notable contribution to engineering literature; it will undoubtedly be the leading treatise in the English language on design, construction methods and plant for substructure work.

"Ordinary" foundations are dealt with in the present volume. Vol. II is to cover pneumatic and open caissons, deep foundations, building foundations, underpinning, foundations for machinery, dams, seawalls, drydocks and locks; methods and forms for concreting; and cost estimates. Vol. III will cover the design and construction of harbors, piers and wharves, harbor tunnels—all unusual subjects for a book on foundations—besides rockfill foundations, dredges, dredging pumps tugs and scows, diving, and quarrying.

Is a "building foundation" an ordinary foundation"? The reviewer will not venture an answer here, but he feels free to state that the present Vol. I does not cover all the subjects one would naturally expect to find its title to include. Largely it is confined to subaqueous foundations of moderate depth—an important class no doubt, but by no means the whole of the "ordinary" class. More specifically, Fowler's "ordinary" foundations are chiefly bridge substructures where the site can be unwatered with cofferdams or sheetpiling, or the construction carried out in open caissons sunk in place, say in depths not exceeding 35 ft. Within this range, however, it does not restrict itself to design or working methods but brings together a considerable amount of information of great value on the selection and details of plant, matter brought together for the first time. This part of the book is likely to prove an agreeable surprise to many an engineer.

Possibly the needs of many readers would have been better served had the large amount of matter on plant and equipment in this volume (and presumably also in the two subsequent ones) been segregated to form an independent volume. This question, however, is similar to the one above as to why building foundations are not included. It is likely, in short, that those who need Vol. I in their work will find that they also need Vols. II and III, especially if their interest or practice is at all general or covers a broad range. For example, methods and forms for concreting are surely just as much needed in "ordinary" foundations as in others.

Some of the preceding comments have been directed at omissions from the present volume. The reviewer would not, however, critisize the inclusion of matter that he himself might have reserved for a later volume; for, what one man might exclude as of small value, another, who is differently situated as to region and class of practice, might find vitally necessary. Thus, examples of crib cofferdams given in the second and third chapters, may be applicable to conditions in sections where timber is cheap, while they would prove uneconomical where steel, concrete, highly developed plant and skilled labor are available and at low price. In a new country it is natural to resort to old precedents, and the author has liberally provided for such needs without neglecting the requirements of sections favored with a higher industrial development.

Summarizing the present volume, its eighteen chapters and eleven appendices may be described as covering historical development, cofferdams, piledriving, sheetpiles, drivers, pile jetting, removal of old piers, pumping and dredging, foundation design, piers, retaining walls, abutments, culverts, timber piers, wood preservation, specifications, steel sheetpiling, and finally recent piledriving data.

In the extensive treatment of piledriving, jetting and sheet-pile construction (Chapters IV to VII, and Appendix XI) a satisfactory practical treatment of the subject is found, with an important exception however: Reinforced-concrete piles and sheetpiles are inadequately dealt with, and examples of exceptionally large sections are missing. Of the various dangers and difficulties that must be guarded against and overcome in the use of concrete piling only one is briefly mentioned. The reader is referred to Vols. II and III for cost and description, respectively, of "the use of ordinary reinforced rectangular concrete sheetpiling."

Because of the troubles and losses so often incurred through providing insufficient pumping capacity—suitably mentioned in the Introduction—Chap. IX, on pumping and dredging, will be widely welcomed for the ample data it gives on pumping capacity and required steam supply.

Seven chapters following relate chiefly to ordinary bridge substructures. They cover the foundations, soil pressures, the location, design and calculation of piers and footings and the like, various types of masonry abutment, and the design of pier masonry. Comprehensive tables of quantities for preliminary estimates are included. Interpreted solely with regard to bridge substructure of normal type, these chapters leave little to be desired. But it is not apparent to the reviewer why they should not have been extended to apply also to foundations and footings on land, whether for bridges, buildings or other structures. The possible future lowering of groundwater level impervious soils and its effect on foundation settlement are not treated. Possibly the author has reserved the subject for discussion in connection with building foundations in Vol. II.

Two details in these chapters attract special notice. The formula for length of span to give least cost of structure does not appear to offer much advantage over the old method of equating cost of the complete substructure and superstructure. The treatment of test borings omits some recent details and methods, and little is given to aid in determining the number and location of borings or how far they should penetrate the rock (or other foundation stratum), so as to make it possible to lay out a reasonable tentative plan for the explora-

tion. A record of some precedents, accompanied by proper data, would have proved useful here. In a recent case one boring at each pier site proved to be entirely insufficient, the result being very deceptive, so that additional cost of construction amounting to many thousands of dollars became necessary. Had the author enlarged on the relation of geological formation to the number of borings required to determine the probable foundation conditions it would have improved this part of the work distinctly.

Other sections of the book, such as those on historical development, on removal of old piers, on timber piers and wood preservation, require no special comment. A chapter on retaining walls and culverts, however, should meet with an appreciative reception on its merits in spite of the fact that it would hardly be expected under the title of the present volume.

Of the eleven appendices, nine are devoted to specifications, one to steel sheetpiling, and the eleventh (already mentioned) to recent piledriving data.

The book as a whole represents an immense amount of labor. For due credit it should also be remarked that the illustrations are not only ample but unusually clear. A tabular synopsis of 47 cofferdam examples is especially valuable. The index, though not as full as desirable and containing several obvious errors, is fair.

On p. 434 the author presents his patents to the engineering profession—an unusual action. In the reviewer's opinion he deserves commendation for his action, which puts into concrete form an old-time rule of professional ethics, now perhaps obsolete but still regarded by many civil engineers.

Chinese-American Engineering Journal

JOURNAL OF THE ASSOCIATION OF CHINESE AND AMERICAN ENGINEERS: Vol. I., No. I., Sept., 1920—Peking, China: P. Y. Tsai, Secy., c/o The Chuchow-Chinchow Railway. Paper; 6 x 9 in.; pp. 44; illustrated. 50c.

The initial number of the *Journal* noted above contains a spirited Introduction stating in most friendly terms a number of reasons for an association of Chinese and American engineers. To quote:

> As a country China is similar in many respects to America and since each year sees more of her sons educated in the schools and colleges of America, and each year sees a larger number of these students returning to China, it is only natural that the engineers of China and the engineers of America should co-operate and work together in the development of this country along modern scientific lines; for China, though old in history and culture, is new in her present form of government and in the science of engineering.
>
> Having studied the same courses in the same colleges and universities in America where the same ideas and ideals were inculcated in the minds of both Chinese and American engineers, it is but natural that there should be and is much in common between the large number of Chinese engineers educated in America and American engineers now resident in China.

After stating that the objects of the association are to advance engineering knowledge and practice and promote co-operation among engineers, the Introduction emphasizes the need for trained engineers and other technical men in China and predicts a great industrial and engineering future for that country.

This issue of the *Journal* has a brief article on the surveys of the Chuchow-Chinchow and Chouchiakou-Hsiangyang railways lines, besides other short articles, numerous news notes and personals and a list of members.

High Points in the Life of Hoover

THE MAKING OF HERBERT HOOVER—By Rose Wilder La[illegible] New York. The Century Co. Cloth; [illegible] x [illegible] in.; pp. [illegible]. $[illegible]

Beginning, as all good biographies should, with a sketch of his forebears the author rapidly outlines the high points in the life of Herbert Hoover from his boyhood in Iowa and Oregon until he became known around the world, first in mining and financial circles as an engineer of remarkable technical and financial ability and then, and still more widely, as the head of the Belgian Relief Commission and the U. S. Food Administration. Throughout the author dwells on "the making" of Hoover—in character and in organizing, technical and financial ability.

How rapid Hoover's professional progress was is shown in part by the fact that at twenty-four he was engineer of mines for the Chinese government, while soon afterward he became a partner in the large mining house in London for which he had done brilliant work in Australia before going to China. At forty he began his great war work.

Both in matter and method the volume makes a strong appeal. It cannot fail to interest engineers. It is a good book for boys and young men and, regardless of age, should stimulate any one to a life of service and all-round personal development.

Irrigation Engineers' Note-Book Expanded

IRRIGATION POCKET BOOK (Or, Facts, Figures, and Formulae, for Irrigation Engineers): Being a Series of Notes on Miscellaneous Subjects Connected with Irrigation—Compiled, with the Kind Help of Others, By Robert Burton Buckley, C.S.I., Chief Engineer India Irrigation Department (Retired), Member of the Institution of Civil Engineers, etc. Third Edition. New York: Spon & Chamberlain. London: E. & F. N. Spon, Ltd. Cloth; 5 x 7 in.; pp. 625; illustrated. $10.

The third edition of this beek has been enlarged by contributions from irrigation engineers in India and Egypt. The book is still, to quote from the Preface, "simply a compilation of facts, figures and formulas bearing on the everyday work of the Irrigation Engineer," which originated in a note-book kept "during 33 years work in India." A wide range of data on hydraulics and on the design, construction, cost and operation of irrigation works is given. Some of these data are as useful to other engineers as to those engaged in irrigation work. Naturally, many of the data are more applicable to India than to other countries but at the same time many are of world-wide applicability. There are numerous citations from American books and reports.

Water-Borne Typhoid in New York State

Most of *Health News* for October is filled with "A Review of Certain Water-Borne Typhoid Fever Outbreaks in New York State," by Theodore Horton, director, Division of Sanitary Engineering, State Department of Health, Albany, N. Y. One of the outbreaks reviewed, that at Schenectady, N. Y., early in 1920, is described at length by Mr. Horton in *Public Health Reports*, Oct. 29, 1920 (Washington, D. C.).

Sanitation Number

The "Typical Diseases Bulletin" (23 Endsleigh Gardens, London, N. W. 1, England; two shilling at issue) for Oct. 15, 1920, is a "Sanitation Number" containing abstracts of articles and reports falling under the general head, "Applied Hygiene in the Tropics," prepared by Lt.-Col. W. W. Clemesha.

Publications Received

THE AIRPLANE: A Practical Discussion of the Principles of Airplane Flight—By Frederick Bedell, Ph.D., Author of "Airplane Characteristics," "The Air Propeller," etc. New York: D. Van Nostrand Co. Cloth; 6 x 9 in.; pp. 257; illustrated. $3.

AMERICAN RURAL HIGHWAYS—By T. R. Agg, C.E., Professor of Highway Engineering, Iowa State College. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 139; illustrated. $2.

BUILDING OPERATIONS IN THE LARGER CITIES IN 1919—By Jefferson Middleton. Washington, D. C.: U. S. Geological Survey. Paper; 6 x 9 in.; pp. 18; ilustrated.

Classified figures from 128 cities and more general statistics from 13 additional cities of 35,000 population with text summary. Shows numbers of permits and costs for new buildings and for alterations and repairs, grouped into wood and fire-resisting classes, the latter subdivided into brick or hollow tile, stone, concrete and steel skeleton.

CAST IRON FOR LOCOMOTIVE-CYLINDER PARTS—By C. H. Strand, Associate Physicist, Bureau of Standards. Washington, D. C.: Bureau of Standards. Paper; 7 x 10 in.; pp. 25; illustrated. Free upon request to the Bureau.

COLLISIONS, DERAILMENTS, AND OTHER ACCIDENTS RESULTING IN INJURY TO PERSONS, EQUIPMENT, OR ROADBED, ARISING FROM THE OPERATION OF STEAM ROADS USED IN INTERSTATE COMMERCE: Oct., Nov., Dec., 1919—Washington, D. C.: Bureau of Statistics. Paper; 9 x 12 in.; pp. 69. 10c. from Superintendent of Documents.

CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT: Comprising Condensed, Uniformly Presented and Illustrated Catalogue Information Covering the Products of Manufacturers of Various Classes of Mechanical Equipment; with General Classified Directory and Consulting Engineers' Directory, Tenth Annual Vol., Oct., 1920—New York: The American Society of Mechanical Engineers. Cloth; 6 x 9 in.; pp. 1004; illustrated. $4. Issued free to every standing member of the Society of the year of publication. (Extra copies to members, $3.)

THE CONSTRUCTION OF ROADS AND PAVEMENTS—By T. R. Agg, C.E., Professor of Highway Engineering Iowa State College. Second Edition Revised and Enlarged. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 463; illustrated. $4.

Revised to include recent progress in highway engineering and changes in highway practice. Among the additions to the first edition are chapters on drainage and on the control of erosion and maintenance and a section on the proportioning of aggregates for concrete roads. The chapter upon testing highway materials has been rewritten. The first edition was reviewed in *Engineering Record*, Sept. 30, 1916, p. 418 and in *Engineering News*, Oct. 19, 1916, p. 745.

CONTRACTS, SPECIFICATIONS AND ENGINEERING RELATIONS—By Daniel W. Mead, Consulting Engineer, Professor of Hydraulic and Sanitary Engineering, University of Wisconsin, M. Am. Soc. C. E., M. A. S. M. E., etc.; with Chapter on Contracts by Frank Jenks, Member of the Wisconsin Bar. Second Edition. New York: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 557; illustrated. $4.

The first edition was very favorably reviewed in these columns May 17, 1917, p. 364. In the present edition, the chapter on Contracts has been entirely rewritten and enlarged by Frank Jenks, of the Wisconsin Bar. The chapter on Success in the Engineering Profession now includes, in modified form, an inventory of personal characteristics as a basis for character study, originally prepared by Dean A. A. Potter of Purdue University; also a section on personal financial success and notes on the relations of engineering to business and finance.

DAILY RIVER STAGES AT RIVER GAGE STATIONS ON THE PRINCIPAL RIVERS OF THE UNITED STATES: Vol. XVII, 1919—By Alfred J. Henry, Meteorologist. Washington, D. C.: Weather Bureau. Paper; 9 x 12 in.; pp. 291.

DIE FLUSSMETALLE IM BRUCKENBAU: Insbesondere Ihre Einfuhrung—Von Dr.-Ing. E. J. Albrecht. Leipzig, Germany: Wilhelm Engelmann. Paper; 7 x 11 in.; pp. 56; illustrated. 12M.

A review of the introduction of steel in bridge construction, together with elementary comments on working stresses. A chapter on the use of high-strength steels has special interest through the favorable emphasis it lays on the prospects of high-carbon steel.

DORR SYSTEMS OF SEWAGE AND TRADE WASTE TREATMENT—By R. H. Eagles. Reprinted from the *Journal* of the Boston Society of Civil Engineers, Nov., 1920. New York: The Author, care of the Dorr Co., 101 Park Ave. Paper; 6 x 9 in.; pp. 268; illustrated.

EFFECTS OF CAL AS AN ACCELERATOR OF THE HARDENING OF PORTLAND CEMENT MIXTURES—By Roy N. Young, Associate Chemical Engineer, Bureau of Standards. Washington, D. C.: The Bureau. Paper; 7 x 10 in.; pp. 24; illustrated. 5c. from Superintendent of Documents.

ELASTIZITAT UND FESTIGKEIT: Die für die Technik wichtigsten Satze und deren erfahrungsmassige Grundlage—Von Dr.-Ing. C. Bach, Wurtt. Staatsrat, Professor des Maschinen-Ingenieurwesens, Vorstand des Ingenieur laboratoriums und der Materialprufungsanstalt an der Technischen Hochschule Stuttgart; Achte, vermehrte Auflage; Unter Mitwirkung von Professor R. Baumann, Stellvertreter des Vorstandes der Materialprüfungsanstalt an der Technischen Hochschule Stuttgart. Berlin, Germany: Julius Springer. Cloth; 6 x 9 in.; pp. 698; illustrated. 88M.

ELEMENTARY DYNAMICS: A Textbook for Engineers—By J. W. Landon, M. A., Fellow of Clare College, and University Lecturer in Mechanical Engineering, Cambridge. London: Cambridge University Press. Cloth; 5 x 7 in.; pp. 246; illustrated. 10½s.

ERTRAGREICHSTER AUSBAU VON WASSERKRAFTEN.—Von Dr.-Ing. Leiner, Beratender Regierungsbaumeister und Privatdozent an Der Technischen Hochschule Munchen. Berlin, Germany: Von R. Oldenbourg. Paper; 8 x 11 in.; pp. 111 illustrated.

Mathematical discussion of the efficient development of water powers.

FINANCIAL ENGINEERING: A Text for Consulting, Managing and Designing Engineers and for Students—By O. B. Goldman, Consulting Engineer, Professor of Heat Engineering, the Oregon State Agricultural College, etc. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6 x 9 in.; pp. 271; illustrated. $3.50.

THE FIREMAN'S HANDBOOK AND GUIDE TO FUEL ECONOMY: A Simple Manual for the Use of Stokers, Furnacemen, Foremen and Others operating and Controlling Boiler and Furnace Plant—By Chas. F. Wade, A.M.I.Mech.E., A.M.I.E.E., Technical Expert in Fuel Economy. New York and London: Longmans, Green & Co. Cardboard; 5 x 7 in.; pp. 84; illustraded. $1.

THE FLOW OF WATER IN CONCRETE PIPE—By Fred C. Scobey, Senior Irrigation Engineer; With Discussion by Kenneth Allen, Arthur S. Bent, F. C. Finkle, Allen Hazen, J. B. Lippincott, and H. D. Newell. Washington, D. C.: U. S. Department of Agriculture. Paper; 6 x 9 in.; pp. 100; illustrated. 25c. from Superintendent of Documents.

Contains a general discussion of the subject; a review of formulas; a new formula by the author; summaries of 130 observations by the author on 30 separate conduits, of which 29 ranged from 8 to 63½ in. in diameter and one had a diameter of 120 in. and of other observations on conduits up to 18 ft. in diameter; discussions as noted in the sub-title; and three pages of conclusions. A valuable study and a worthy companion to the author's earlier bulletin (376) "The Flow of Water in Wood-Stave Pipe."

THE GREAT GAME OF BUSINESS: Its Rules, Its Fascination, Its Services and Rewards—By J. George Frederick, President of the Business Bourse, New York; Sales Engineer and Counselor; Treasurer and Governor for the New York Sales Managers' Club; Author of "Modern Salesmanagement," "Business Research and Statistics," etc. New York and London: D. Appleton & Co. Cloth; 5 x 8 in.; pp. 175. $1.50.

HANDBOOK OF BUILDING CONSTRUCTION: Data for Architects, Designing and Constructing Engineers, and Contractors, Vol. I and II—Compiled by a Staff of Forty-six Specialists; Editors-in-Chief, George A. Hool, S.B., Consulting Engineer, Madison, Wisconsin, Professor of Structural Engineering, The University of Wisconsin, and Nathan C. Johnson, M.M.E., Consulting Engineer, New York City. New York and London: McGraw-Hill Book Co., Inc. Flexible cover; 6 x 9 in.; pp. 1,474 in the two volumes; illustrated. $10 for both volumes (not sold separately).

THE HANDBOOK OF INDUSTRIAL OIL ENGINEERING: A Reference Book of Data, Relating to Lubrication and Industrial Oils, Including Tables, General Oil Information, etc.—By John Rome Battle, B.Sc. in M.E., M.E., Assoc. M. Am. Soc. M.E., M. Engrs.' Club of Philadelphia, Consulting Engineer. Philadelphia and London: J. B. Lippincott Co. Flexible cover; 5 x 8 in.; pp. 1,131; illustrated. $10 plus postage.

"The Lubricating Engineers' Handbook," which in revised form is included in this new work, was reviewed by Prof. John J. Flather in *Engineering News*, Feb. 15, 1917, p. 275. The scope of the enlarged volume is indicated by its subtitle, given above.

LABOR'S CRISIS: An Employer's View of Labor Problems—By Sigmund Mendelsohn. New York: The Macmillan Co. Cloth; 5 x 8 in.; pp. 171. $1.50.

LEHRBUCH DER EISEN- UND STAHLGIESSEREI: Verfasst Fur Den Gebrauch Beim Unterricht, Beim Selbststudium Und in Der Praxis—Von Bernhard Osann, Ordentl. Professor An Der Bergakademis in Clausthal, Geh. Bergrat. Ehrenmitglied Des Vereins Deutscher Giessereifachleute. Vierte, New Bearbeitete Und Erweiterte Auflag. Leipzig, Germany: Wilhelm Engelmann. Paper; 7 x 10 in.; pp. 672; illustrated. Paper; 42m. bound 54m.

THE PROBLEM OF HEALTHY TOWNS AND A HEALTHY INDUSTRIAL SYSTEM—By Captain J. W. Petavel, Lecturer on The Poverty Problem, Calcutta University. Reprinted from "The Englishman." Calcutta, India: Calcutta University Poverty Problem Study Fund. Paper; 6 x 8 in.; pp. 20.

PROPORTIONAL REPRESENTATION AND MUNICIPAL GOVERNMENT—By Charles A. Mullen. Reprinted from The Municipal World, May, 1920. Montreal, Can.: The Author, 84 Saint Antoine St. Paper; 5 x 8 in.; pp. 20. Single copies free from the author.

An exposition of proportional representation as a preventive of minority control of governments. The author is director of the Paving Department of the Milton Hersey Co., Ltd., Montreal and Winnipeg, Can.

PUBLIC SERVICE COMMISSION: Report, 1919, Second District, Albany, New York: The Commission. Cloth; 6 x 9 in.; pp. 820.

REPORT OF THE CHIEF OF THE CONSTRUCTION DIVISION OF THE SECRETARY OF WAR, 1920. Washington, D. C.: War Dept. Paper; 6 x 9 in.; pp. 83.

SAFETY IN THE MACHINE SHOP. Hartford, Conn.: The Travelers Insurance Co. Paper; 6 x 9 in.; pp. 188; illustrated. Free on application.

An up-to-date exposition of the subject, written from the viewpoint of accident prevention.

SEWAGE DISPOSAL FOR RESIDENCES AND SMALL INSTITUTIONS—By R. B. Wiley. Lafayette, Ind.: Engineering Experiment Station of Purdue University. Paper; 6 x 9 in.; pp. 33; illustrated.

SILVANUS PHILLIPS THOMPSON (D.Sc., LL.D., F.R.S.) HIS LIFE AND LETTERS—By Jane Smeal Thompson and Helen G. Thompson, B.Sc. New York: E. P. Dutton & Co. Cloth; 6 x 9 in.; pp. 372; illustrated. $7.50.

UNION SCALE OF WAGES AND HOURS OF LABOR, MAY 15, 1919. Washington, D. C.: Bureau of Labor Statistics. Paper; 6 x 9 in.; pp. 281.

Letters to the Editor

The Dirty Automobile and the Quebec Bridge

Sir—In reading a recent issue of a motorist's paper I find they have discovered a new reason for the collapse of the Quebec bridge, which might be of interest to the profession. Under the caption "Keep the Car Clean," they say: "It is a sound method of procedure never to allow dust or dirt to collect . . . If the owner will understand that one loose bolt, made so by grit and dirt, caused the collapse of the Quebec bridge, better attention will be given by him to the near-godliness of cleanliness."

Buffalo, Nov. 22. TOWNSEND CARPENTER.

Resistance of Aggregate in Galveston Fire

Sir—In the various interesting articles on the destruction of Pier 41 at Galveston which you have published one feature appears to have no consideration.

As is well known, lime rock calcines under high temperatures and to be strictly fireproof an aggregate that will withstand heat better than lime rock should, of course, be used. Gravels of igneous origin, sandstone, trap and other aggregates will undoubtedly withstand heat better. Some of the aggregate used in Pier 41 was limestone, some glacial gravel, and the observations reported in your journal would have considerably more value if the character of aggregate were named in the floors, beams and columns.

Wichita Falls, Tex., Dec. 4. HARRY PENNINGTON.

Canal-Seepage Water Transferred Through Under-Saturated Soil

Sir—The article describing the experiments of W. W. McLaughlin on "Capillary Siphoning of Water Through Soil," in your issue of Nov. 11, p. 933, recalls some studies which the writer made a few years ago.

A controversy arose between the owners of some 10,000 acres of waterlogged land and a ditch company whose canal was constructed on high ground on one side of the wet area, as to the relative responsibility of the canal company in waterlogging the area. The land owners maintained that the canal was one of the main contributors to the condition through its seepage water. The canal company took the position that the losses from their canal were insignificant, and to prove their point made an extended investigation. A series of vertical shafts, spaced about a mile apart, were sunk adjacent to the ditch and as near the edge of the water as safety would permit. The shafts were sunk to about twenty feet below the water line and tunnels were then driven under the ditch across its full width. No water was visible in any of the excavations although the material was moist. Actual seepage measurements on the canal indicated a considerable loss, but the engineers of the canal company concluded from their experiments that the proportion of their loss which reached the water table was negligible.

It was therefore up to the engineers for the wet land owners to prove that the seepage losses from the canal reached the water table even though the water had to travel through a column of soil which was not saturated. As a matter of fact the water did travel downward as capillary water in much the same manner as described by Mr. McLaughlin, but in this case the action was not strictly siphonic, since no impervious layers of soil intervened between the water table and the canal.

The controversy was aired in court before a jury. Lacking a systematic soil-moisture determination it became necessary to make an ocular demonstration of the phenomena before the jury in order to convince them of its truth. To do this a pan of water was set on the table and one end of a dish towel inserted in the pan, the other end being allowed to hang over the edge and reach almost to the floor. The experiment was started before court adjourned one evening and the next morning the pan was empty and the water on the floor. The towel, however, was saturated only at both ends, and was just moist in the middle. The jury was evidently convinced, for the "[illegible]" was their point.

There is no reason why a column of soil should not have the same capillary characteristics as a piece of cloth, the rate of movement of course varying with the texture.

Boise, Idaho, Nov. 18. W. G. SLOAN,
Hays, Sloan & Lewis, Inc., Engineers.

Brick-Wall Demolition

Sir—In looking over the *Engineering News-Record* of Dec. 2, p. 1106, I noticed the article: "Brick Wall Torn Down With Dynamite," in which I was interested, as I have been handling explosives for many years, using them in blasting in quarries, wells, ditches and in removing old engine beds out of factory plants. I also recently shot down a brick wall. The brick wall was 125 ft. long, 40 ft. high and placed on a stone foundation. The thickness of the wall, which was laid up in cement mortar was 22 in. at the base. Holes were cut into the brick just above the stone foundation on 5-ft. centers. We placed 1 lb. of dynamite in each hole and exploded the charges with an electric blasting machine. The wall fell as a unit and covered the ground like a carpet, breaking all to pieces after striking. I find that in blasting walls of this nature, that the charges usually are too far apart and too heavy, as a result of which holes are blown in the wall, making it very dangerous to work with.

My practice, therefore, is: Place the charges close together, and use a light charge. Then you can always be pretty sure of your result. WILLIAM D. MEYER.

Quincy, Ill., Dec. 7.

The Dangerous Emergency Intake

Sir—*Engineering News-Record* of Dec. 2, p. 1101, notes an outbreak of typhoid at Schenectady, N. Y., which was due to pollution of the well water supplying the city by admission of raw river water through an old suction pipe extending into the Mohawk River and left in place "for use in case of emergency."

Is it not time for water-works engineers to desist from retaining abandoned intakes for "use in emergency"? Surely instances in plenty exist showing the unwisdom of such a practice. The experience of Butler, Pa., was convincing enough and followed the opening of an abandoned intake during repair work on the filter plant. A few years later the City of Erie in the same State suffered from a severe typhoid outbreak due to practically the same cause, although in the Erie case the former intake gate was not actually opened. Upon walking up to the head of the old inlet tunnel which ended on the wharf line the gate was found closed but a flow amounting to about one thousand gallons per day of exceedingly foul water was seen trickling through the surrounding masonry and passing thence to the pump well. About eight hundred cases of typhoid resulted. Orders were at once issued to stone up the tunnel—orders which should have been give years before when the old intake was abandoned "except for emergency reserve."

Troy, N. Y., Dec. 9. WILLIAM P. MASON.

Center Form for Wide Concrete Road

In the recent construction of a 30-ft. concrete road in Wayne County, Mich., a new method of striking the concrete surface was used. Instead of having a strike-board the entire width of the concrete the board was made only 17 ft. in length. Forms made of 2 x 8-in. lumber were put in at the road center. Use of these made is possible to strike half of the road at a time. As soon as the strike-board work was completed the center form was removed, the space filled with mortar and the belt finishing continued across the entire width of the pavement. It is stated in the annual report of the Wayne County Road Commission, that this method allowed smoother construction with fewer men than could have been effected with a long strike board used according to the usual methods.

NEWS OF THE WEEK

New York, December 16, 1920

Hettrick, Head of "Code of Practice" Ring Indicted

Charged with a violation of the Donnelly anti-trust law, John T. Hettrick, New York attorney and head of the so-called "Code of Practice" ring, which is said to have been a clearing house for the activities of a building combine operating in New York City, has been indicted by the grand jury as a result of disclosures made before the Lockwood joint legislative committee on housing. He was arraigned Dec. 13 before Justice McAvoy, in the criminal branch of the Supreme Court and released under $100,000 bail.

The activities of the Lockwood Committee have thus far resulted in the indictment of fifty-five individuals, not including Hettrick. This number includes Robert P. Brindell, president of the Building Trades Council, who has been indicted on five counts; Peter Stadtmuller, Brindell's lieutenant; sixteen members of the Employing Metallic and Furring Lathers Association; thirty-one members of the New York Cut Stone Contractors' Association; John A. Philbrick, Joseph Penny and Wright D. Goss, indicted for failure to answer questions; George Backer, indicted for perjury, and William H. Chapman, of the plumbers' union, indicted on charges of extortion. Backer has been tried, the jury disagreeing. The committee has also succeeded in having dissolved the Masons' Supply Bureau of Brooklyn, and the New York Cut Stone Contractors' Association.

Better Distribution of Aliens Aim of New Bureau

Through the establishment of a new bureau at Ellis Island, New York, in charge of economic and linguistic experts, better distribution of aliens, particularly with a view to avoidance of their congestion in large centers of population, is to be sought. The census this year reveals a tendency of the general population to flock to cities, and the new bureau, through its co-operation with state authorities, hopes to gain a much better distribution of aliens through rural communities.

The new bureau is to be known as the Division of Immigration Distribution and its chief, according to Immigration Commissioner F. A. Wallis, will probably be P. A. Donohue, an economic expert from the U. S. Department of Labor. Mr. Donohue has been a member of several boards of inquiry at Ellis Island, and it is believed he will be well fitted for his new position through his war work for the Federal Employment Bureau.

Transportation Representatives Discuss Place of Motor Truck in Modern Transport

Store-Door Delivery, Terminal Work and Short-Haul, Are Topics at Federal Highway Council Committee Meetings

Representatives of transportation agencies and other bodies met with the three transportation committees of the Federal Highway Council Dec. 10 at the Hotel Commodore, New York City, to determine the place of the motor truck in a modern transportation system. The motor truck was considered from the point of view of an aid to the railroads in short-haul business, as a means of reducing terminal charges in handling less-than-carload merchandise freight through the use of unit containers, and as a farm-to-market transportation agency.

General discussions preceded and followed the breaking up of meeting into three committee sessions. The transportation committees of the Federal Highway Council are: Committee on relation of highways to railroads and waterways, W. J. L. Banham, chairman; committee on study of rural motor express, J. H. Collins, chairman; committee on highway transport functions of state highway departments, David Beecroft, chairman. Special consideration was given to such topics as store-door delivery, terminal work, short-haul, economic and business-like operation of rural express lines, transportation surveys, traffic control and snow removal.

Store-Door Delivery

A. E. Beck, traffic manager of the Merchants and Manufacturers' Association of Baltimore, recalled that store-door delivery service by a railway-operated trucking company was begun in Baltimore in 1867 by the Philadelphia, Baltimore & Washington Ry. (now part of the Pennsylvania system). Later the Baltimore & Ohio instituted a similar service. Both companies then began store-door delivery, also in Washington. After successful operation for 46 years the service was withdrawn because of actions before the Interstate Commerce Commission looking to extensions of the free-delivery zone beyond what the railroads considered reasonable. As a result of the dropping of the plan great congestion ensued at the terminals.

Mr. Beck advocated store-door delivery strongly, asserting that only through it could terminal congestion be avoided. He advocated that existing trucking companies be employed for this work, though the service should be included in the railroad rate. It should apply, he believed, only to l.c.l. freight, and a pick-up or collection system for outgoing freight should be worked in connection with the delivery plan.

A digest of the recommendation of the subcommittee on store-door delivery, adopted at the recent meeting in Akron, Ohio, was presented stating that municipal areas should be divided into zones and zone distribution designated on way bills. Colonel Charles D. Hine, special agent, Erie R.R. and New York, New Haven & Hartford R. R., who was previously vice-president of the Southern Pacific R.R. Co. of Mexico, pointed out that the fear of carriers having the additional cost of store-door deliv-

Chicago Railway Electrification Before Engineer Board

The Illinois Central R.R. has taken another step toward electrifying its Chicago terminal and suburban lines by the appointment of a board of engineers to consider the different systems and prepare general plans. It is expected that the report will be made in about six months. The board is composed of A. S. Baldwin, vice-president Illinois Central R.R.; D. J. Brumley, chief engineer Chicago terminals; Bion J. Arnold, consulting engineer; George Gibbs, consulting engineer; Cary T. Hutchinson, consulting engineer; W. M. Vandersluis, signal engineer. Under the ordinance of July 21, 1919, work must be commenced by 1922.

Cement Manufacturers and Dealers Lower Prices

In line with a sharp decrease in the price of cement in the Middle West, cement manufacturers supplying the New York district have dropped their price 20c. per barrel, while New York dealers on Dec. 6 cut their prices from $4.10 per barrel, delivered, exclusive of bags, to $3.80—a decline of 30c. per barrel. In Jersey City dealers who were receiving $3.55 net, delivered, are now asking $3.20.

In Chicago the dealers' net price has declined from $3.60 to $3. Minneapolis reports a drop of 50c.—from $3.50 to $3—and the city purchasing agent has advised that the city has been given a quotation of $2.76 per barrel on large orders.

ery harnessed onto them without additional compensation was a practical obstacle, but that the carrier should control transfer and storage. Colonel Hine said that carload store-door delivery was as important as l.c.l. delivery in releasing cars. W. C. Brinton, consulting engineer, New York City, pointed out the need for heavier capacity elevators in industrial and loft buildings to facilitate freight delivery and shipment from origin.

F. E. Williamson, general superintendent New York Central R.R. Lines East, said that terminal operation was the neck of the bottle in railroad transportation and anything that could be done to increase terminal capacity would increase line haul and would be welcomed by the railroads. A. E. Beck said that store-door delivery of carload freight in Baltimore was abandoned because it was found that manufacturers with sidings would use such delivery instead of a full use of existing sidings. When store-door delivery was furnished in Baltimore, embargoes were unknown.

F. S. Holbrook, vice-president and treasurer American Railway Express Co., New York City, believed that it was not feasible at present for express companies to handle store-door delivery because of the too great proportional increased cost and the probable difficulty with labor conditions. Mr. Lincoln, traffic manager Merchants' Association, New York City, said that the freight situation in New York City could never be satisfactorily relieved without store-door delivery, but that laws would have to be revised so as not to require 48-hr. arrival notices. Such delivery at New York would have to provide for carload shipments.

Resolution

Following the discussion on store-door delivery a resolution was passed instructing the committee on store-door delivery to consult with certain carriers and shippers with a view to the establishment of the store-door delivery plan, and to report at the next transportation conference of the council upon a concrete plan.

Cincinnati Terminal

B. F. Fitch, president Motor Terminals Co., New York and Cleveland, who developed the system of operation for transferring less-than-carload freight between main and sub-stations in the city of Cincinnati in demountable truck bodies, described the method of operation in that city and outlined the results obtained. Fifteen motor-truck chassis have handled about 28 per cent of all less-than-carload business in Cincinnati on six railroads, as indicated by the actual figures of one. Mr. Fitch presented a report from one of the railroads in Cincinnati indicating that loss and damage claims on such l.c.l. freight had been reduced about 50 per cent since the motor transfer service had become fully effective. The transfer company has not sustained a single claim for loss and damage in handling 200,000 tons of freight.

Mr. Fitch outlined the further general application of motor transfer service for railroad transportation and in the case of New York City he pointed out that it would be possible to increase the carrying capacity of Manhattan city streets 1,500 per cent before present congestion would be reached.

Terminal Costs High

C. W. Reid, manager transportation bureau, Federal Highway Council, presented figures from the Interstate Commerce Commission reports and other data indicating that total terminal l.c.l. cost in the eastern district averaged about $2 per ton. He said that the Federal Highway Council could take no better position than to urge that the railroads undertake a study of short-haul conditions involving such l.c.l. movement. The total terminal cost of handling such freight including delivery to store door of miscellaneous shipments would probably amount to $12 per ton, or 60c. per 100 lb. Colonel Hine stated that these figures were probably high and that the best results could be obtained not by taking short-haul business away from railways but by enabling them to carry out broader transportation functions by the operation of motor trucks and other equipment. W. J. L. Banham proposed a resolution which was adopted providing for enlargement of the committee to include additional representatives of trucking, shipper and railroad interests.

The committee on the study of rural motor express enlarged upon the material which it is to include in its publication, which will contain facts and figures as to the economic management of rural express lines. This committee hopes to establish a status for the rural motor express, to eliminate the fly-by-night concerns, and through its publication, offer sound policies for rural express lines to adopt.

Need for Transport Engineers

That the state highway departments need the services of a new official in the form of a "highway transport engineer," was the opinion expressed by W. G. Thompson, H. G. Shirley and others at the meeting of the committee on highway transport functions, of which David Beecroft is chairman. It was pointed out by Mr. Thompson that the traffic surveys, as ordinarily made, form no basis for pavement design. A campaign of propaganda designed to educate members of commissions and the general public to the necessity for highway transport engineers is required. Recognizing the shortcomings of the traffic census, as now taken, Mr. Shirley advocated a new kind of census, involving a house-to-house canvass of producing and consuming units.

To Prof. Arthur H. Blanchard, professor of highway engineering at the University of Michigan, was intrusted the duty of preparing a report defining the functions of a highway transport engineer. With this material in hand it is proposed to enlist the co-operation of civic organizations, such as chambers of commerce, toward securing the necessary legislative authority for the appointment of these officers in various states.

The outcome of the discussion on the subject of snow removal was the approval of a recommendation to the effect that a communication should be sent to the American Association of State Highway Officials suggesting to that body that state laws be amended so that snow removal shall be considered as a part of maintenance, thereby opening up the way for the use of highway maintenance funds for snow-removal work.

Shut-Down Threatened on Skagit Power Project

Work on the Skagit River hydro-electric power project, under development by the city of Seattle, is threatened with indefinite suspension on account of the inability of the city to dispose of its bond issue voted for the project. Work has been reduced 75 per cent and may be forced to close down next month unless money is obtained by the city to continue its operations. More money has been spent than has been realized on the sale of utility bonds. Several millions in bonds remain available, but are useless until sold as conditions in the bond market make 6 per cent utility bonds somewhat unattractive.

According to a statement submitted by City Comptroller Harry W. Carroll the deficit amounts to $45,756.[illegible]. Thus far $1,698,769.01 has been expended. It is estimated that an expense of $100,000 would be entailed by suspension of operations and later reassembling of crews.

Engineer C. F. Uhden, in charge of the project, states that he will continue operations, although confining them to the tunnel being bored for the Newhalem power site, which is only preliminary to the Gorge development, the first unit in the Skagit project, so far as delivery of power to Seattle is concerned. Mr. Uhden states that if he is able to proceed without his forces being crippled current will be delivered in Seattle in 1923 at a cost estimated at 4⅔ mills per kilowatt-hour, or less than half a cent.

Bonds totaling $5,500,000 have been voted for the Skagit work. Informal negotiations with bond houses for their sale have been undertaken. The bond issue voted will not be enough to cover the project as contemplated, City Engineer Dimock stating that the modest development plans involve an expenditure of $9,000,000, such construction developing 34,500 kw. This sum would install wheels capable of generating 54,000 kw. by the construction of a great dam costing several more millions, and further development of the Gorge Creek unit.

Pennsylvania Contractors Effect Permanent Organization

Permanent organization of Pennsylvania highway contractors was effected at Harrisburg recently, the new body to be known as the Associated Pennsylvania Highway Contractors. The following officers were elected:

President, Henry H. Wilson, Winston & Co., Hughesville; 1st vice-president, Benjamin Harrison, Harrison & Co., Derry; regional vice-presidents, W. J. Wiseman, Booth & Flinn, Pittsburgh; R. S. Rathbun, Rathbun Contracting Co., Bethlehem; H. S. Souder, Souder Construction Co., Lancaster; William Horn, Horn and Devling, Galeton; treasurer, Samuel M. Irwin, Union Paving Co., Philadelphia. The board of governors will be composed of the president (ex-officio); Aldrich Durant, MacArthur Bros. Co., New York; William D. Hill, Samuel Gamble Co., Carnegie, Pa.; Samuel M. Irwin, Union Paving Co., Philadelphia; William McCrady, McCrady Bros. Co., Pittsburgh.

E. J. Harding, assistant secretary of the Associated General Contractors of America, has been loaned by that association to perfect all details of organization and act temporarily as secretary and general manager of the new association.

Steel-Wood Stave Pipe Controversy in Seattle

A strong effort is being made by the Chamber of Commerce, Seattle, through its Pacific Northwest Products Committee, to force the city to spend the greater part of the proposed $3,000,000 extensions to the city's water system in Seattle in the purchase of wood stave pipe instead of steel pipe as proposed. The contract to be let for steel or wood pipe is for the No. 3 pipe line, to bring in water to the municipal reservoir. Representatives of Seattle industries point out that if steel pipe is purchased practically all of the $3,000,000 will be sent to eastern points while wood stave pipe may be purchased from a Seattle manufacturer. An early conference will be held by Mayor Caldwell, A. H. Dimock, city engineer, and representatives of the committee to discuss the question. L. B. Youngs, superintendent of water, is said to favor steel pipe.

Let Contract for New Savannah Coaling Terminal

Contracts were recently awarded by the Savannah Coal & Dock Co., Inc., a subsidiary of the New York Tidewater Coal Co., to the A. Bentley & Sons Co., Toledo, Ohio, for the development of a coaling station on the Savannah River, Savannah, Ga., at an amount approximating $5,000,000. The work includes the dredging of a ship canal, 1,000,000 cu.yd., and a railroad transfer station covering 500 acres. Charles P. Lyman, New York City, is president of the company, and Charles H. Preston, corporation engineer, Waterbury, Conn., has been retained as consulting engineer.

Work Started on New Hudson River Power Development

Construction has just been begun on a 30,000-kw. hydro-electric plant on the Hudson River, about 5 mi. west of Glens Falls, N. Y., for the International Paper Co. A head of 70 ft. will be developed by a hollow reinforced-concrete dam located 800 ft. above Sherman Island; the present north branch of the river will be utilized for a tailrace. The contract for the work was given to the Parklap Construction Corp., an organization auxiliary to the firm of Parsons, Klapp, Brinckerhoff & Douglas, consulting engineers, New York City. W. J. Douglas, president of the corporation, is in general direction of the work, and E. A. Little, works manager, has field charge.

Sanitary Engineers Hold Conference on Malaria Control

A conference of sanitary engineers engaged in malaria control work was held at Louisvill, Ky., Nov. 16 and 17. The purpose of the conference was to discuss methods of malaria control, particularly in regard to experiences in anti-malaria campaigns conducted during the past year by co-operation of the U. S. Public Health Service and the International Health Board with state boards of eleven southern states.

Among the papers read were: "Organization of Malaria Control Division in State Boards of Health," L. M. Fisher, associate sanitary engineer, U. S. P. H. S.; "County Mosquito Extermination Organization," Wm. H. De Mott, chief engineer, Nassau County, N. Y.; "Railroad Malaria Work" H. W. Van Hovenberg, sanitary engineer, St. Louis Southwestern R.R.; "The Relation of Agricultural Drainage to Malarial Control," S. H. McCrory, engineer-in-charge, Agricultural Engineering, U. S. Department of Agriculture; "Sub-Soil Drainage," J. G. Foster, assistant sanitary engineer, U. S. P. H. S. Other subjects discussed included: methods of promoting and financing anti-malaria campaigns; publicity; malaria statistics; relation with outside engineering departments; use of fish, oil burners and weed-killing larvacides in mosquito eradication; foreman and labor problems.

On Nov. 15, the sanitary engineers met with the National Malaria Committee, a section of the Southern Medical Association, in session at that time. At this meeting a paper on "Co-operative Anti-Malaria Campaigns in the United States in 1920" was read by J. A. LePrince, senior sanitary engineer, U. S. P. H. S. Mr. LePrince was with General Gorgas in direct charge of the yellow fever and malaria control work in Panama from 1904 to 1914.

A joint meeting was held with the Engineers and Architects' Club of Louisville on the evening of Nov. 16. A paper, "Engineers and Malaria Control," was read by W. G. Stromquist, sanitary engineer, City Health Department, Memphis, Tennessee.

Government Studying Columbia Basin Project

Three engineers appointed by the U. S. Reclamation Service are now making an investigation of the Columbia Basin Irrigation project noted in *Engineering News-Record*, Nov. 11, 1920, p. 944. They are D. C. Henny, James Munn and C. T. Pease. It is expected that they will soon present a report on the general features of the scheme, which will be used as a basis for any Governmental connection with the work.

Large Majority for Kansas Good Roads Amendment

Out of a total vote of 478,036 the Kansas good roads amendment, the passage of which was noted in *Engineering News-Record*, Nov. 11, p. 960, received a favorable majority of 91,342 votes. Of 105 counties in the state 72 were favorable to the amendment, 32 unfavorable and in one county the vote was a tie.

Proposal to Transfer Patent Office and Weather Bureau

The McCormick bill to establish a department of public works and public welfare, noted in this journal Dec. 2, p. 1107, also provides for transfers to the existing Department of Commerce as follows:

(a) From Department of Agriculture—Weather Bureau.

(b) From Department of Interior—Patent Office.

(c) From Department of the Treasury—Coast Guard.

(d) From Department of War—Lake Survey Office, Inland and Coastwise Waterways Service.

(e) From Department of the Navy—Hydrographic Office, Naval Observatory.

(f) Commission for Standardization of Screw Threads—(Abolished and its Functions transferred to Bureau of Standards).

Sacramento Goes From Commission to Council-Manager Plan

By a vote of 7,692 to 1,587 out of a registration of 30,469 Sacramento, Cal., voted on Nov. 30 to change from the commission to the council-manager plan of city government and to elect the nine members of the Council by the proportional representation system. The first election under the new plan will be held on May 3, 1921, when a full new Council will be chosen. Within five days after the election the Council must organize, but for the sole purpose of choosing a city manager—to the end that, if possible, the manager may take office on June 30, when the new charter goes into full effect. The city manager will appoint all executive officers except himself, the city attorney, city treasurer, city clerk and police judge. The city engineer will exercise many of the present functions of commissioners of streets and of public works. The present board of parks and playgrounds will be succeeded by superintendents of parks and playgrounds. The Board of Education will be appointed by the City Council and will have as its executive officer a superintendent of schools. The population of Sacramento by the 1920 census was 65,857.

Washington Needs $6,000,000 for 1921 Road Work

State Highway Commissioner James Allen, Olympia, Wash., announces that between $6,000,000 and $7,000,000 will be necessary to complete the road building projected in the State of Washington during 1921. In all, 112 miles of state highways have been hardsurfaced during the past two years representing virtually the whole program outline. No new work will be started until after the legislature decides how much money is to be made available.

May Rebuild Gulf Coast Bridges

At hearings held in New Orleans during the past week the Louisiana Railroad Commission inquired into the question whether bridges and trestles of the Louisville & Nashville R.R. Co. over Chef Menteur and the Rigolets, between New Orleans and Mobile, are unsafe and should be replaced with new structures. In the testimony at the hearings it was shown by the railroad company that the bridges had given satisfaction and were equal to all requirements except hurricanes and tidal waves such as that of 1915, when it would have been perilous for railroad trains to attempt to cross the bridges in any event. However, in view of the severity of storm effects in the exposed locations of the bridges under extraordinary weather conditions the railroad company decided three years ago either to change the line of the road by an inland diversion, or to reconstruct its bridges and change the type of construction employed.

After detailed surveys for inland routes, it is said, the company discovered that the present constitution of the State of Mississippi prohibits changes in the main line of railroads traversing the state, and therefore has concluded that rebuilding the structures on their present locations is necessary. Plans have been drawn for steel bridges resting on concrete piers in place of the trestle supports heretofore used. The proposed work was stopped by the government taking over the railroads, and since their return, according to W. L. Mapother, executive vice-president of the Louisville & Nashville, financial conditions and high prices have interfered with execution of the project.

Plans for the proposed structure have been filed with the Railroad Commission by W. H. Courtenay, chief engineer of the railroad. The estimated costs are $1,334,000 and $3,422,000. A contract for the construction has been made with the American Bridge Co., to be carried out as soon as the financial condition of the company will warrant the expenditure. It is said to be not unlikely, however, that the railroad company will be asked to hasten the work of constructing new bridges in order that the present timber construction may as soon as possible be replaced by concrete substructure and steel superstructure.

Federal Power Commission Needs $482,000

Estimates of the Federal Power Commission submitted to Congress Dec. 6 indicate that an appropriation aggregating $482,065 is required, $100,000 to be used to reimburse executive departments for investigations requested by the commission. General expenses for authorized work of the commission, exclusive of personnel, are fixed at $137,000 and the estimate covering salaries is $240,000. All of these estimates, according to Engineering Council, appear to be the lowest amounts consistent with effective operation of the commission under the requirements of the law. Since this item will effect practically every phase of the engineering field it is appropriate, Engineering Council believes, that engineers and engineering organizations as such should use their efforts to obtain this appropriation by advising their representatives in Congress of the engineering and commercial value that power development, properly administered, will be to the country.

Defer Grand Trunk Arbitration

At the meeting of the Board of Arbitration on the Grand Trunk Ry. settlement, Nov. 5, it was decided to allow representatives of the stockholders such time as might be needed to prepare the case. Feb. 1, 1921, was set for the formal opening of the arbitration proceedings, which will take place at Montreal. The principal point at issue is to fix the value of the Grand Trunk stock in transferring the property to the control of the Canadian Government.

Small Referendum Majority Against Portland Zoning

The zoning ordinance for Portland, Ore., passed by the City Council last March (see *Engineering News-Record*, May 6, 1920, p. 899) but through petition of opponents sent to referendum, was defeated by a vote of 30,651 to 30,150 on Nov. 2. The measure had to compete for attention with 92 candidates for office, 11 state measures and 6 city charter amendments. Petitions have been filed with the City Planning Commission asking that the 149 precincts (about half the area of the city, mostly residential) that voted for zoning should be allowed to come under the ordinance. The proposal is being given consideration. Meanwhile the city has the advantage of a building code provision requiring a special hearing before the City Council on application for a permit for a new apartment, industrial building, garage and buildings for some thirty other kinds of business, the hearing to be preceded by a notification to all owners of buildings within 200 ft. of the proposed building. It is stated that the Portland ordinance in question is the first zoning ordinance that was ever submitted to popular vote in this country

George S. Rice, Rapid Transit Engineer, Dies

George S. Rice, whose death on Dec. 7 was announced in these pages last week, was widely known for his prominent connection with rapid transit subway development in Boston and New York and for his work on the Croton Aqueduct for supplying water to New York City. He had been division engineer of the Transit Construction Commission in charge of subway construction in Brooklyn and continued work to within a few weeks of death.

Born in Boston, Feb. [illegible], 1849, Mr. Rice was graduated from the engineering school at Harvard University in 1870. During his later days in college he obtained work in the engineering department of the Boston water works and on graduation became assistant to the chief engineer. In that capacity he had charge of the construction of several miles of tunnel running to the Chestnut Hill reservoir.

From 1880 to 1887 Mr. Rice engaged in mining engineering in Colorado and Arizona. He later returned to New York and became deputy chief engineer of the Aqueduct Commission, in which capacity he remained until 1891, when he went to Boston to act as chief engineer of the Rapid Transit Commission of that city. From 18[illegible] to 1[illegible] he was an instructor in sanitary engineering at Harvard University, during which time he made studies for the first subway in New York. In 1900 he was appointed deputy chief engineer of the Rapid Transit Commission of New York and when William Barclay Parsons resigned as chief engineer in 19[illegible] Mr. Rice was appointed to the position. When the Rapid Transit Commission was absorbed by the Public Service Commission Mr. Rice continued as construction engineer, and, later, in the capacity of division engineer for the Brooklyn subways.

Shortage of Railroad Facilities Shown in I. C. C. Report

Emphasis is laid on the general shortage of transportation facilities in the annual report of the Interstate Commerce Commission to Congress, transmitted Dec. 9, 1920. "As a result of the inadequacy of the car supply and of railroad transportation facilities generally during the past year," says the report, "a practice has grown up among shippers of bribing operating employees." However, despite the shortage of equipment, it is shown that the volume of freight carried during the first seven months of 1920 exceeded the freight carried during the corresponding period of 1919 by 17.1 per cent, as a result of more intensive operation.

The report also says that the immediate payment to the railroads of sums due them under the guarantee provisions of the Transportation Act, but withheld by the U. S. Treasury on a legal technicality, is "vital . . . in order that the carriers may properly

serve the public," and suggests amendment of the law to permit payment.

Other amendments suggested cover the transportation of explosives, the use of wooden passenger cars, and penalties for accepting bribes for preferred car service.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City, Jan. 19-20, 1921.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. 25-27.

ENGINEERING INSTITUTE OF CANADA, Montreal; Toronto, Feb. 1-3.

The Engineering Institute of Canada will hold its thirty-fifth annual general and professional meeting at the King Edward Hotel, Toronto, Feb. 1-3. The program for Feb. 1 includes registration at King Edward Hotel, address of welcome, annual business meeting, reports of scrutineers, address of retiring president, inauguration of incoming president, reception, smoker. Feb. 2: Professional meeting, new business and general discussion, annual banquet of the Institute at King Edward Hotel. Feb. 3: Excursions, continuation and closing of profssional meeting, dance at Hart House to be given jointly by the Engineering Society, University of Toronto and the Institute.

The Vancouver Branch, British Columbia Technical Association, held its second smoker in the Old Colony Tea Rooms, Dec. 2.

The Engineers' Club of Philadelphia, will hold a meeting Dec. 21; the subject will be "Road Construction for Heavy Truck Traffic."

The Rochester Engineering Society, at its noonday luncheon, Dec. 7, was addressed by Edward D. Seymour, chief plant engineer, Vacuum Oil Co., who has recently returned from a seven months' trip in Italy, France, Portugal and England.

The Iowa Engineering Society will hold its annual meeting Jan. 18-20, 1921, at Des Moines. Under the new plan of consolidation prepared at the last annual meeting, six local engineering organizations have become district clubs of the State society.

The Engineers' Club of San Francisco, at its noon-day meeting Dec. 1, was addressed by J. Waldo Smith, chief engineer, board of water supply, New York City, on New York's water supply problems. Mr. Smith was introduced by M. M. O'Shaughnessy, city engineer of San Francisco who announced that Mr. Smith was in San Francisco at the invitation of the Chamber of Commerce to advise in regard to the future water supply of San Francisco.

The Seattle Branch, Am. Soc. E. C., is considering the establishment of a student section at the University of Washington.

The Engineers' Club of Seattle, at a recent special meeting, was addressed by C. F. Uhden, chief engineer Skagit River power project, on "Skagit River Development."

The Western Society of Engineers, at its meeting Dec. 7, was addressed by three speakers on "The Commercial Use of the Airplane." John F. Hayford discussed research problems; A. R. Rhenisch, recent progress and costs; Walter Painter, commercial airplane types. The following meetings are announced: Dec. 17, three speakers will present papers on "Recent Tendencies in Electric Railway Development"; Dec. 18, the Young Men's Forum is sponsor for a talk by O. M. Fox of the Business News Department of *Engineering News-Record* on "Economics and the Engineer"; Dec. 20, "Investigation of the Water Supply of Small Cities," by William Artingstall.

Personal Notes

J. K. SIMMS, formerly with the St. Louis-San Francisco Ry. on railroad location work, has accepted a position on the engineering staff of the Tela Railroad Co., Tela, Honduras, C. A. The Tela Railroad is controlled by the United Fruit Co., which is developing the banana industry of Honduras.

WALTER E. SPEAR, formerly department engineer of the New York Board of Water Supply, has returned to New York from Greece where he conducted for a period of eight months an investigation for Ford, Bacon & Davis, consulting engineers, New York, of the projects for water supply and sewerage systems for Athens and Piraeus.

PROF. C.-E. A. WINSLOW of the Yale University School of Medicine, has been granted leave of absence for the spring term in order that he may assume the directorship of the public health activities of the League of Red Cross Societies at Geneva. Prof. Winslow will return to New Haven for the opening of the fall term, Oct. 1, 1921.

A. W. K. BILLINGS, consulting engineer, Barcelona, Spain, is in the United States for a brief visit and may be addressed at the Engineers' Club, New York City. Since 1912 he has been connected with the Ebro Co., filling successively the position of manager of construction, managing director, vice-president and consulting engineer. During the World War he was in charge of naval aviation construction in Europe, and was promoted to the rank of commander and awarded the Legion of Honor and the Navy Cross for distinguished service in this work.

T. J. STRICKLER, chief engineer, Kansas Public Utilities Commission, Topeka, Kan., has resigned to become engineer for the Empire Gas & Fuel Co., Bartlesville, Okla.

ARTHUR H. BLANCHARD, professor of highway engineering, University of Michigan, has been engaged as consulting engineer for paving work to be done in Colorado Springs, Col., next year at a cost of about $1,000,000.

RICHARD S. HOLMGREN, formerly with H. K. Barrows, consulting engineer, Boston, is now assistant engineer with L. H. Shattuck, Inc., engineers and contractors, Manchester, N. H., who are making investigations of the sewerage system of Manchester.

N. D. DOANE, formerly experimental engineer with the Goodyear Tire & Rubber Co. of Akron, Ohio, is now engaged in sanitary work for Charles H. Hurd, consulting engineer, Indianapolis, Ind.

H. McL. HARDING, consulting engineer of New York, has been retained by the city of New Haven, Conn., as consulting engineer on its port development.

C. F. GRAESER, formerly resident engineer on design and construction of municipal improvement work with W. B. Saunders, consulting engineer, Helena, Mont., has accepted a position as assistant engineer, Minnesota Highway Department.

ROBERT K. WILLIAMS has been engaged as Southern representative of F. L. Grant, Inc., engineers and contractors, Clarksburg, W. Va.

FREDERICK C. HITCHCOCK has resigned as vice-president and general manager of MacArthur Brothers Co., contractors, New York, with whom he has been associated many years, to become president of Carey, Campbell & Co., contractors, with offices in New York and Erie, Pa. Mr. Hitchcock is also vice-president of the Siems-Carey Railway & Canal Co., which holds concessions for railway and canal work in China.

HENRY S. COWELL, formerly with the American International Shipbuilding Co., Hog Island, Pa., as structural designer and for the past year with the Southern Engineering Co., Charlotte, N. C., is now designing engineer on plant construction with the Champion Fibre Co., Canton, N. C.

HIRAM D. PHILLIPS, assistant division engineer, Massachusetts State Department of Public Works, Bureau of Highways, has been appointed engineer of District No. 2, Franklin and Hampshire Counties, Conn., to succeed C. H. Howes, resigned.

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Port Discussion

LAST WEEK there was presented before the New York Section of the American Society of Civil Engineers a technical discussion on New York's port problem, remarkable for its high quality and its broad treatments. Since the report of the New York-New Jersey Port and Harbor Development Commission has not yet been made, Mr. Cresson presented only an analysis of the many phases requiring solution, but the discussion that followed brought out striking recommendations for an ultimate solution. A report of the meeting appears elsewhere in this issue and merits a thoughtful reading by port-terminal engineers everywhere.

New Light on Water Hammer

NEW light is thrown on the vexed subject of water hammer by Prof. Durand's valuable discussion on p. 1212. The last part of the paper, relating to water hammer under conditions of partial or incomplete reflection at the valve, is believed to be quite new, valuable, and likely to dispel some of the doubts and uncertainties which hydraulic engineers have had regarding the applicability of the best previous existing formulas. Experimental data on the degree of reflection at the valve are needed before it can be determined what, if any, economy in the design of penstocks and surge tanks can be effected by consideration of actual rather than ideal conditions of complete reflection of the pressure wave.

Foreign Financing

MUCH deserved commendation has been accorded the launching at Chicago week before last of the Foreign Trade Financing Corporation, which will have a loaning power of $1,100,000,000. Our foreign-trade relations are in a bad condition. The organization of this banking instiution will help more than any other action that has been taken to enable European powers suffering under an adverse rate of exchange to buy our products. Great as the step is, however, it is not a cure-all and we must expect neither full relief for European countries nor immediate, or even rapid, equalization of the exchanges. European governments alone owe our government $10,000,000,000, while the financing ability of the new organization is approximately one-tenth of that sum. Nevertheless, the importance of the step intrinsically and as an example should be recognized.

Salem Typhoid Outbreak

WATER-BORNE typhoid epidemics that prostrate ten per cent of the population of a city are happily becoming rare. Meanwhile prompt and effective methods for combating the spread of the disease and for ameliorating the appalling conditions in typhoid stricken communities have been elaborated. These facts lend unusual interest to the epidemic at Salem, Ohio, officially reviewed in concise detail on p. 1244. The Salem epidemic, like the one at Schenectady early this year (see *Engineering News-Record*, Dec. 2, p. 1101), shows that a water supply itself pure, even though from an underground source, must be guarded against pollution en route to the consumer. An abandoned river intake at Schenectady, flooded at high water, led to the pollution of the water supply, much gastroenteritis and 53 cases of typhoid. At Salem, the menace was continuous and when the epidemic came it was of large proportion compared with the Schenectady outbreak. These and other typhoid outbursts of the last few years, even though most of them have been minor, show that eternal vigilance is still essential for the maintenance of pure water supplies and for a continuance of the remarkable progress that has been made in the elimination of water-borne typhoid.

Highway Contracts

HIGHWAY contract provisions have been under discussion by a joint committee appointed a year ago by the Association of State Highway Officials and the Associated General Contractors. There are, it is generally recognized, many unsatisfactory features in the contractual relations on highway work. Nevertheless, there is common ground and it was with the hope that this ground would be broadened that the committee was appointed. Unfortunately, after a year of labor the committee was not able to make a report at Washington last week. It was distinctly stated that the committee could not agree. No information as to the character of disagreement has been given out so that one can express only general regret that the deliberations have been abortive. We believe that both of the parent organizations, through their executive bodies, should counsel with their representatives on the joint committee to the end that the cause of disagreement may be removed. Even a frank statement of the subject on which there is a disagreement would be helpful, for the subsequent discussion by the members of the two bodies at large would help to clarify and settle the issues. The matter is too important for the interests of the public to allow it to drag.

Concrete Road Reinforcement

WHETHER reinforcement is of advantage is one of the controversial points in concrete-pavement design. Many believe in its efficacy in preventing cracks or at least in delaying the breaking up of the slab if cracks occur. In fact, some state highway departments call for reinforcement in all their concrete roads. Others, on the other hand, are emphatic that reinforcement is not worth what it costs. Some time ago H. Eltinge Breed undertook a study of matured roads to learn the

effect of reinforcement, later widening and completing the examination on behalf of the National Steel Fabric Co. His conclusions can be found in an article on page 1231 of this issue. His observations show that reinforcement prevents cracking, that it is worth what it costs. We have no doubt, however, because of the depth of feeling on this subject, that there will be disagreement with Mr. Breed's findings. It is, nevertheless, a definite contribution to the literature of the subject and should be amplified by the experiences of other highway engineers. Not less interesting than these conclusions of Mr. Breed are the adoption in his own practice of 40 lb. of reinforcement per 100 sq.ft. instead of the customary 25, and also his use of two layers of reinforcing steel. The latter design carries 75 lb. per 100 sq.ft., 40 in the lower and 35 in the upper layer. Mr. Breed's article thus suggests two lines for discussion and further data—regarding simple reinforcement and regarding the advisability of the two-layer design. While it may not yet be general, the opinion has been frequently enough expressed that the time for true *reinforcement* of concrete pavements has come, to suggest that there is a definite drift toward use not merely of some steel but of much more steel than has heretofore been used.

Government Economy

THE opening of a session of Congress is always preceded in an editorial office by the receipt of letters urging that certain proposed legislation be given publicity in the columns of the journal and, if possible, editorial approval. This year there has been an exception to that rule in so far as there have been no communications from engineers or contractors urging projects or measures pertaining to engineering and the construction industries. That fact is, we believe, significant. The feeling among thoughtful men is that there must be the utmost economy in Government expenditures. The situation is further emphasized by the fact that the appeals for editorial support on congressional measures have been made only for the adoption of the budget system and the modification of the tax laws. How far the cutting in Washington should proceed cannot be expressed as a generalization. Each governmental service needs separate investigation and appraisal. Those that immediately prevent heavy loss to the community, such as the measures for keeping down crop pests and for the extirpation of disease, must be maintained at full vigor. However, we must expect heavy curtailment in research, even though one can reasonably demonstrate that it would be a good investment of Government funds. Even the shrewdest business corporation often finds that instead of making a profitable investment it must conserve its cash and husband its resources. A similar situation faces the Government today. Engineers and contractors must, therefore, expect neglect of favorite agencies and projects, existing and prospective, unless they themselves, like the proposed department of public works, are measures of economy. The Government must reduce its expenditures.

Progressive Highway Thinking

WAYNE COUNTY, Mich., has long had the reputation—and justly so—for progressive highway work. Its road system was for years the Mecca of those who wished to study concrete highway construction. Therefore, it is not a surprise to learn that the Wayne County road commissioners continue to think in a forward-looking way regarding their problems. Surfacing—as to design, construction and maintenance—they consider quite well settled for present and reasonable future conditions. Their concern is rather with the effort to foresee future needs. They believe that highway traffic is certain to increase in weight and have, therefore, adopted a 24-ton load as the standard in bridge design. They have advocated the gradual acquisition of forested areas in different parts of the county, so that there may be in the not distant future a goodly-sized forest-preserve system, tempting the city people into the country. Finally, they believe that on certain of their roads the provision of lighting and of sidewalks require consideration. Lighting would encourage the shifting of part of the heavy day traffic to the night, and enable the traffic to proceed at greater speed and in greater safety. Sidewalks are needed that pedestrians may be safeguarded along the heavily-traveled roads. The consideration of these problems indicates that the Wayne County commissioners, under the able leadership of Edward N. Hines, are keenly alive to their responsibility and have profited by the lessons of the past rapid expansion of traffic on their improved highway system.

A Note of Inconsistency (?)

IN COMMENDING in the previous note advanced thinking in highway practice we may be charged with inconsistency, for we have urged in these columns a strict examination of the propriety of expenditures under present financial conditions. The charge, however, in our judgment can not be sustained. The thinking in question does not necessarily mean immediate expansion of expenditures. It does mean, though, that when conditions are easier those who have visioned their responsibilities broadly will be ready to take steps in directions called for by reasonable traffic demands. Those who restrict their thinking only to present needs are not apt to be able to handle large problems effectively when the demand comes suddenly upon them.

Terminal Motor Trucking

A FAIR and full trial of the motor truck in terminal service was urged in these columns last week with reference to the problems of inland cities. This suggestion was based on two years of highly successful operation in Cincinnnati, where demountable truck bodies are employed for less-than-carload interchange between railroad main and substations. It is important to note, however, that the method, necessarily in modified form, is applicable as well to the country's most difficult terminal problem—that of the port and city of New York. B. F. Fitch of the Cincinnati Motor Terminals Company has publicly proposed such a plan in detail for New York, and such authorities and students of the port problem as J. J. Mantell, of the Erie Railroad, William Barclay Parsons, F. L. Molitor and E. P. Goodrich, under one form or another, have pointed to store-door delivery as an essential of a satisfactory solution. Even under Gustav Lindenthal's Hudson River Bridge plan, detailed in this issue, the motor truck would play an important part in handling l.c.l. freight. Mr. Fitch's proposal, however, does not call for big capital outlay, but the use of sulplus capacity of present passenger-vehicular ferries to carry truck loads between

New Jersey rail transfers, zone-station warehouse distributing points and store-doors in Manhattan. While the *Engineering News-Records* believes that the bridge must ultimately come, for rapid transit as well as for freight and vehicles, it is distant, while the truck plan could be rapidly effected, providing for the fullest use of present plant at comparatively small cost. Moreover, such a method of intensive motor-truck operation, effectively tied in with existing terminals, gives promise of fulfilling four of the five major requirements laid down as fundamental to satisfactory freight distribution at the port of New York by engineers who have given the subject careful thought. These requirements are: Division and distribution rather than concentration and congestion; a belt railroad system; prodigious expansion of storage; a single organization to direct and conduct distribution, both in- and out-bound, and, finally, store-door delivery. Any large plan for efficient terminal-operation at the port of New York will no doubt be opposed by some intrenched interests selfishly fostering wasteful methods so widely condemned by engineers. However, those charged with the solution of the port problem should give full consideration to a test of a system successfully established elsewhere, particularly since it is fully agreed that other proposed solutions will require very heavy capital expenditures for equivalent results.

City Traffic Distribution

PASSENGER transit facilities in cities commonly operate to produce or intensify concentration. Their real function, however, is distributive, and in recognizing and utilizing this function the municipal engineer has the opportunity to do important constructive service to his community.

In large cities the necessity of striving to distribute traffic and population is rather obvious, and transit improvements usually are planned to this end. In the small city it is less easy to perceive the importance of encouraging distribution by the layout or control of transit lines, and here, perhaps, the principal errors are committed. Important lessons in this field may be learned by the small city from the large.

Motor traffic has helped to emphasize urban concentration suddenly and sharply. It has led many towns and cities of moderate or even small size to realize for the first time that they suffer from excessive concentration. But motor traffic is only an index of concentration, not a cause; rather the reverse. Anti-parking ordinances, therefore, while they have decreased motor congestion, have not remedied the general condition of low efficiency of business and slowed-down community activity through the retardation of passenger and freight movement that concentration produces.

Street-car and other transit facilities with fixed routes differ from the automobile in deliberately seeking the most concentrated sections and streets. They aim to get the traffic, and find best returns when they take fullest advantage of concentration of people. By doing so they inevitably increase downtown concentration. This tendency can be prevented or limited, however, by suitable control in laying out transit lines, and to some extent in subsequent rerouting.

In the small town these conditions are not at once apparent; in very large cities they stand out unmistakably. Downtown Chicago pictures clearly the confining effect of railway, street-car, and elevated-railway concentration superadded to the effect of unfavorable geography. By contrast, Philadelphia, for example, exhibits the benefits of distributed transit layout in decentralizing population and traffic. In New York the construction of the first subway favored an intense concentration—though this merely adapted itself to pre-existing tendencies of growth—whereas the recently built subway lines are beginning to develop a strong distributing effect. Such actions and tendencies, we believe, are worth close study on the part of the engineers responsible for the development of small communities; for city development is most easily guided when the city is small.

Large cities present other situations which exhibit the relations of traffic and concentration more in detail, and these supply particularly valuable material for study. In this light there is special interest in an attempt recently made in New York to bring about the construction of a local subway loop to encircle a part of the up-town business district, a district already highly overconcentrated and provided with transit service fully as good as that of other parts of the city. The proposed loop—which by the way has been rejected—would very surely have created an iron-bound district like that within the Chicago Union Loop, with most unfortunate results on the freedom of traffic movement, and clearly to the injury of the city at large. The movement was promoted by commercial and realty interests within the proposed loop area, but it was opposed by the technical authorities of the city, who appreciated the harmful effect of such transit localization on municipal conditions.

In smaller cities, traffic localization proposals of remotely similar character are sometimes made, and because their effects are less pronounced than in a large city they usually are judged to be advantageous and find acceptance. Reference to the situation in a large city, as in the instance cited, is capable of giving decisive help in such circumstances by illustrating the real effect of the proposed localization and making possible a correct balancing under the given conditions of harmful against beneficial effects.

Without restriction to special cases of this kind, however, we would emphasize the need in all cities, small as well as large, of developing the distributive function of city transit facilities by properly controlled lay-out and operation. The most fertile field for effective work in this direction is the small city, where the close interrelation of transit and concentration is most likely to be overlooked. It should be one of the objectives of the municipal engineer to combat the many tendencies toward concentrating traffic routes in a few downtown streets.

He will have to meet hostile arguments of many kinds, but the facts, if rightly interpreted, should easily overcome them. The most cogent plea, that transit lines should be put where the traffic is centralized, can be met on the basis of a proper analysis of street and traffic conditions and it it cannot be so met it should prevail. Least logical, though perhaps most tenacious, is the opposition offered not by transit operators but by selfish property interests and by civic-pride enthusiasts of the type which finds its satisfaction in the sight of a street choked with crowds. In overcoming all such opposition, however, the engineer will be doing true public service.

Water Hammer in Pipe Lines*

Studies Extended to Include Effects of Imperfect Reflection at Discharge End, Friction, Non-Uniform Change of Valve Opening and Imperfect Action of Discharge Opening as a Nozzle

By W. F. Durand
Professor of Mechanical Engineering, Stanford University, Cal.

The primary purpose of the present paper on water hammer in pipe lines and especially of that part relating to partial reflection has been to extend the general method hitherto employed in treating this problem to include the case of assumed partial reflection and thus to provide a method of analytical treatment which may serve as a basis for the analysis of experimental observations taken with a view of throwing some light on this general problem. With such observations in hand the methods and results developed in the present paper should serve to direct such analysis intelligently and thus aid in a determination of the degree of accoustic reflection to be expected at a partially open valve discharging a liquid.

Shock or water ram in pipe lines has been developed in some detail by Joukovsky and later by Allievi and others. *Memoirs* Imperial Academy of Science, St. Petersburg, 1897, Vol. IX; *Annali* della Società degli Ingegnieri, Rome, Vol. XVII, 1902. The basic principles or assumptions involved in the treatment include the following:

(1) The analysis of the continuous valve movement in opening or in closing into a series of differential elements after the usual manner of differential analysis.

(2) Recognition of the elementary pressure change (increase or decrease) consequent upon the elementary valve movement with its resultant change in discharge area.

(3) Consideration of the liquid within the pipe together with the pipe itself as constituting an elastic system capable of receiving and transmitting longitudinal waves, compression or expansion, with accompanying change of pressure, increase or decrease.

(4) The assumption that each elementary change of pressure at the valve (increase or decrease) will give rise to a corresponding wave (compression or expansion) which will then be propagated the length of the pipe with a velocity dependent upon the characteristics of the system comprising liquid and pipe conjointly.

(5) The assumption that such elementary pressure waves, will, at the upper or reservoir end of the line, undergo complete or perfect unloading, which unloading will then be propagated or reflected back to the valve end of the line. This assumption is based on the consideration that the upper end of the line is a point of uniform pressure and therefore while admitting movement will not permit pressure change. It is therefore like the free end of a spiral spring undergoing longitudinal vibration, or again like the mouth end of a closed organ pipe.

A complete picture of the phenomena, as assumed, may be readily obtained by considering a straight coiled elastic spring moving longitudinally and suddenly at the forward end coming into contact with a fixed wall. A wave of compression will travel along the spring until it reaches the free end, at which instant the entire spring is in a state of compression at rest, and with its former energy of motion stored for the moment as potential energy in the compression of the spring. Following this the compression will begin to unload at the free end by a reverse movement of the particles of the spring, and such unloading will be propagated back to the fixed end of the spring as a wave of relative expansion (back to normal). At the instant of complete unloading the entire spring is in motion in direction the reverse of its original motion and in amount equal (assuming perfect elasticity). The energy is therefore now again all kinetic with motion reversed.

(6) The next assumption made is that the valve end of the pipe constitutes a fixed end of the vibrating column similar in effect to the closed end of a closed organ pipe or to the fixed end of an elastic spring, and at which point motion is suppressed while pressure changes may develop.

*A paper read before the National Academy of Sciences, Washington, D. C., April, 1920, heretofore printed only in a brief academy abstract.

It thus results that the kinetic energy, reversed in direction, and which reaches its full amount just as the unloading reaches the valve end of the line, will tend to carry the pipe contents bodily away from the valve end. This will result in a reduction of pressure at the valve and thus there will be started a wave of reduced pressure or of expansion, traveling from the valve to the free end, following which will be a reversal or return to normal pressure with forward movement starting at the free end and propagating back to the valve end. In particular it is assumed that this reflection at the valve end of the line is complete.

The phenomena outlined in (5) and (6) are entirely similar to those manifested in a column of air vibrating in a closed organ pipe, the closed end of such pipe corresponding to the valve end of the pipe line, or again to those in a spiral spring, fixed at one end and free at the other, and undergoing longitudinal vibration.

Following these basic assumptions the application of familiar principles of mechanics gives for the velocity of the longitudinal wave along an elastic liquid within an elastic pipe the following value:

$$S = \sqrt{g\frac{J}{w}} \tag{1}$$

when S = velocity in feet per second
g = gravity acceleration = 32.16
w = density of water, pounds per cubic foot
J = virtual cubical co-efficient of elasticity of elastic liquid within the elastic pipe

J is then given by the relation:

$$\frac{1}{J} = \frac{1}{K} + \frac{1{,}944\,r}{t\,E} \tag{2}$$

Where K = cubic coefficient of elasticity of liquid = for water, 43,200,000 with foot as unit.
E = linear coefficient of elasticity of pipe material = for steel, 4,032,000,000 with foot as unit.
r = radius of pipe (inches)
t = thickness of pipe wall (inches)

The numerical value 1,944 also includes an assumed value of 3.6 for Poisson's modulus for steel.

Again let $\alpha = S/g$
ds = elementary change in velocity of flow.
dh = elementary change in pressure head accompanying velocity change ds.

Then likewise from well-known principles of mechanics we derive:

$$dh = \alpha ds \tag{3}$$

We have thus far given in brief resumé the basic principles used by Joukovsky, Allievi and others in the usual treatment of the subject, together with the resultant basic relationship between an elementary change in the velocity of flow and the resultant or accompanying pressure change; see (3) above.

Restrictive Conditions (see treatment by Allievi).—In the application of these principles to actual problems of pipe-line flow it has been customary to assume for simplicity various restrictive conditions rendering the treatment of the problem simpler but omitting thereby the influence of certain important factors which cannot but have an important bearing on actual numerical results. These conditions are as follows:

(1) The assumption of complete or perfect reflection at the valve end, regardless of the fact that the valve may during the period of reflection be partly open with water issuing therefrom.

(2) The omission of the effect due to friction or otherwise the assumption of a frictionless liquid in so far as friction may effect the values of the pressure head h.

(3) The omission of the head due to the velocity $v^2/2g$.

(4) The assumption of a uniform time rate of valve area change (increase or decrease) in opening or closure.

(5) The assumption of perfect efficiency of the valve considered as a nozzle, or otherwise, the neglect of any loss of energy in the passage of the water through the valve.

The results due to (1) are uncertain in amount simply because we lack experimental research on the influence of the factor. It is obvious, however, that reflection at the valve end must often be far from perfect, especially in cases where the area of full opening approaches the cross-section area of the pipe and when the valve is nearly wide open.

The results due to (2) will depend much upon the hydraulic characteristics of the case. Where friction absorbs a large part of the actual head its omission may involve serious error; where friction absorbs but a small part of the actual head the importance of its omission is correspondingly reduced.

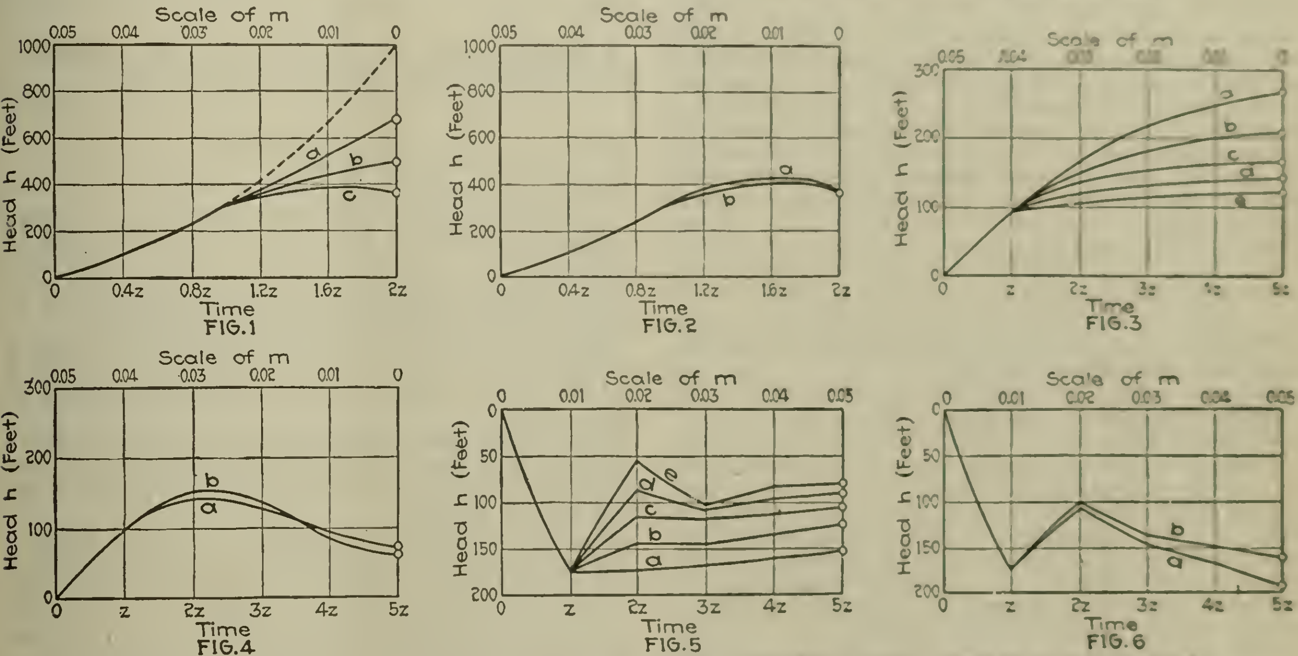


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

FIGS. 1 TO 6. HISTORIES OF PRESSURE HEADS, H, WITH ASSUMED PARTIAL REFLECTION AT VALVE

Valve closure in first four figures; opening in last two. Values in all figures as follow: L = 4,000; H = 500; m for full opening = 0.05; m for complete closure = 0.00; Z = 2; T = 2z.

Percentages of reflection at valve:

Fig. 1 (Closure): Case a, .00; b, .60; c, 1. The dotted line shows the course of the curve with full reflection for full closure in time z.

Fig. 2 (Closure): Case a, $(m_0 - m)/m_0$; b, s/V_0.

Fig. 3 (Closure): Case a, .00; b, .25; c, .50; d, .75; e, 1.

Fig. 4 (Closure): Case a, $(m_0 - m)/m_0$; b, s/V_0.

Fig. 5 (Opening): Case a, .00; b, .25; c, .50; d, .75; e, 1.

Fig. 6 (Opening): Case a, $(m_1 - m)/m_1$; b, [illegible]

The results of condition (3) are usually not important since, as a rule, the head due to the velocity is but a small part of the total head.

The results of condition (4) will depend on the character of the valve movement and the extent of its departure from the condition assumed. In the usual case the rate of area change is not uniform, especially at the beginning of the movement. In many cases, however, the rate of area change may be approximately uniform over a considerable part of its course.

The results of condition (5) will depend on the type and form of the valve. They will be small in the case of a needle nozzle, but relatively more significant with most other types and forms of valve.

Any extended discussion of the influence due to these various restrictive conditions is beside the purpose of the present paper. It will, however, be clear that as a result of the effects due especially to conditions (1) (2) and (4) any ideal solution based thereon may represent something widely removed from the results in the actual case.

It will therefore be of interest to essay the analytical treatment of the problem, using the same basic physical principles as previously outlined but including within the treatment recognition of the five conditions as they exist in actual practice—imperfect reflection at the valve, friction in the pipe line, velocity head $v^2/2g$, any time rate of valve area change, and loss of energy through the discharge valve.

It will be found convenient to undertake this program in two stages, first including all conditions except (1) and then extending the treatment to include imperfect reflection.

Treatment of Problem With Removal of Restrictive Conditions (2), (3), (4), (5).—To fix the ideas we shall first assume the case to be one of valve closure. It will then be found that with appropriate interpretation this treatment includes that for valve opening likewise.

Let L = length of line

$z = 2L/S$ = time for round trip of acoustic wave from valve back to valve

h = excess pressure head (summation of elements dh)

T = time for complete valve movement.

Other notation as before.

In a problem of this character any equation giving the value of pressure, pressure head, velocity, etc., will refer to some instant of time t and to some point in the pipe line. For the present we shall assume the latter as the valve or discharge end.

As a notation of special convenience in this problem quantities with no subscript will refer to time t, quantities with subscript 1 to time $(t - z)$, quantities with subscript 2 to time $(t - 2z)$, etc.

Then assuming complete reflection at the valve the application of the basic equation (3) to the physical conditions assumed gives immediately the equation

$$dh = z\,[ds - 2ds_1 + 2ds_2 - 2ds_3 + \text{etc}] \ldots\ldots (4)$$

This gives a measure of the element of pressure head dh developed from time t to $(t + dt)$ as the sum of a series of terms. The first of these, zds, represents the element generated at the valve itself by a small movement which results in an elementary velocity change ds. The second term, $-2zds_1$ represents the element generated at the valve at the time $(t - z)$ and which has, in the meantime, traveled to the free end and back again to the valve, arriving just at the time t and by complete reflection now gives a negative element of pressure head, $-2zds$. The third term, $+2zds_2$, represents the element generated at

the valve at the time $(t - 2z)$ and which has, in the meantime, completed one full cycle of four traverses of length L and now reaches the valve at time t and by complete reflection gives a positive element of pressure head $2\alpha ds_2$, and similarly for successive elements.

All of this is, of course, simply an expression of Joukovsky's theory in somewhat simpler form as regards notation.

From (3) we have by integration for any given period of time:

$$h = \alpha\,(s - 2s_1 + 2s_2 - 2s_3 + \text{etc}) \qquad (5)$$

It is readily seen that the number of terms will be given by the whole number next below t/z, and that they will have alternately plus and minus signs according as they represent elements which have made an odd or even number of double traverses of the length L.

Equation (5), thus representing the integrated result at the valve for a time period 0 to t, comprises successive terms each of which represents the summation of a series of elements αds (as in equation (4), all of which are similar as to sense and time history (number of double traverses of pipe-line length). Thus, for the first term the time period is 0 to t, giving the summed effect (all in the positive sense) of all elements as formed and previous to propagation or reflection. For the second term the time interval is 0 to $(t-z)$, giving the summed effect (all in the negative sense) of all elements which have had time to make the double traverse $2L$ with return to the valve and reflection at that point, and similarly for the successive terms.

Rewriting (5) we have $h = \alpha\,(s - 2s_1 + 2s_2 - 2s_3 + \text{etc.})$ .... (5)

We shall have similarly $h_1 = \alpha\,(s_1 - 2s_2 + 2s_3 - \text{etc.})$ .... (6)

These two expressions, after the terms in s, have the same terms with opposite signs.

Hence: $h + h_1 = \alpha\,(s - s_1)$ .... (7)

Again in (5) put $B = 2s_1 - 2s_2 + 2s_3 - \text{etc.}$

We have then $h = \alpha\,(s - B)$ .... (8)

Noting also the make-up of h as in (6) we have $h_1 = \alpha\,(B - s_1)$ or $\alpha B = h_1 + \alpha s_1$ .... (9)

Thus from either (7) or (8), (9) it appears that the value of h for a given time t can be immediately determined if we can find s for the same time and also knowing h and s for the time $(t - z)$. These results are of remarkable simplicity, connecting, as they do, successive values of h separated by the time interval z.

The determination of the values of h during any period of time in general involves three distinct phases or time periods: (1) t between o and z; (2) t between z and T; (3) t beyond T.

With proper interpretation (7) (8) and (9) apply generally to all three periods. Thus for the first period the subscript 1 implies a time $(t - z)$ negative, and in such case the term is to be omitted, giving in (7)

$$h = \alpha s \qquad (10)$$

For the second period the equations apply as written.

For the third period, for $t = T$ and beyond, s becomes v_0. Hence for values of t between T and $T + z$ we shall have from (7)

$$h + h_1 = \alpha\,(v_0 - s_1) \qquad (11)$$

while for $(t - z) > T$ or $t > (T + z)$, both s and s_1 become v_0 and we have

$$h = -h_1 \qquad (12)$$

It now remains to provide means for the determination of the value of s corresponding to any given time t.

Let

- A = cross-section area of pipe
- a = efflux or outflow area through valve
- m = a/A
- u = velocity through valve
- v_0 = initial velocity of flow
- v = velocity of flow in general
- s = aggregate velocity change = $v_0 - v$
- f = coefficient of efflux through valve
- H = head
- C = Chezy coefficient
- r = hydraulic mean radius

We may then write three equations as follows:

$$v = mu \qquad (13)$$

This expresses the continuity of flow along the pipe and through the valve.

$$h = \alpha\,(s - B = \alpha\,(v_0 - v - B) \qquad (14)$$

This gives from (8) the excess head developed at the valve corresponding to any reduction of velocity $s = (v_0 - v)$, and hence the excess head at the valve at the instant when the pipe velocity is v.

$$\frac{u^2}{2g} = f\left(H + h - \frac{Lv^2}{C^2 r}\right) \qquad (15)$$

This expresses the head on the discharge side of the valve, $u^2/2g$, transformed under efficiency f from the net head just back of the valve, and made up of the original head H plus the excess head h, minus the friction head $L\,v^2/C^2\,r$ as given by the familiar Chezy formula.

Putting (15) all in terms of u and transforming we have

$$Mu^2 - H + h \qquad (16)$$

Where
$$M = \frac{1}{2gf} + \frac{Lm^2}{C^2 r}$$

If then between (13), (14) and (16) we eliminate u and v and reduce the equation in h, we shall find

$$h^2 - 2\,(E + F)\,h + E^2 - 2FH = 0 \qquad (17)$$

where $E = \alpha(v_0 - B)$, $F = \dfrac{(\alpha m)^2}{2M}$ and $\alpha B = h_1 + \alpha s_1$

Solving for h we have

$$h = (E + F) - \sqrt{F^2 + 2F\,(H + E)} \qquad (18)$$

When $m = 0$, $F = 0$ and $h = E = \alpha/(v_0 - B)$ as in (8) with $s = v_0$.

For the period of time 0 to $t = z$, we shall have $B = 0$ and the above equations will simplify accordingly.

Having found h from (18), u follows from (16), v from (13) and then $s = v_0 - v$. We then find αs, add h and thus find the value of B and of E for the instant of time z ahead.

It is to be especially noted in the equations thus developed that: (1) The influence of friction is represented by the term Lv^2/C^2r in (15) or in the values of M and F in the final solution of (18).

(2) The velocity head is implicitly included in equation (15) since H is the total initial head and H — friction head + excess head h will equal total head at valve, composed partly of pressure head and partly of velocity head.

(3) The solution is entirely unrestricted so far as the time rate of valve movement or rate of change of a and m are concerned. The various equations expressing h as the sum of a series of terms are entirely independent of any term expressing the time rate of valve movement. The valve opening is represented solely by the factor m which appears in equation (13) and in F, and no matter what the character of the valve movement may be, so long as it is known, it will be possible to assign to a series of values of t the corresponding series of values of m. This insures, therefore, the solution of the problem for any assigned rate or character of valve movement.

(4) The influence of nozzle inefficiency or loss of energy in flowing through the valve outlet is represented by the factor f in the terms M and F.

Pressure at Any Point in the Line.—The discussion thus far has related solely to the pressure at the valve. The same principles generalized for any point P at a distance x from the valve enable us to write down a general equation similar to (5) in the form

$$h = \alpha(s_{t-i} - s_{t-(z-i)} - s_{t-(z+i)} + s_{t-(2z-i)} + s_{t-(2z+i)} -, \text{etc.} \qquad (19)$$

In this and subsequent equations i = time x/S.

As in (5) each of these terms represents the summation of those parts of the final result which have had, so to speak, a common life and which thus admit of summation. The first term is the summation of the elements generated at the valve and which have at least traversed the distance x between the valve and the point P, distant from the valve by the time interval i. The second term is the summation of the elements generated at the valve

and which have at least traversed the distance L to the upper end and back again to the point P, a distance $(2L - x)$ and requiring a time $(z - i)$. These come back as an unloading of pressure and hence appear with the negative sign. The third term is similarly the summation of the elements which have at least traversed the distance L to the upper end and back again to the valve and back by reflection there to the point P, a distance $(2L + x)$ and requiring a time $(z + i)$. This likewise operates as an unloading term and hence appears with the negative sign. Similarly the other terms represent the summation of elements corresponding each to a common distance of propagation and approaching P alternately from the upper end and from the valve.

It is of interest to note that when the point P is at the valve and $x = o$, the two unloadings represented by the second and third terms occur simultaneously at the valve and become by their sum $2s_{t-z}$ or $2s_1$, as in equation (5). In this manner by the assumption of $x = o$, or $i = o$, equation (19) becomes reduced to (5) and the latter is thus seen to be only a special case of the former when $x = o$.

Writing equation (19) for time $(t - z)$ and adding the two values thus found, we have by the cancellation of all terms after the second,

$$h + h_1 = \alpha(s_{t-i} - s_{t-(z+i)}) \qquad (20)$$

It will be noted that at any given instant of time, s is the same throughout the length of the pipe. Hence the investigation of the pressure at the valve end will give a series of values of s which may be applied throughout the length of the line as indicated in (19) or (20). To this end there is needed a general history of s on time and this may be most conveniently laid down graphically from the results derived for the valve end. With such a graphical history of s the determination of h for any point in the line and at any time becomes through (19) and (20) a matter of simple routine.

Valve Opening.—The treatment for the case of valve opening is implicitly contained within that for closure, and it is only necessary to note certain special interpretations in order to apply in full the equations for the case of closure to that of opening. The change of head is now a decrease instead of an increase and is therefore essentially subtractive instead of additive. The change in velocity will be reversed in direction. That is, $s = v - v_o$, where v_o = the initial velocity through an initial opening m_oA, and if the movement starts from complete closure we shall have $s = v$.

With this value of s and all other terms in (13), (14) and (16) the same, we derive results as follows:

$$h = -(E + F) + \sqrt{F^2 + 2F(H + E)} \qquad (21)$$

where $E = \alpha(v_o + B)$, $F = \frac{(\alpha m)^2}{2M}$ as before and $\alpha B = h_1 + \alpha s_1$, as before.

If again the valve movement starts from full closure we shall have $v_o = 0$ and $E = \alpha B$.

These equations represent, for the case of valve opening, the same degree of generality as in the case of closure, and in particular with reference to friction, loss of energy through valve and time rate of valve movement.

Turning to equation (21), it is readily seen that the terms under the radical form two terms of $(F + H + E)^2$. In the case of valve opening, F continuously increases and in cases where the valve opening is nearly the full size of the pipe and H is small, F may be large compared with $(H + E)$. In such cases the value of the radical will be approximately $(F + H + E)$ and hence $h = H$ (actually slightly less). Hence as F becomes large relative to $(H + E)$ the value of h will approach H as a limit. This corresponds to the well known result that in cases of large valve area relative to pipe and small head H, the opening of the valve within the time z will drop the pressure at the valve practically to the atmosphere.

In the application of these equations, it will be noted that (18) or (21) gives the solution for any value of m within the time $t = z$, independent of the quantity B and hence independent of the solution for any other or previous time. If, however, $t > z$ the solution must be made stepwise with a time interval z, beginning at a time $(t - nz)$ less than z itself and for which B is not required, and progressing step by step to the given value of t. Any one solution will give the values of h and s. These from (9) will give the value of B for the next step ahead and this, with the appropriate values of the other quantities, will give values of E and F and hence of h, as in (18) or (21).

Up to the present time no solution seems to have presented itself permitting the direct computation of h for $t > z$, without in effect going through the series of computations involved in the stepwise process outlined above. All this is indeed well known and has been pointed out by other writers on the subject, notably Allievi.

The purpose of this section of the present paper, omitting discussion of the resulting equations, is simply to generalize the treatment of earlier writers with reference to the four restrictive conditions (2), (3), (4), (5), as noted previously.

PARTIAL OR INCOMPLETE REFLECTION AT VALVE

We now approach the problem of generalizing the treatment in such manner as to include the assumption of partial or incomplete reflection at the valve. First with regard to the conditions affecting the assumption of complete reflection. Physically this requires a closed end, similar to the closed end of the organ pipe and against which the pressure changes may develop as required by the physical phenomena assumed. It implies furthermore complete arrest of the moving column of water, a condition not consonant with the movement of the column attendant on a flow of water through the valve while partially open.

It is clear, however, in the case of closure, that if the entire valve movement is completed within the time z, the phenomena at the valve itself, up to complete closure, will take place without involving reflection at the valve, and that all subsequent phenomena will develop at a completely closed end and hence the assumption of complete reflection is justifiable, at least so far as complete closure of the valve is concerned. It results for valve closure that whenever the time T of valve movement is not greater than z, the assumption of complete reflection may be justified by the presence of a closed end at the valve. On the other hand, it is clear that when T exceeds z, as is more often the case, the return wave from the free end will reach the valve with the latter partly open and with water issuing therefrom. Under such circumstances reflection from the valve end cannot be complete. In the general case, as we have seen, we shall have a series of waves formed at the valve, propagating to the free end and then back to the valve, undergoing reflection there and so on—new waves joining with waves which have suffered 1, 2, 3 . . . n reflections back and forth, the net result at any point being the entire summation of the individual results of all elements, direct and reflected; and much of this reflection at the valve and realized while the valve is partly open and with water issuing.

It is therefore clear that the assumption of complete reflection at the valve is not justifiable in the general case, and its incorporation as a basic principle in the treatment of the problem will therefore give results which must be viewed simply as representing ideal or limit conditions, and to which actual cases will approximate as the conditions for complete reflection are more and more fully realized.

In the development of a mode of treatment free of this particular assumption, the first difficulty met with lies in the definition or measurement of partial reflection. Complete reflection is a definite and specific condition; partial reflection may be anything from 100 per cent to zero and distributed in any manner through the valve movement.

There are at least four assumptions which may be taken as a basis for the specification of partial reflection, as follows:

(1) A constant fraction of full reflection.

(2) A fraction of full reflection measured by the ratio $(m_o - m)/m_o$. That is, reflection in proportion as the valve opening is reduced in area from full opening to closure.

(3) A fraction of full reflection measured by the ratio $(A - a)/A$. That is, reflection in proportion as the cross section area of the pipe A is closed over at the valve end.

(4) A fraction of full reflection measured by the ratio $(v_0 - v)/v_0$ for closure or by $(v_1 - v)/v_1$ for opening. That is, reflection in proportion to the difference between v_0 or v_1 and v, or reflection less as v is greater. In the above, v_0 and v_1 denote the normal steady motion full opening velocities in the two cases, closure and opening.

We shall briefly indicate the results as developed from these various assumptions regarding the degree of reflection realized.

In the development of the treatment, we shall, where there is any distinction to be drawn, assume first the case of valve closure, noting subsequently such changes as may serve to adapt the same treatment to the case of valve opening.

Case (1) Let f denote the constant fraction. Then equation (5) will become

$$h = \alpha\,[s - (1 + f)\ s_1 + f\ (1 + f)\ s_2 - f^2\ (1 + f) s_3 + \text{etc.}] \quad (22)$$

The second term represents at time t an unloading s_1 + a reflection fs_1. The third term develops first at time $(_{t-z})$ as an unloading s_2 with reflection fs_2 and then at time t as a second unloading fs_2 with second reflection f^2s_2, giving by the sum of the two latter the term as written; and similarly for subsequent terms.

Denote all terms in the parenthesis after the first by B we then have

$$h = \alpha\ (s - B) \quad (23)$$

With the makeup of (22) we then readily find, in manner similar to that followed with full reflection, the following relations

$$h + fh_1 = \alpha\ (s - s_1) \quad (24)$$

$$\alpha B = fh_1 + \alpha s_1 \quad (25)$$

It will be noted that these equations all reduce to the forms for full reflection, as in (7) (8) (9), if we put f = 1. We may then proceed, exactly as indicated for full reflection, using equations (17) (18) but with the value of B as in (25).

Case 2: We shall in this case have for f a varying value given by $f = (m_0 - m)/m_0$. There will be, therefore, a value for each instant of time during the closure, and in particular a series of values for the instants t, t-$2z$, t-$2z$, etc. These we may denote by f, f_1, f_2, etc. the same as for the series of values of h, s, etc. We shall have, then, instead of (22) the equation

$$h = \alpha[s - (1 + f)\ s_1 + f_1\ (1 + f)s_2 - f_1\ f_2\ (1 + f)\ s_3 + \text{etc.}] \quad (26)$$

The second term represents at time t an unloading s_1 plus a reflection fs_1. The third term develops first at time $(t - z)$ as an unloading s_2 with reflection $f_1\ s_2$ and then at time t as a second unloading $f_1\ s_2$ with second reflection $f\ f_1\ s_2$, giving by the sum of the two latter the term as written; and similarly for the other terms.

Denote, as before, everything within the brackets after the first term by B. Put also

$$P = s_1 - f_1\ s_2 + f_1\ f_2\ s_3 - \text{etc} \quad (27)$$

Then $P_1 = s_2 - f_2\ s_3 + \text{etc.}$

Whence we derive

$$P + f_1\ P_1 = s_1 \text{ or } P = s_1 - f_1\ P_1 \quad (28)$$

We have then for (26)

$$h = \alpha(s - B) \quad (29)$$

and from the composition of (26) (27) it is seen that

$$B = (1 + f)\ P \quad (30)$$

We also readily derive the relation

$$h + h_1 = \alpha\ s - f\ s_1 - P_1\ (1 - f\ f_1) \quad (31)$$

It will be noted that (26) and (31) reduce to the forms for full reflection if we put f = 1.

We may now proceed as described for the case with full reflection finding h from (18) with the value of B as given by (28) (30).

Case 3: In this case the resulting fundamental equation is the same as (26) for Case 2 but with different values of f, f_1, etc. we shall have here:

$$f = \frac{A - a}{A} = 1 - \frac{a}{A} = (1 - m) \quad (32)$$

With a prescribed program of movement for the valve, therefore, f becomes known for any instant of time and we may then use the equations of case 2 but with the appropriate values of f.

Case 4: In this case we have for valve closure

$$f = \frac{s}{v_o} \quad (33)$$

and hence for the series f, f_1, f_2, etc. we shall have s/v_0 s_1/v_0, s_2/v_0, etc.

We may, therefore, use the same general equations as for case 2 except that in this case we do not know, for any given time t, the value of f, since this depends on v and this in turn on u or h. This implicit relation does not, however, introduce any new variable into the equations and we proceed by taking equations (13), (14), (16) with the special values of B and f as given in (30) and (33). From these equations, and substituting for s in terms of v, we eliminate v, u, and s, and derive, as before, an equation in h,

$$h = (E + F) - \sqrt{F^2 + 2F(H + E)} \quad (34)$$

where $E = \alpha(v_o - 2P)$ and $F = \frac{(\alpha m)^2}{2M}\left(1 - \frac{P}{v_o}\right)^2$, the same in form as in the previous cases, and differing only in the values of E and F.

Valve Opening with Partial Reflection.—The preceding discussion, with the equations developed, applies without change to the case of valve opening, except that in Case 2 the value of f will be $(m_1 - m)/m_1$ where m_1 is the ultimate value of m, while in case 4 we shall have:

$$f = \frac{(v_1 - v)}{v_1}/v_1.$$

Where v_1 = ultimate steady motion velocity with $m = m_1$

$$E = \alpha(v_o + 2P),\ F = \frac{(\alpha m)^2}{2M}\left(1 + \frac{P}{v_1}\right)^2.$$

Basis of Estimate for Degree of Partial Reflection.—As between these four bases for estimating the degree of reflection realized, we have little experimental evidence as a guide. There is no reason for assuming a constant value of f, but a constant value somewhat less than 1 would presumably give more accurate results than to assume it constant at 1, as with the assumption of complete reflection.

For a case where the open valve area is the full size of the pipe, assumptions 2 and 3 become the same, and in such case assumption 4 will differ widely from these in the values of f through the period of closure. For a case where the open valve area is small relative to the c. s. area of pipe, assumption 3 will imply practically complete reflection, while in such case assumptions 2 and 4 will more nearly agree.

Motor Car Regulation in England

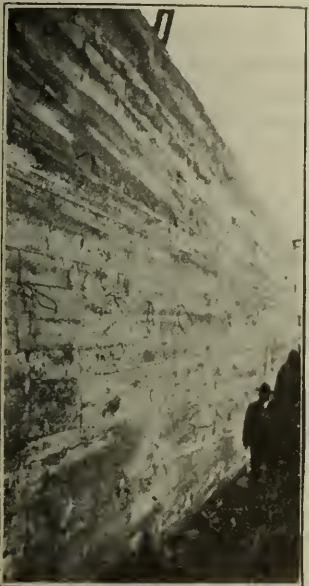
Several new regulations for the control of traffic are being considered by the taxation and regulation of road vehicles committee of the British Ministry of Transport. It is believed by some that, should the proposed regulation be determined upon, making it compulsory for a driver to raise his arm when stopping, turning a corner, or slowing down, it will have some effect upon the design of motor vehicles through the elimination of the left-hand drive machine. The advisability of continued manufacture of left-hand drive cars is a subject of considerable argument in England. Another possible regulation soon to be put into force in England is the one making it possible for motor car owners to secure quarterly licenses at 30 per cent of the annual license. This regulation is to be put into force, because of the presence in England of a great number of British colonials who buy their cars in London and use them for a few months and then take them home with them. The payment of the total annual license fee for a few weeks' use in England is considered unfair.

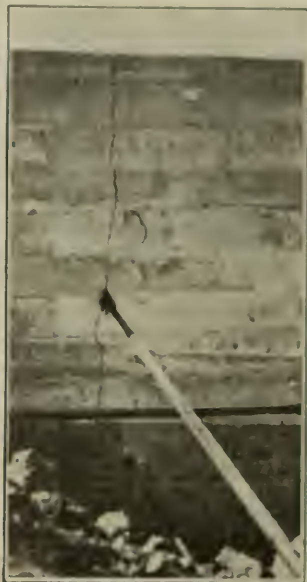
Retaining Wall Failure Predicted

By C. W. Cook
Associate Professor of Civil Engineering,
University of Southern California, Los Angeles

This is written to predict the failure of a retaining wall which has just been finished on the northwest corner of Sixth St. and Vermont Ave., Los Angeles. The drawing (Fig. 4 herewith) shows the wall as designed and as built; three views showing its condition before any large amount of backfill had been placed are given as Figs. 1-3.

At *A* in Fig. 4 is represented the original design of the wall, prepared by a firm of engineers in Los Angeles. The wall is 32 ft. 6 in. high above the ground at the high point, and was designed to be 10 ft. below the ground. Its base width is 3 ft. 6 in., this width continuing up to the surface of the ground, whence it decreases to a thickness of 1 ft. at the top. The site is a marsh, and has standing water in it all the year round. The soil is clay and loam mixed, saturated with water.





FIGS. 1, 2 AND 3. WALL CRACKED BEFORE BACKFILLING
Front of wall—Crack in face—Anchor rods

According to the original drawings of the engineers, a fill was to be put in back of the wall, 21 ft. 3 in. deep, to be surfaced with a cement floor. At the level of the top of the wall there was to be built a reinforced-concrete roof, the 12 x 30-in. beams of which frame into the wall at intervals of 21 ft. 5 in. The space under the roof was to be used as garage, with 150 lb. per sq.ft. designed live-load.

The wall itself weighs 15,550 lb. per lin.ft., and the roof weight is equivalent to 610 lb. per lin.ft., making a total dead load of 16,160 lb. per lin.ft., which acts with an eccentricity of 0.39 ft. The dead weight alone would cause a pressure at the toe of 7,700 lb. per sq. ft.—on a wet clay swamp upon which it would be unsafe to assume a unit pressure of one-half ton! Considering the 150-lb. live load (and still neglecting the fill) this pressure would become 8,350 pounds.

Computing the pressure from the fill at 25 lb. per sq.ft. equivalent fluid pressure (which is low for this case) and neglecting the 10 ft. below grade, the horizontal pressure against the wall would be 4,500 lb. per sq.ft., applied at a point 7 ft. 1 in. above the original grade. Assuming that the roof beams would hold the top of the wall (which is very unlikely since the settlement would be very great and the end of the beams would probably shear off), the wall would act as a simple beam, and having no steel in it the concrete would have to take all the tensile stress, which is about 210 lb. per sq.in. and which would undoubtedly break the wall in tension.

Disregarding the restraint at the top, the resultant of the horizontal pressure and the weight of the wall would fall about 3½ ft. outside the base, which would cause a tremendous pressure on the base and undoubtedly would turn the wall over.

When the wall was finally built the original architect and engineer had been discharged, and the work was done by another man who is a contractor and builder. He drew an entirely new set of plans for the main part of the building, but kept the design of the retaining wall as originally planned. So the original engineers are not now connected with the work.

In the revised plans, the owner decided not to build the concrete floor shown at *A* in Fig. 1, but to continue the fill up to the top of the wall and simply lay a 4-in. cement floor with no steel in it at the level of the top of the wall, as shown at *B*. The completed wall looked so slender and high, however, that the owner decided to put in some anchors. So he drilled holes through the concrete and put in 1¼-in. rods at varying spacing from 12 ft. to 15 ft. apart horizontally, about 4 ft. 2 in. from the top of the wall. They were anchored to a deadman, a block of concrete about 4 ft. cube, but this was apparently placed in front of the angle of repose of the material and was therefore of no value.

In excavating for the lower portion of the wall it was necessary to build dikes to keep the water out, and in addition pumps had to be kept going continually. The excavation was made about 2 ft. wider than the wall, and forms were built for the concrete, the remaining space on front and back being backfilled with the material taken out.

The pressure caused by 32½ ft. of fill (neglecting a surcharge to provide for the live load) would be 13,200 lb. per lin.ft., applied at a point 10 ft. 10 in. above the original grade. In analyzing this wall, moments must be taken about the toe, as the backfill of the trench cannot hold the wall. Taking moments at the toe, the overturning moment would be 13,200 x 20.83 = 275,000 ft.-lb. The righting moment would be 15,550 x 1.36 = 21,100 ft.-lb., leaving an overturning moment of 253,900 ft.-lb. If this was to be taken up by the rods, whose arm is 38.33 ft., it would cause a reaction at the rods of 6,130 lbs. per lineal foot of wall, or, assuming the rods 12 ft. apart (some of them are 15 ft.) would cause a tension in each rod of 73,500

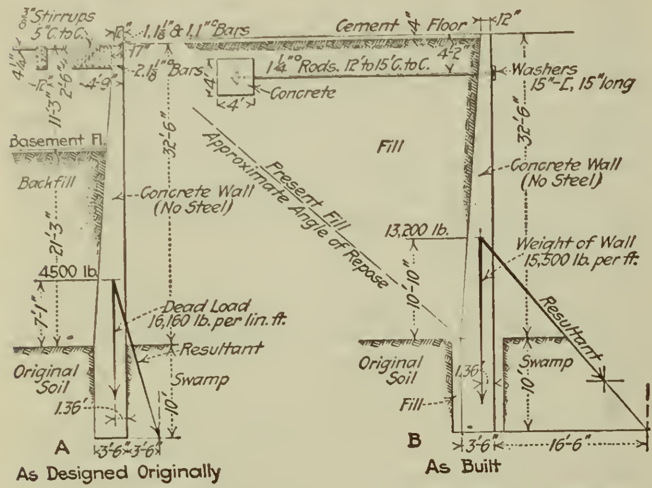


FIG. 4. A "RETAINING WALL" BUILT IN LOS ANGELES
As designed and as built.

lb. This is equivalent to 82,600 lb. per sq.in. at the root of the threads. Some of these rods have been welded, with an apparent efficiency of weld of about 50 per cent. Channels 15 in. deep and 15 in. long, with the flanges vertical, were used for washers.

Photograph Fig. 2 shows a settlement crack through two of the anchor rods. This crack extends from the top to the bottom of the wall and is about ½ in. wide. This view also shows the channel washers, with flanges parallel to the crack. Fig. 3 shows another settlement crack from the inside of the wall, also the 1¼-in. rods with their ends forged into hooks.

As yet none of the backfill bears against the wall. All of the cracks have been caused by the settlement of the wall due to its own dead weight. The dirt is being dumped in from the rear and allowed to fall toward the wall on its own angle of repose, which exerts maximum pressure against the wall. The owner says that he intends to soak the fill with water as he puts it in, to insure it packing solidly.

In the opinion of the writer the wall will turn over before the fill is halfway up to the top. It will probably bend the channel washers out and allow a whole section of the wall to fall out, leaving the rods where they are now. As it begins to fall it will probably break in tension at about the level of the original soil.

This wall is not a part of the building, being designed only to hold a fill of earth to make a yard in back of a garage and therefore does not come under the jurisdiction of the Los Angeles building department. It does not support a part of a street and therefore is not checked by the street department. It has not been checked by anyone except the original engineer. The writer is not connected with the work in any way, being interested solely because of the very apparent weakness of the wall. He has told the owner that the wall will not stand up, and has warned him not to allow men to work on the outside of the wall. The approximate cost of the wall is $7,000.

The Itinerant Engineer

Records of the change of address made by members of the American Association of Engineers indicate that four engineers out of 10 move in the course of a year. During November, the month on which the estimate is based, 802 changes were recorded. The daily average was 32; varying from 12 to 66.

Trend of Highway Development —a Survey

Kansas Practice

THIS IS THE SEVENTH *of a series of staff articles on the highway situation. It deals with adaptations of pavement design to permit utilization of native materials and the development of laboratory investigations of these materials.*

The eighth article of the series will appear in next week's issue.—EDITOR.

KANSAS, by an amendment to its constitution this year, completed the list of 48 states which in some manner extend financial aid in highway construction; in other words, every state in the Union now aids highway work. The campaign by which this amendment has been fought through against both popular and, in instances, corporation opposition perhaps deserves record as the outstanding feature of the year in the highway development of Kansas. It is notable, however, that the state has an exceptional mileage of paving under construction and contract, is developing interesting practices in brick and concrete construction and is conducting material tests and investigations of exceptional character.

Until the amendment was voted at the election of Nov. 2, the Kansas constitution prohibited state road construction. The amendment adopted enables the state to grant aid not in excess of a quarter of the cost, or of $10,000 per mile, for not more than 100 mi. in any county. There is but on exception: it extends the mileage entitled to aid to 150 mi. in counties whose assessed valuation exceeds $100,000,000. Provision of legislation for executing the new constitutional privilege awaits the action of the coming State Legislature. As the thought of highway officials is at present being expressed it favors raising the money for state aid by levying a tax of 1 cent a gallon on all gasoline, and by an increased license fee on automobiles. Two other methods, one a mill tax on all property and the other state bond issues, are open for consideration.

Present Program

Passing from speculation on future highway programs to actuality, the important fact to be noted is that Kansas, through county and benefit-district initiative, has approximately 300 mi. of paved road under construction and contract. Projects have been scheduled absorbing practically twice the Federal-aid funds available for the state, and contracts have been let, as of October, 1920, absorbing $3,681,000 of Federal aid, and aggregating a contract cost of about $9,575,000. Without state aid and with a state highway department organized only since April, 1917, and inadequately financed, the figures are a record of accomplishment which merits recognition.

Concrete and brick on concrete base are the preferred types of paved roads. About two miles of concrete to one mile of brick are being constructed. The paved width is ordinarily 18 ft., but occasionally a 16-ft. or a 20-ft. project is listed. Selecting Federal-aid projects for 18-ft. pavements, a compilation gives the approximate costs per mile for 53 mi. of brick road as $42,000 and for 93 mi. of concrete road as $40,000 per mile.

As in most states where lack of materials has been assumed, surveys in Kansas have shown greater resources than were anticipated. To utilize these materials, modifications from fixed practices must be developed. Materials studies and tests directed toward this purpose are a salient line of development in Kansas.

In the beds of the Kaw and the Arkansas Rivers and their tributaries there is gravel running high in good quartz sand but low in pebbles; the latter, moreover, contain a considerable proportion of disintegrated granite undesirable for concrete wearing surface. Except for some isolated "flint hills," the main rock deposits are limestone of not very good quality. The state, however, has a source of imported stone supply in the chats of the Missouri mining districts, but transportation makes this material rather expensive. As a result of these materials conditions, attention is being directed toward two-course concrete construction, using native materials for the base course and imported chats for the surfacing. Using a finishing machine, the base course is struck off and the top course placed and tamped. Observation of sections cut from slabs constructed in this manner indicate (1) a nearly perfect merging together of the two courses and (2) a well-defined mortar surface layer ¼ to ½ in. thick.

Brick pavements in Kansas have been mostly of monolithic construction, using "vertical fibre" brick. Failure of one of the earlier roads of this type, as described by M. W. Watson, state highway engineer, in *Engineering News-Record*, Sept. 23, 1920, p. 595, has led to distrust of monolithic construction under the extremes of Kansas temperature. One of the characteristics of the failure described was a separation of the brick surface from the concrete base. A change in construction to meet this danger has given some success in Reno County as will be described in a separate article. Meanwhile, attention is being directed to the use of a bituminous sand cushion and bituminous filler, and the outcome is promising. Sand mixed with 5 per cent Tarvia is producing a sand cushion which will stay where placed.

Studies of Materials

Laboratory investigations of the suitability of native materials for road construction is a noteworthy feature of Kansas highway development. This work is being done at the engineering experiment station of the Kansas Agricultural College. A brief survey permits the following enumeration of work under way and planned:

1. Southeastern Kansas has available large quantities of chats or tailings from the lead and zinc mines. This material is used to a greater or less extent for construction of all kinds, but not always with good results. Tests are being made to determine whether or not this material can be satisfactorily used for highway construction.

2. The Arkansas River valley is rich in excellent gravel for concrete aggregate and has very little stone suitable for highway construction. Tests are being made to determine the ideal mixture, with the natural run of the material, which contains an excess of sand.

3. In some of the counties in the southwestern part of the state there are beds of "gyp" or "mortar bed" that has excellent binding properties. Tests indicate that this material should make a binder superior to clay or stone dust, as it is very resistant to the softening action of water. In combination with the river and pit gravel this should make very good material for roads of the secondary type.

4. A test is being developed to determine the relative wearing value of stone and gravel.

5. The laboratory has developed a test for the wearing value of concrete that is original and, it is felt, has given encouraging results.

New Test Specimen

Briefly, the new test (item 5, above) consists in molding 9-in. spherical specimens of the desired mix. These are tested in the standard brick rattler, using three specimens at one time and a standard abrasive charge. The results so far secured are not conclusive but have demonstrated the practicability of the test. No difficulty is encountered in molding the specimens or in securing a smooth wearing surface to take the abrasion. There is no tendency for the specimens to break or go to pieces in the rattler when tested at 28 days. It is thought that tests at an earlier age should not be made. The time required for a test seems to be about ½ hour, as the loss in nearly every case is great enough at 900 revolutions to make comparison of different specimens possible. The specimens have thus far been molded in concrete forms which were cast around a wooden ball and later paraffined and oiled. The really original feature is the use of a spherical test specimen. Two advantages over other abrasive test specimens are that the spherical surface offers no angles or curves to be broken off, and that no special equipment is required for the test, as the standard rattler may be used.

With the enactment of the constitutional amendment state-aid legislation is the important highway development of the coming winter.

Effect of Hard Inclusions in Spruce Compression Members

Some observations on the effect of hard inclusions in compression members on ultimate strength were made by Prof. James E. Boyd, Ohio State University, in the course of tests of the strength of spruce struts carried out for the Bureau of Standards. The tests are described in Technologic Paper 152 of the Bureau, recently issued. All the struts tested were 1¼ to 1¾-in. square, while their lengths varied from 12¾ to 10 ft. 6¾ in. (1/r from 25 to 250). To measure the shortening of the struts, strain gages were applied, their ends resting in conical pits in ¼-in. steel pins driven through holes drilled in the struts. The effect of these pins on the failure strength of the struts came to attention by the fact that most of the struts of the 1-ft. and 2-ft. lengths failed by compression at these pins. It was thought, therefore, that a cylindrical pin with higher modulus of elasticity than the material which surrounds it is a source of weakness in a compression member. To investigate this question two of the shortest struts were tested without pins, the strain gages being supported by clamps. Each of these two struts failed at a lower load than the struts from the same plank which had been tested with pins. Professor Boyd concludes that "if any conclusion may be drawn from these few tests it is that the pins do not seriously weaken the struts."

Observations on a Pacific Coast Trip

By Frank C. Wight
Associate Editor, *Engineering News-Record*

Vancouver and Its British Flavor

THE national spirit is a great and curious thing. At the foot of Yesler Way in Seattle lies a boat flying the British flag. You pass down that street, a typical waterfront entrance in a distinctly American city, where the signs and the talk and the whole flavor of things are as familiar to a native of Chillicothe or Omaha as his own town, and you walk across a gang plank into a little section of Great Britain. From then until you get off that boat some days later when it comes back to Seattle, to all intents and purposes you are in England. The ship's officers, with the characteristic tilted cap, the cockney waiters in the dining saloon, the Clyde-built engines—and even the American-baiting Canadian who rails at the dollar-chasing Yankee in the sheltered space behind the pilot house—are part of the essence that sends a little island's sons across the seven seas to set up in the world's far places a part of its great dominion.

For an hour the boat stops at Victoria, the farthest west of the Canadian capitals, and the remoteness of the States is more than ever emphasized, for here at the seat of Provincial government the British spirit is plain in the things that appeal to an engineer. The massive masonry sea-wall guarding the inner harbor, in particular, came straight from the craft which designed and built the ports of England; its like is not found in our more practical, and possibly ephemeral, practice. The new breakwater, with its concrete blocks, looks familiar, though, and the huge new government piers, wide, long and with equally wide and long transit sheds, show the trend of Pacific port design; also, there are emptiness and signs of disuse, which indicate that the slump in Pacific shipping is not confined to American ports.

Vancouver, a day's journey by boat from Seattle and only a few miles across the border, adds to the feeling that one is far from home, especially as it still sticks to left-hand running of street traffic, to the imminent danger of life and limb of the American used to looking to his left at street crossings. The nearness of the state of Washington, however, with the ever increasing cross-border automobile travel, has led the province to pass a law requiring change to right-hand running at an early date. Like Halifax, Vancouver is more truly British than the inland Canadian cities, where dilution of American-born residents is beginning to show. The Canadian termini of the "all-red" British steamship lines stick closer in habit and custom to the old country.

The Port

Economically and industrially, Vancouver is a part of the great Northwest. Conditions here are about the same as in Seattle. During the war the focus of England's oriental trade and a shipbuilding center, it suffers now from the cessation of war business.

Lumbering and mining are its big industries and the former particularly is flourishing. To one long accustomed to the structural timber of the East the kind of material they get here is amazing. It is a pleasure to look at the great clear sticks that go into the sheds and floating dry docks. Such wood, properly framed, is a structural material of lasting quality which can well compete with what we generally consider more durable stuff.

But lumbering and mining are not enough to make Vancouver the great city it wants to be. It must get more shipping business and must develop the industries which go hand in hand with a harbor to make a city a successful port. Its bulk shipping is large—the largest in tonnage last year in Canada, though Montreal's values passed it—but not so much is moving this year. The Harbor Commission is going ahead actively, though, and work now in progress is greater than anywhere else in the Northwest.

This work comprises in actual construction two large shipping piers and a graving dock. One of the piers is being built by the commission—the Ballantyne Pier. This is on the main harbor front, a little more than a mile from the center of town. It is 1,200 ft. long and 340 ft. wide with a marginal quay wall 936 ft. long. It will be built with a middle fill and side extensions on reinforced-concrete cylinders and will carry two-story reinforced-concrete transit sheds on either side, each 110 ft. wide. Following the practice on the existing government wharf, which has approximately the same dimensions, there are marginal railway tracks and also tracks and a roadway between the sheds. The other pier is being built close to the center of town by the Canadian Pacific Ry. and will be 1,100 ft. long by 330 ft. wide with 335 ft. slips. Work on it at present consists only in placing the middle fill and its final design has not been announced, but it will probably be similar to the Ballantyne Pier. The dry dock is a private enterprise, with a 12½ per cent subsidy from the Canadian Government and will eventually be 1,150 x 110 ft. in plan, but at present will be built only to a length of 800 ft.

In addition the Harbor Commission is developing a sizable industrial area in one of the creeks making in from the harbor and is studying the development of a larger one farther down the creek. At present the various railways reach the wharves so that rail connections is assured, though somewhat complicated, but plans are under way for the construction of a government terminal belt railway.

Vancouver is blessed with the most picturesque natural harbor on the Pacific Coast—a perfect refuge among mile-high mountains. Its man-made harbor requirements are being advanced with a reasonable and judicious speed.

One thing here is common to all these Northwest ports. The large grain elevators are empty. Of course the farmer is holding his wheat for better prices, but the more knowing say that even when the wheat moves ships cannot compete with the railroad for European wheat shipments. The big wheat country is far enough east so that rail rates are sufficiently attractive to draw the grain to bottoms in Atlantic ports. Beside that, the Europe-bound ships these days have little to bring back and only return-cargo business pays. At any rate at Portland, Seattle and Vancouver there are many millions now tied up in huge concrete grain elevators that are lying idle.

Although Vancouver is far north it is not a freezing country so that the concrete in the port works has only to stand the sea water. So far it is in very good condition, and has not shown any of the destruction which is reported so common farther down the coast.

The teredo and his smaller relatives are active, though, and timber below water is uniformly creosoted.

Hydro-electric power development is of course talked about, but as yet little new work is being done. One big scheme only 120 miles from Vancouver and with a power house site right on a railroad is being held from publicity until certain rights are obtained. It has a remarkable natural advantage—a 4,000-sec. ft. river, 1,200 ft. above and only two miles away from another river, which can be reached by an easily driven tunnel and on which the power house can be located. Plans are now being made to develop 50,000 hp. in two units. Particular interest attaches to such developments because of the oil shortage. Oil contracts are now being written only on a short-time basis, with no prospect of bettering conditions. In fact, the Canadian Pacific is now engaged in transforming all of its coast-division locomotives from oil to coal burning. This condition prevails all down the coast and steam power houses are being converted to a coal and hogged-fuel basis. This hogged-fuel—the wood refuse from saw mills—is very effective but requires exceptionally good transportation and loading conditions because of the rapidity with which it is consumed. In view of current eastern discussions on the steam versus the electric locomotives it is surely pertinent to record the conditions in a country where coal and oil are both hard to get and where, of course, for the locomotive hogged-fuel is out of the question.

Industrial development in British Columbia must of necessity be in its infancy. The province has approximately 400,000 square miles and 400,000 inhabitants. Of this huge area 99½ per cent is unorganized and has only 14 per cent of the population. Consider, for instance, the financial difficulty of building roads and railroads through such a country. So far only the surface has been scratched, the main routes cut through; there are only 1½ miles of road per capita and ¾ mile of trail. The burden of cost must necessarily fall on the cities and unfortunately they have been over extended. That curse of the Northwest—the real estate shark—has gotten in his deadly work and the towns and cities are already staggering under a debt burden due mostly to unwarranted development of municipal area far beyond the needs of the population.

Municipal Over-Extension

From a test section of Vancouver, for instance, it was found that a population of twelve to the acre could hardly pay the necessary charges for the construction and maintenance of municipal necessities. Yet in the adjoining city of South Vancouver, the multiplication of subdivisions and the extension of remote sections farther and farther out, to escape the rising prices of the partly settled districts, has resulted in an average population of three to the acre. In consequence South Vancouver has gone into the hands of a receiver! It could not meet its obligations and to protect the credit of its other municipalities—which naturally would suffer in the bond markets—the Province of British Columbia has taken over South Vancouver's liabilities. It has established there a representative who virtually runs the city and will probably continue to do so until conditions become normal.

Vancouver itself is of course in no such dire plight. It is better managed and more prosperous, but even so one of the Dominion authorities recently stated that "streets and building sites have been laid out in the districts immediately adjacent to Vancouver alone which would provide for a population half the size of the present population of the whole Dominion." Such extensions demand improvements, which political exigencies often supply—and the city's credit steadily grows less. Wide and open spaces are necessary to health and happiness. Out here in the mountains and the woods and by the open sea men expect them, but too high a price can be paid. Intelligent planning of city development and the curbing of the real estate promoter are necessary to the right upbuilding of a city and its industries. In British Columbia these facts are being realized and the city-planner—an economist and an engineer, not a landscape gardner or a "prettifier"—is apt to come into his own in the near future.

This over-extension is doubtless no greater in Vancouver than in many other Coast cities on both sides the line, and that it has been recognized here argues well for the future. For Vancouver—though a Canadian and as has been intimated a British city—is a part of the great Northwest and moves up or down with the whole section. Just now it is sitting tight and waiting to see what is going to happen—but in that it has many companions not only on the Pacific but the country over. It is the terminus of two transcontinental railways and it has one of the great natural harbors of the world. Ordinary prudence will insure its growth and to that is being added a sound engineering foresight which is gradually developing the city's resources in a satisfactory manner.

Big Tidal Power Project Announced in England

Ministry of Transport Plans to Dam Severn River and Install Turbo-Generators to Produce 500,000 Hp.

UTILIZATION of the tidal flow of the Severn River in England to produce electrical energy estimated at 500,000 h.p. for industrial purposes is proposed in plans, involving the construction of a reinforced concrete dam across the stream below Chepstow and the installation of turbo-generators, which were made public a few weeks ago by the Ministry of Transport. One of the novel features of the project is the proposed use of surplus power for pumping to a high-level lake water which will be allowed to flow back through turbines during periods of high tide, thus maintaining a continuity of electrical supply regardless of the precession of the tides. The head of water under which the main turbines will operate varies from 5 to 30 ft. The following notes regarding the project, which has been planned by Sir Alexander Gibb, J. Ferguson and T. R. Menzies and is estimated to cost, according to published "guesses," between £8,000,000 and £30,000,000, are from an article in the Dec. 3 issue of *The Engineer*, London:

The power available in the Severn by reason of the ebb and flow of the river is largely in excess of all the potential sources of inland water power within the United Kingdom. It is claimed that the Severn is unique in that it possesses all the features which are essential for the economic development of tidal water power on a large scale. It has, first of all, an exceptionally high range of tide and an estuary of large capacity. Then, too, it occupies an ideal geographical situation in relation to the industrial centers of the country, while there is abundance of suit-

able land along the banks of the estuary for the further development of industry.

At the point where it is proposed to construct the dam the river Severn is about 2¼ mi. wide, and the country on both sides of it is fairly low-lying. At present the greater part of the bed of the river is exposed at low water. Not far from the center of the river there is, however, a deep channel, which is known as "The Shoots."

The project provides not only for the construction of a level roadway across the dam, but also for the quadrupling of the Great Western Railway Co.'s line between the West of England and South Wales, when required, at a considerably less cost than could be achieved in any other way. By it, too, there would be provided a locked basin for shipping purposes of over 27 sq.mi., a large proportion of which would be suitable for the accommodation of ocean-going vessels of the largest size, and which would be usable at all states of the tide.

Two Separate Installations

Two separate electrical installations will be required in connection with the power scheme. First, there will be that comprising the turbines and generators on the dam, which will be in operation when the level of the water in the shipping basin is sufficiently high above the water in the estuary to enable current to be generated efficiently. It is quite evident, however, that not only will continuous working of those turbines be impossible, but that the portion of each 24 hr. during which operation will be possible will vary from day to day. Hence the need for the second installation, which will include a high-level lake, to be formed by constructing a dam across a valley leading from the Wye Valley just above Tintern Abbey. Into that reservoir water is to be pumped when surplus energy is being produced by the turbines in the dam, and allowed to escape back through other turbines into the river when the turbines in the main dam cannot operate, thus maintaining the continuity of electrical supply. No statement is made as to what is to be the elevation of the water in the high-level lake or reservoir. It is only explained that it is "high." It is stated, however, that there is to be "an immense pumping and turbine powerhouse" on the banks of the tidal portion of the Wye.

The method which it is proposed to adopt in order to utilize the power of the tides in the Severn is to trap this water in the part of the estuary above the dam at high water, so as to create an artificial difference in the level between the water thus impounded above the dam and the water in the estuary below the dam, for a period of several hours round about the period of low tide.

A feature of the proposal is that the water from the river Wye is to be forced to the high-level reservoir through a tunnel driven through more than a mile of solid rock. The tunnel is to be 40 ft. in diameter; that is to say, it will have nearly four times the cross-sectional area of an ordinary double-line railway tunnel, and will be, it is claimed, the largest tunnel of its kind in the world.

No figures are given in the official document as to the first cost of the scheme as a whole, but published guesses at it have varied between £8,000,000 and £30,000,000. It is stated, however, that the estimated cost for generation at present-day prices is a little over ½d. per board of trade unit. It is claimed that incidentally the utilization of the power derived from the operation of the scheme would effect a saving in coal consumption of from three to four million tons per year.

The principal characteristics which distinguish the tidal power scheme from a hydro-electric installation of the usual description are, first, that the power is only obtainable intermittently according to the state of the tide, and, secondly, that even while the turbines are at work the conditions of head are continually varying. In the scheme which is under consideration at the Severn barrage, the working period for the turbines occurs shortly after the ebb tide has commenced to run, and continues throughout the hours of low water and until the tide has risen to about half its height. Owing to the fact that the ebb tide in the Severn occupies a longer period than the flood tide it is possible to obtain a working period for the turbines of approximately 7-hr. duration, which is followed by the period of 5-hr. duration during which no power is obtainable. The head under which the turbines work would be to commence with about 5 ft. and toward the middle of the 7-hr. working period it would increase to a maximum on Spring tides of 30 ft.

It is contemplated to use mixed flow turbines, the runners being of 10-ft. diameter and having their axes vertical. With this type of turbine it is essential, in order to obtain the highest efficiency at every head, that the turbines should be run at a different speed for each particular head. The first difficulty, therefore, which has to be overcome from an electrical point of view is to adapt the electric generator to the varying speeds of the turbine. In the case of the Severn installation the turbines would rotate at speeds approximately between 40 and 80 r.p.m. It is proposed in this case to drive the generator through helical gearing, having a ratio of approximately 7½ to 1, and producing generator speeds of between 300 to 500 r.p.m.

Electric Equipment

The generator proposed is a direct-current dynamo of special design with a vertical axis. These machines would be separately excited with shunt characteristic. The control would be effected either automatically or by an operator controlling the excitation and load currents of the dynamos in such a way that the resisting torque offered by the dynamo would be such at any moment as to prevent the turbine from rotating at a speed greater than the theoretically correct speed for maximum output under the particular head of water which happened to prevail at the moment in question. The operator would, of course, be guided by an indicator, which would show him exactly what head of water he had to deal with at every moment. The greatest rate of change of head which is anticipated will be 10-ft. increase or diminution in the hour. Dynamos would be required to produce current at the varying speeds, but at constant voltage of 525 volts, the average output of each dynamo being approximately 1,300 kw.

The direct-current so produced would be passed into rotary converters of large capacity, which would produce alternating-current at 330 volts. Static transformers would transform the pressure up from 330 to 60,000 volts, the tension at which it would be proposed to transmit the energy.

When circumstances will permit it energy would be transmitted direct to industry from the tidal turbines. At such times, however, as the tidal turbine installation was producing a greater amount of power than that which could be absorbed by industry the residue of the power would be transmitted a distance of about 10 miles up to the storage reservoir, where it would be made use of to drive motors, which, in turn, drive centrifugal pumps to force water up the 40-ft. diameter tunnel into the high-level lake.

The motors which it would be proposed to make use of would have a speed of about 375 r.p.m., working at 2,200 volts and each having an output of about 13,000 kw. The type made use of would, in respect of 90 per cent of the motors, be induction alternating-current motors, and in respect of the remaining 10 per cent synchronous alternating-current motors. The induction motors would be used as being cheaper and more easily paralleled. The purpose of the synchronous motors is to keep up the power factor when they are acting as motors, and to supply wattless current to the induction machines when the whole are acting as generators. In order to save the cost of installing two sets of electrical machines at the storage reservoir it would be proposed to combine in one machine the motor for driving the centrifugal pumps and the generator, which is to be driven by a turbine at such times as when the storage reservoir is giving forth power.

Whereas the amount of energy to be derived from the tides in the Severn average week in and week out about 500,000 hp. for a 10-hr. day, it would be proposed to install machinery at the storage reservoir to give a maximum or peak output of approximately 100,000 hp.

Venturi Flume Data Throws Light Upon "Control Weir"

Drop at Throat Makes Special Case in Which Head at Upstream End of Flume Only Is Read to Obtain Discharge

By Julian Hinds
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Having recently completed a design for a specialized type of Venturi flume, the writer is much interested in the data on this subject presented by Messrs. Wilson and Wright in the *Engineering News-Record*, Sept. 2, 1920, p. 453. The special type of Venturi referred to has, for lack of a better name, been called a "control weir" and is in fact a Venturi flume operating with the "maximum Venturi difference." It may be of interest to outline the principles of the proposed device and to investigate the bearing of the data submitted upon its operation.

A sketch of the control weir is shown in Fig. 1. A

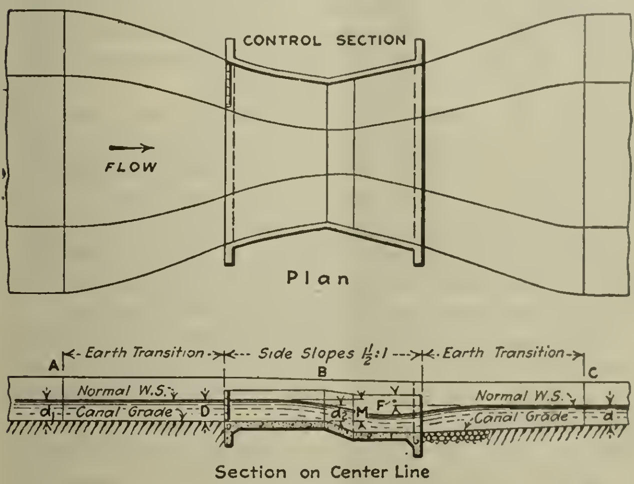


FIG. 1. CONTROL WEIR BASED ON VENTURI FLUME

slight drop is provided at B and the sides are brought in to choke, or control, the flow at that point. Theoretically, if the drop is sufficient to prevent interference from back water, the water surface at B will be "drawn down" to a definite point, and *no lower*. The corresponding depth will be that for minimum head, or minimum value of depth plus velocity head, and is called the critical depth. This depth will be independent of fluctuation in the water surface below the structure so long as the drop from A to C is sufficient to overcome the losses incidental to the operation of the weir.

It therefore follows that for a given discharge the stage at B may be computed, or if the stage is known the discharge can be found. Theoretically, the quantity of flow may be determined from the measured depth at B, but the water surface at that point is usually unsteady and may be materially altered by a slight obstruction or irregularity in the channel. For this reason the depth at B is not a reliable indication of the discharge, but the energy head (depth plus velocity head) at that point is definite and constant. By adding the estimated losses between A and B to the energy head at B the energy head at A is obtained, and from this the depth at A may be computed. Reversing the process, the depth at A may be measured and the discharge computed. The depth at A should not fluctuate unduly.

Having the depth d_1 at A, the discharge for a given weir may be computed by the formula for the Venturi flume, the value of h being determined from its known relation to d_1, but in the preparation of rating curves or tables it is more expeditious to proceed as follows:

(a) Assume depths at B and find the discharges for which these depths are critical; also the corresponding velocity heads and energy heads.

(b) Add the estimated losses from A to B to the energy head thus found to get energy head at A.

(c) Find by trial the depth, d_1, for which the depth plus velocity head at A will equal the required energy head.

(d) Construct a rating curve from the corresponding discharges and values of d_1 thus found. If tables are desired they may be constructed from the curve.

The discharge for which an assumed depth is critical may be found by taking the velocity head (hv) equal to the area of the water section (F_2) divided by twice the width of the channel at the water surface ($2T$), as expressed by the following equation:

$$hv = \frac{F_2}{2T} \qquad (1)$$

For rectangular and triangular channels equation (1) reduces respectively to equations (2) and (3) below:

$$hv = \frac{1}{2}d_2 \text{ (Rectangular Channel)} \qquad (2)$$

$$hv = \frac{1}{4}d_2 \text{ (Triangular Channel)} \qquad (3)$$

In analyzing the data tabulated by Messrs. Wilson and Wright, it was observed that in a number of cases the Venturi difference was maximum and that the flume was, consequently, operating as a control weir. Since the experimental flume was rectangular, the maximum Venturi difference, h, neglecting losses above throat and velocity head due to velocity of approach, should be approximately one third of d_1. Observations fulfilling this condition were selected and the values of d_1 and the discharge platted on Fig. 2, upon which a line showing the theoretical relation of these functions had been previously platted. The experimental points all fall reasonably close to the theoretical line.

A few points fall below the curve, indicating an actual discharge in excess of the theoretical. This is probably due to slight errors in observation. Only six such points fall below the line by an appreciable amount and all such points are for the 8 x 8-in. throat, for which the data are less reliable.

From the original tabulations it will be noticed that generally the value C_f for points below the curve is more than unity, and for points above less than unity. There are, however, certain exceptions to this, due possibly to methods of reduction used. After trying about fifteen "sets" the writer is unable to check exactly any of the tabulated values of C_f. This is undoubtedly due to the fact that the data of each set were averaged after reduction, in which case the "average data" will not necessarily give the same coefficient as that obtained from averaging the coefficients from the individual computations.

The formula for Q_f in conjunction with slightly erroneous observations, may also be responsible for part

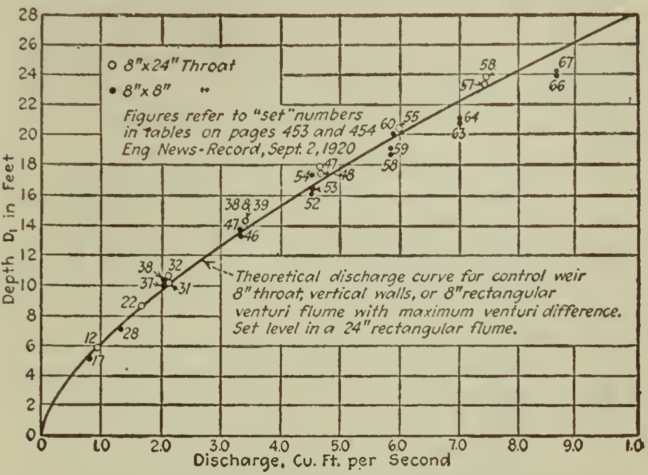


FIG. 2. COMPARISON OF THEORETICAL AND OBSERVED DISCHARGE FOR CONTROL WEIR AND VENTURI FLUME

of the discrepancies. In a number of cases the Venturi difference, h, is slightly greater than is theoretically possible. Such values of h, if used in formula for Q_I, will give discharges smaller than would be obtained by using the theoretical maximum values of h.

The "maximum Venturi differences" taken from the data for the 8 x 24-in. flume tend to run greater than the theoretical maximum, while for the 8 x 8-in. flume they are generally smaller. The location of the points of observation may have been partly responsible for this, and the more or less unstable condition of flow at the critical depth doubtless contributed further to the variation.

It has been expected that the loss necessary for the operation of the control weir would be smaller than is indicated by the author's Fig. 6. It is probable that these losses are somewhat increased by the proportions of the apparatus. While the side tapers appear to have been sufficiently gradual, the water surface slopes were rather steep and may have produced contractions on the top. The losses, it will be noticed, are much more marked for large flows, where the drop in the inlet is comparatively great. For irrigation or other canal work such a narrow, deep flume or control weir as that used in the experiments would seldom be desirable, since it would tend too greatly to check high flows.

When properly proportioned, the control weir should act as an automatic check, and a trapezoidal or triangular section is usually most effective for measuring a widely varying discharge. These forms are also economical for construction in concrete, since they involve no form work.

The automatic checking feature of the control weir may be secured by properly proportioning the section at B. Theoretically, the control can be designed to hold the water surface at A exactly up to normal for all flows, but practically it is sufficient to design for an exact control for two depths only, as in the design of the notched drop.

The form, size and vertical setting are the three fundamental variables affecting the section at B as a control. If only two point control is desired one of these variables, preferably the form, may be arbitrarily chosen. Suppose for example that it is required to prepare a design for a structure which will exactly control either 100 sec.-ft. or 25 sec.-ft. flowing in a given canal where the difference in normal depth for the two flows is 1 ft., using, if possible, a trapezoidal section having side slopes of 1.5 to 1.0. It is evident that by making the bottom of the control very wide the difference in the values of d_1 for the large and small flows can be made smaller than 1 ft. This difference can be increased by decreasing the bottom width, up to the point at which this width becomes zero. If still further increase is required it will be necessary to steepen the side slopes. For some width of notch the difference will be the required 1 ft., and if the floor of the control is set at the proper elevation the water surface at A will be held at normal for specified flows.

It is possible to derive formulæ from which the proportions of the control may be determined, but such formulæ generally involve transcendental functions, or are otherwise difficult to solve, and it is usually better to make the solution by trial. To do this assume a section at B, compute d_1 for the two controlling flows as directed above, and note whether their difference is equal to the required difference in normal depths in the canal. If not assume a new section and repeat the operation until the required proportions are found, and set the floor of the control to give the proper elevation of water surface at the intake.

While the automatic check feature is not essential to either it is believed that it will improve the operating characteristics of both the Venturi flume and the control weir. A discussion of the principles of the control section will be found in an article by the writer on "The Hydraulic Jump and Critical Depth in the Design of Hydraulic Structure" which appeared in the *Engineering News-Record*, Nov. 25, 1920, p. 1034.

The advantage claimed for the control weir over the Venturi flume is that it requires only a single observation to determine the discharge, this observation being taken and used in exactly the same way as for an ordinary weir. If all water measurements were taken by technical men this advantage would be slight, but the average ditchrider on an irrigation canal has had little or no scientific training, and is inclined to distrust any apparatus requiring refined or complicated observations. He understands the operation of the weir, and it is hoped that the control weir can be developed into an equally simple device, requiring a small head for operation and free from trouble due to silting up of pools.

The control weir is at a disadvantage in that it may be drowned by fouling or checking in the canal below. The elevation of the water surface at C may be increased until the fall from A to C is not sufficient to operate the weir. The water surface in such case will rise at both B and A, and the structure will cease to function as a weir. The possibility of such an occurrence should be considered before the installation of the device. If after a control weir is installed it becomes drowned from any cause and it is found impossible to remove the back water condition, a second gage may be installed at B and the structure used as a Venturi flume.

The control weir is, as yet, only in the experimental stage, and has not been submitted to practical test. A number of installations are being made, however, on the Huntley Project of the U. S. Reclamation Service and will be tested in 1921. It is hoped that these tests, combined with the data submitted by Messrs. Wilson and Wright, will serve to establish the reliability of the control weir as a measuring device, and to determine coefficients of discharge and loss.

Revised Rules on Compressed-Air Work in New York

Conference of Engineers, Contractors, Workmen and State Departments Adopts Measures for Safety of Men and Work

A REVISION of rules providing for the safety of work in compressed air in the State of New York has been adopted by the State Industrial Commission in accordance with the Labor Law, this revision having been undertaken on the advice of a committee composed of representatives of the New York State Labor Department, the Transit Construction Commission, the Compressed Air Workers Union, and tunnel and caisson contractors. A summary of the revised rules. dated March 1, 1920, is given herewith:

Working Time.—The hours of labor per 24-hr. period which are permitted for work in compressed air vary with the pressure employed, as shown in the accompanying table:

HOURS OF WORK FOR MEN WORKING IN COMPRESSED AIR

Air Pressure Lb. per Sq.In.	Max. Hours of Work per 24 Hours	No. and Length of Working Periods	Compulsory Interval in Open Air Between Working Periods, Hours
0 to 22	8	........*	½*
22 to 30	6	2 : 3-hr.	1
30 to 35	4	2 : 2-hr.	2
35 to 40	3	2 : 1½-hr.	3
40 to 45	2	2 : 1-hr.	4
45 to 50	1½	2 : 45-min.	5

* The way in which the 8-hour period is to be divided by the ½-hour interval in open air is not specified.

Decompression.—Decompression in the intermediate air lock must give a drop of half the maximum gage pressure at the rate of 5 lb. per minute, the remaining decompression being at a uniform rate and the total time being equal to that specified for the original maximum pressure as follows: For pressures up to 15, 20 and 30 lb. and over 30 lb., the decompression is to be at the minimum rate of 3 2 1½ and 1 lb. per minute, respectively.

Where the pressure exceeds 17 lb., a recording gage must be attached to the exterior of each man lock, with a dial of such size as to show readily the rise or fall in air pressure in 5-minute intervals. On the outer side of each working chamber must be at least one back pressure gage, which must be tested every 24 hours and record kept of each test Fittings must be provided also for test gages. The man in charge of the valves and gages of the working chamber must be on duty not more than 8 hr. in a 24-hr. period and must not operate more than two separate pipe lines.

Tunnels.—When the air pressure in a heading exceeds 22 lb. per square inch two air chambers must always be in use, except when starting headings from shafts. Intermediate bulkheads at a prescribed distance from the heading may be required by the Industrial Commission. Tunnels 16 ft. or more in diameter must have hanging walks from the working face to the nearest lock, 6 ft. headroom being maintained and ramps provided under all safety screens. These screens, not less than 200 ft. from the face, may be required in tunnels 12 ft. or more in diameter when the heading extends beyond the shore line.

Tunnels 12 ft. or more in diameter, or of equivalent area, must have at least two locks, one to be a man lock at least 5 ft. high and of such size that those using it are not compelled to be in a cramped position. The emergency lock must be large enough to hold an entire heading crew. Valves must be provided to enable the locks to be operated from within and without. Where the pressure exceeds 17 lb., a record of all men working in the air chamber is to be kept by a man who is detailed for that purpose and remains near the outside of the lock entrance. This record must show for each man the period of stay in the chamber and the time taken for decompression.

Each shaft must have a covered stairway 2½ ft. wide or, if this is not practicable, a ladder with landings at 20-ft. intervals of sufficient width to permit men to pass. The minimum dimensions for the ladders are a 12-in. width with rungs of 14-in spacing and 6-in. clear from the wall.

Explosives and detonators must be carried separately, in covered wood boxes painted red, being taken at least 25 ft. apart during transportation and not carried on the same cage. When taken into the air chamber they must be kept at opposite ends of the lock, only the carriers and lock tender being in the lock. Between firing rounds, the explosives and detonators must be kept on wooden platforms 25 ft. apart, at least 600 ft. from the heading and on the side opposite to the electric light and power line. After blasting, the explosives not used are to be returned to the magazine in accordance with the same rules.

Caissons.—In pneumatic caissons all shafts must be provided with ladders and man shafts must be lighted by guarded incandescent lamps 10 ft. apart. Caissons in which more than fifteen men are employed are to have two locks, one being used as a man lock, and caissons more than 10 ft. in diameter must have a separate man shaft.

When the working chamber is less than 12 ft. in length and when such caissons are at any time suspended or hung while work is in progress so that the bottom of the excavation is more than 9 ft. below the deck of the working chamber, a shield is to be erected in the chamber for the protection of the workmen. In the working chamber all electric wires must be provided with a switch to disconnect all current before electric wires are removed or before a charge is exploded. The method of dropping a caisson by removing the air pressure must not be employed for a greater drop than 24 in., and then only by the man in charge

Air, Light and Fire Protection.—Compressor plants must be of ample capacity to provide for emergencies and repairs, and must be capable of furnishing to each working chamber a sufficient air supply at all pressures to enable work to be done as nearly as posssible in the dry. Duplicate equipment and two or more sources of power supply are required when current for electric operation of compressors is purchased from a local plant. Duplicate air feed pipes must be provided to a point beyond the lock and to all caissons. In caisson work every effort must be made to keep the temperature in the working chamber below 100 deg F

Lighting in compressed air chambers must be by electricity only, preferably with two independent lighting systems having independed sources of supply. Smoking and nuisance are prohibited. Fresh air supply must be sufficient to permit work to be done without danger or discomfort. All air lines must have check valves and must be carried as nearly as posssible to the working face The air is to be analyzed by the contractor as required, record being kept of the analyses. Fire hose connections must be provided within reasonable distance of all caissons. Tunnels must have water lines with hose connections at 200-ft. intervals, and on each side of a tunnel bulkhead must be at least 50 ft. of hose with nozzle connection.

Medical Care.—A physician experienced in compressed air work must be employed, no man being permitted to work until he has been examined and reported in fit condition. If a man is absent for ten days or more he must be examined before resuming work, and when he has worked continuously for two months he must again be examined. A man who has not worked previously in compressed air must be re-examined after the first half-day period. and where the pressure is over 17 lb. he must first be tested by the physician in the medical lock required for all work where this pressure is exceeded. When the pressure exceeds 17 lb. or when fifty or more men are employed the physician must be in attendance at all times while the work is in progress. A first-aid room must be provided, in close proximity to the medical lock. All cases of compressed air illness must be reported to the State Industrial Commission on blanks supplied for that purpose.

Petrograd and Moscow Populations Decrease

Preliminary returns of the Russian census, according to a Stockholm press dispatch, show a decrease of 71 per cent in the population of Petrograd and of 45 per cent in that of Moscow, compared with 1914.

Chicago Electrification and Elevation on C., M. & St. P. Ry.

Third-Rail Passenger and Trolley Freight Service on Evanston Suburban Line—Concrete Walls and Trestle—Precast and Poured Bridge Decks

CONCRETE cellular and gravity retaining walls, steel girder spans, bridge decks poured in place and built of precast slabs, concrete cantilever brackets to carry plank walks, a two-post concrete trestle for single track and three-post concrete trestles for double track at stations are structural features included in the track elevation work now in progress on the Chicago and Evanston Division of the Chicago, Milwaukee & St. Paul Ry. Electric operation of passenger traffic by an elevated railway and of freight traffic by the C., M. & St. P. Ry., using the third-rail and trolley systems respectively, will be an unusual combination. The track elevation is a project commenced in 1915 but interrupted by the war.

Operating Conditions—Under the joint system of operation now in force the railway company which owns the line handles only the freight traffic, all passenger service being rendered by the electric trains of the Chicago elevated railway system. The interurban trains of the Chicago, North Shore & Milwaukee Electric Ry. are also operated over this line. Originally the Evanston Division was a surface suburban line with a light service of steam trains from the Chicago union station. In 1906 the railway company leased its tracks from Wilson Ave., Chicago, to Central Ave., Evanston, to the Northwestern Elevated Ry., thus enabling the latter to extend its rapid transit service from the Wilson Ave. terminal of its line into the city of Evanston. An incline was built connecting the elevated line with the surface tracks, and the C., M. & St. P. Ry. then discontinued its passenger service north of Wilson Ave., but retained the use of the tracks for freight and switching service to industries. The district on the whole is a high-grade residence section.

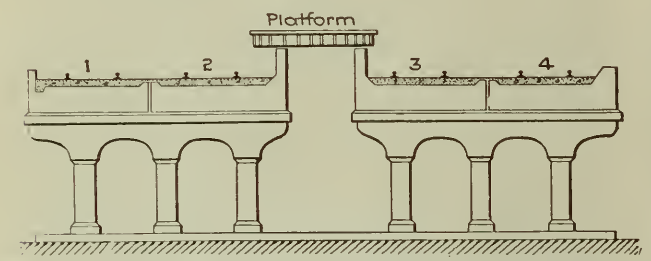


FIG. 1. TYPICAL STATION ARRANGEMENT WITH ISLAND PLATFORM AND THREE-POST DOUBLE-TRACK CONCRETE TRESTLES

Increased train service due to the increase in traffic led to agitation for the elimination of grade crossings, which resulted in the passage of a Chicago ordinance in July, 1910, requiring the elevation of tracks on this line from Wilson Ave. to the city limits, about 4½ miles, where they connected with a similar but smaller track elevation project in Evanston. This work involves 38 street crossings and necessitates the construction of nine new passenger stations. Work on the project was started in 1915, but was stopped in 1917 on account of the war. It was resumed early in 1920 and will be completed next year. Track elevation at Evanston was carried out about ten years ago (see *Engineering News*, Feb. 10 and March 7, 1910, pp. 158 and 191).

With a 60-ft. right-of-way the elevation is built for four tracks, but at present only three tracks will be laid, the third (west) track being for freight service. When the fourth track is laid this will be used for freight, the third track then being given over to the elevated railway for express train service. A track spacing of 14 ft. c. to c. is employed, except at station platforms, where the spacing is 21.16 ft. for the two passenger tracks and 12.84 ft. between the passenger and freight tracks. At Howard Ave. two platforms will be used, making a different spacing necessary. Reverse curves of about 2 deg. will be used for the diversions at station platforms. The trolley wire system is used at present and will be used permanently for the freight track, but the passenger tracks will be equipped later with the third-rail system as used on the Chicago elevated railways.

Freight traffic was handled with steam locomotives by the C., M. & St. P. Ry. until Nov. 1, 1920, since which time the Chicago, North Shore & Milwaukee Electric Ry. has handled it with electric locomotives purchased for that purpose under an agreement entered into recently by the two companies. During the construction period freight trains were handled on the passenger tracks when necessary. As freight cars are wider than the cars of the elevated railway it was then necessary to install a four-rail gantlet in each passenger track at stations, so that the freight trains could be switched to the outer rails in order to clear the platforms.

Bridge and Trestle Design—Concrete structures are used throughout, except that at some long skew crossings steel plate-girder through spans have been used to meet the requirements of the Lincoln Park Commission. These steel spans have transverse floor beams supporting a concrete deck which is poured in place and encases the beams. In general, the bridges over streets have concrete abutments and supporting bents at the center of the street and at the curb lines. With the exception of the single-track trestle south of Wilson Ave. all the bridges now being built have slab decks poured in place at the bents and abutments, precast slabs having been used on some of the earlier structures. A typical bridge is that at Bryn Mawr Ave., Figs. 1 and 2, which has sidewalk spans of 11 ft. and 22 ft. respectively. For each track the deck is a single slab

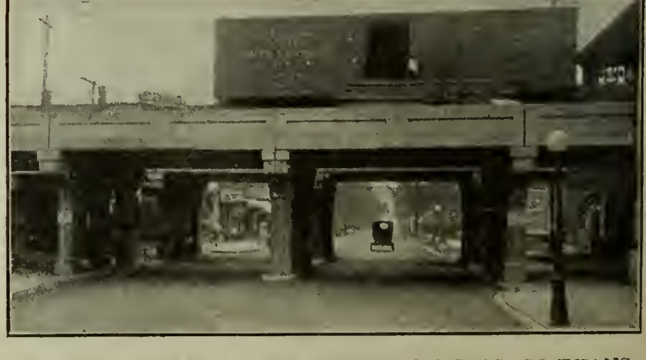


FIG. 2. BRYN MAWR AVE. BRIDGE ON CHICAGO-EVANSTON LINE; C., M. & ST. P. RY.

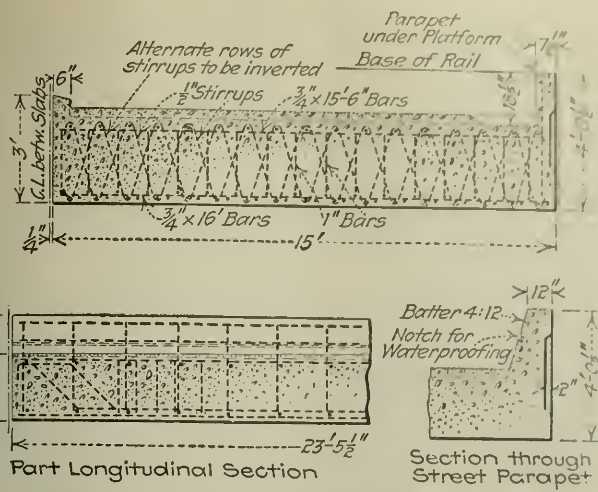


FIG. 3. CONCRETE DECK SLAB OF COLUMBIA AVE. BRIDGE

poured in place the parapet walls being formed monolithically with the outer slabs as shown. At stations, the tracks are carried by double track structures separated by a platform and the bridge construction is extended beyond the sidewalk to form the necessary subtrack space for station facilities.

Slab spans have fixed joints on the abutments and on alternate piers, being keyed to the supporting surfaces. Expansion joints are provided on the intermediate piers, the slabs having zinc plates cast into the bottom and resting on similar plates on the piers. These ½-in. transverse joints are packed with asbestos and asphalt filling. The decks which are built in place have only a longitudinal 1-in. construction joint, which is packed in the same way. Slabs for the Columbia Ave. bridge are shown in Fig. 3. Besides top and bottom bars in both directions there are continuous transverse stirrups of W-shape and longitudinal bent or shear bars.

Membrane waterproofing is applied to the top of the deck and is covered with 1½-in. layer of cement mortar reinforced with wire mesh, this covering being to protect the membrane from the stone ballast. On all slab work the concrete mix is 1:2:4, except that a 3-in. layer of 1:2 mortar is used for the bottom and top in order to secure a good covering for the steel and to form a dense surface.

A single-track concrete trestle 1,150 ft. long, with a grade of 0.3 per cent, connects the elevated line at Lawrence Ave. with the surface freight line mentioned later. The bents, spaced 20 ft. c. to c., are of rectangular form, consisting of two columns resting on a transverse footing and carrying a cap girder. Upon the girders will be precast slab spans for a ballasted track, as shown in Figs. 4 and 5. Each slab will be fixed at the north or upper end and free at the lower end. At present timber stringers are laid upon the concrete bents and intermediate pile bents.

Precast slab construction was adopted in this case as the structure carries only a single track and traffic could not be maintained over it if the concrete was poured in place. Experience on this railroad is said to indicate that there is no economy in the use of precast slabs. A slab casting and seasoning plant has been established on railway property along the line. The slabs are 11 x 22 ft., with a weight of about 43 tons, and will be handled and placed by derrick cars. A special feature in this slab deck is that provision is made for the future attachment of concrete brackets to carry plank walks, as shown. Pockets in the sides expose certain reinforcing bars to which the projecting bars of the bracket will be spliced, the pocket being then filled with concrete or grout.

Reinforced-concrete bents for the bridges consist of rectangular posts on heavy footings and supporting a cap girder. The bottom course of the footing is poured first, having key recesses in the top and having the vertical bars of the column embedded in it. The upper part of the footing, the columns and the cap girder form a monolithic structure. In the exposed portions of the bridges the columns are surmounted with a 2-in. coping, but for those portions which will be enclosed within the stations the copings were omitted. Abutments are of gravity section, similar to the retaining walls.

Stations—The stations are kept within the property lines and are located under the elevated tracks, the bridges being extended far enough beyond the street lines to provide the necessary space. Concrete stairways lead up through wells in the abutments to the platforms, as shown in Figs. 1 and 6, the typical arrangement being that shown in Fig. 1, with one island platform. Fig. 6 shows the special arrangement at Howard Ave., with two platforms, as noted above. The steps have a 7-in. rise and 10-in. tread, the latter being faced at the edge with anti-slipping material, and the remainder of the tread having granite screenings on the wearing surface. The platforms are 12 to 16 ft. wide, being limited by the narrow right-of-way. They will have wood flooring, which is considered the most suitable material where snow and ice have to be considered. The planks will be spiked to timber joists on steel I-beams carried by concrete piers. On each platform will be a canopy roof of butterfly type, supported by steel posts along the center of the platform, except that pairs of posts will be used at the stairways. The roof will be of ⅞-in. ceiling boards with tin cover

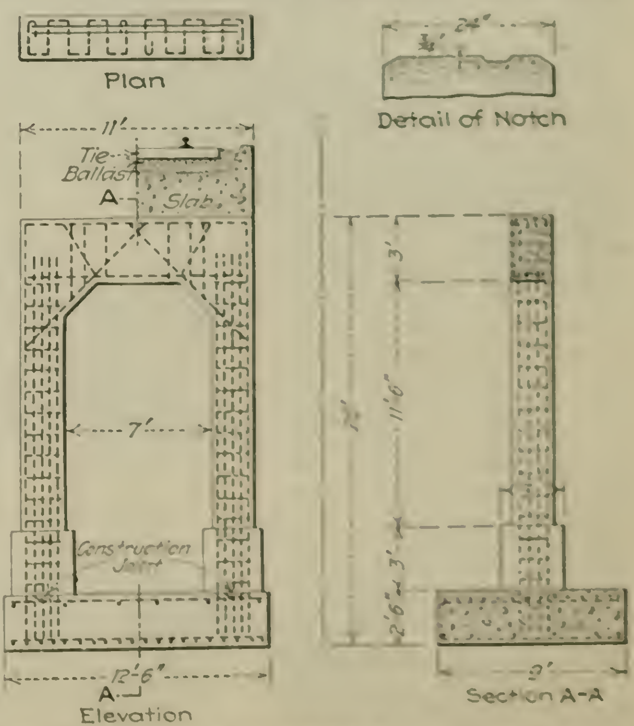


FIG. 4. TWO-POST SINGLE-TRACK CONCRETE TRESTLE

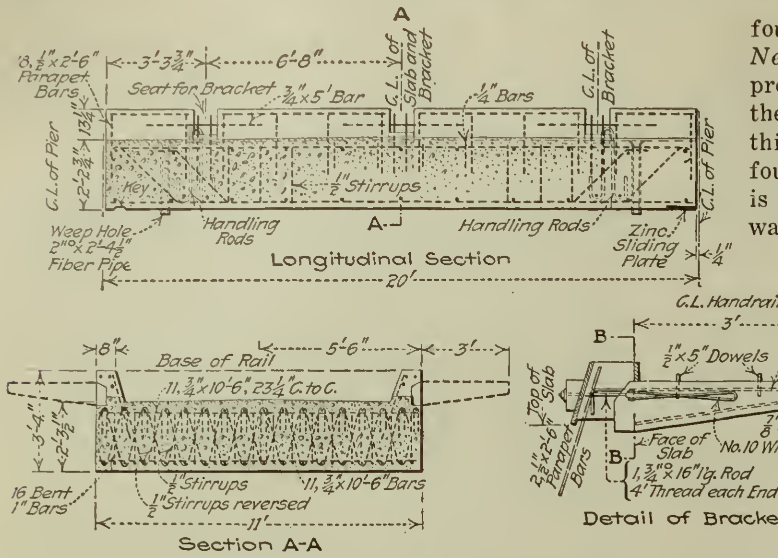


FIG. 5. DECK SLAB AND BRACKETS FOR TRESTLE

ing. This platform shelter construction is shown in Fig. 7.

Retaining Walls—Both cellular and gravity types of wall are used. In the cellular wall of reinforced concrete a relatively thin main wall is connected to a low back-wall or another wall by transverse tie walls embedded in the fill, as shown in Fig. 8. These walls are built in sections 30 ft. long, with the tie walls located approximately at the quarter points so as to equalize the moment in the cantilever portion and the center portion of the walls. The weight of the material upon the back wall and within the cells or compartments serves to anchor the structure in position, drainage of the enclosed sections of fill being provided by a line of 4-in. tile laid through holes in the tie walls, where necessary. In the higher cellular walls, the main or front wall has a small footing to reduce the load on the soil, but this was omitted in the walls of less height. The bottom of the footing is placed at least 3 ft. below the surface of the ground, on a deep stratum of firm sand.

The front wall is designed and reinforced as a slab held at the quarter points and subjected to earth pressure with a surcharge equivalent to Cooper's E-50 loading. For this loading the center line of the first track is assumed to be 6½ ft. from the right-of-way line (or face of wall), with the adjacent tracks spaced 13 ft. c. to c., the live load being assumed to follow a distribution slope of 1 on 2 from the ends of the ties. The maximum bearing under various conditions of loading shows about two tons per square foot beneath the front wall and about ½ ton beneath the back wall.

A similar cellular type of wall was designed a few years ago by the Chicago, Milwaukee & St. P. Ry. for its track elevation work at Milwaukee, Wis., the purpose in that case being to eliminate the necessity of deep and expensive pile foundations in loose material (see *Engineering News*, May 27, 1915, p. 1048). Those walls have proved satisfactory, but it was expected that there would be some settlement and in places this has occurred. On the Chicago work, the foundation conditions are quite different, as there is a deep bed of firm sand. There the cellular wall was adopted for use where the right-of-way runs through private property and no toe or footing could be permitted to extend beyond the property line. In order to provide for possible settlement the wall was built with its face 1 in. back from the property line. The height of front wall is from 16 to 22 ft. In the original design used at Milwaukee the back wall was built only between the tie walls of each section, the closed cells thus alternating with open spaces. In the Chicago work, however, this back wall is continuous, being built in 30-ft. lengths the same as the front wall.

A gravity type of retaining wall is used where the right-of-way parallels the boundary of a public thoroughfare, as the ordinance permits the foundation footings to extend a reasonable distance into the street. For some of the higher walls they extend about 5 ft. beyond the right-of-way and have a reinforced toe. These footings are below the grade line of the paving. This arrangement, shown also in Fig. 8, may be compared with that of the track elevation walls on the Rock Island Lines, in Chicago, where the toe of the footing is placed at the property line, the wall being set back but having a cantilever projection at the top which extends out to the property line (see *Engineering News-Record*, March 28, 1918, p. 622).

As shown by the typical section, the footing is built first, the wall being tied to it by a key groove and steel dowels. Reinforcing bars are used in the base of the footing. It was proposed to build some of the higher gravity walls in two horizontal sections, the first section being high enough to retain the slope of a three-track fill and the upper section being added when the fill was widened for the fourth track. This plan

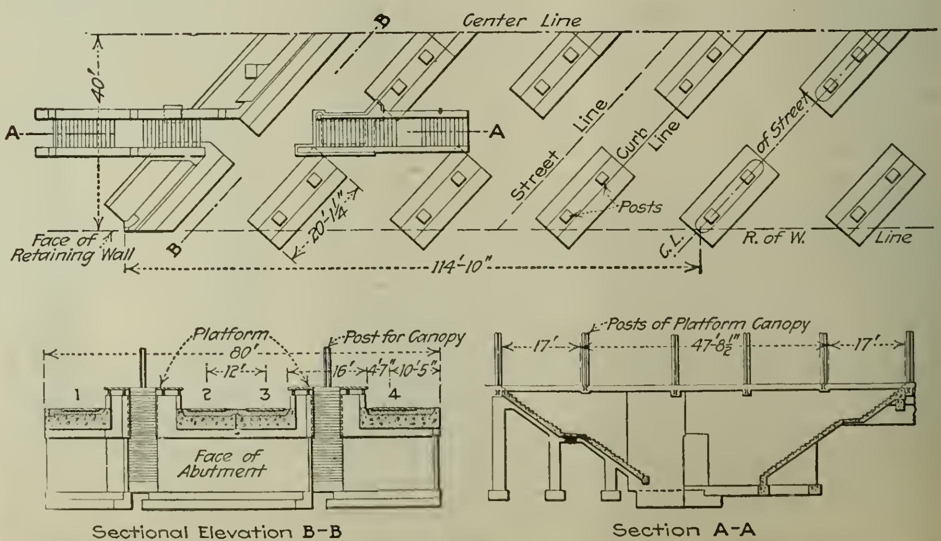


FIG. 6. SPECIAL PLATFORM ARRANGEMENT AT HOWARD AVE. STATION

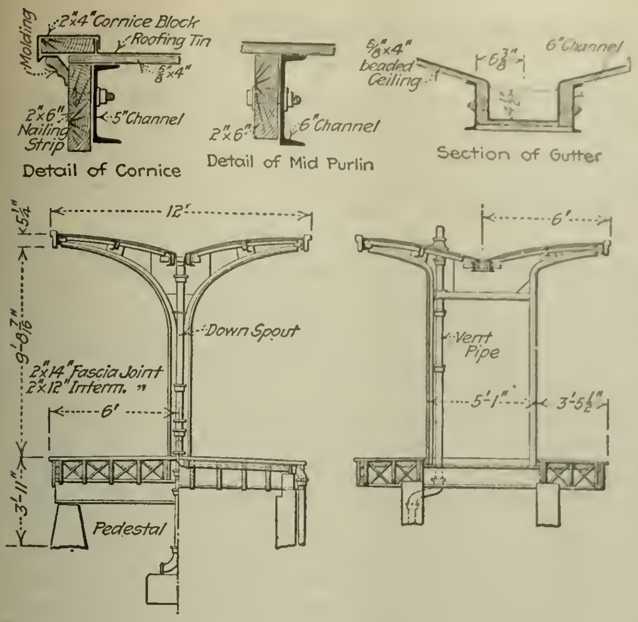


FIG. 7. PLATFORM SHELTER OF BUTTERFLY TYPE

was abandoned, however, and all walls are built to full height, the maximum being about 22 ft. These walls are built in sections 25 ft. long, poured alternately, with a key groove formed in each end of the sections first built. The maximum bearing load allowed on the soil is 2 tons per square foot. Gravity walls are of 1:3:6 concrete, with a 1:2½:5 mix for the footings. Cellular walls are of 1:2½:5 mix throughout.

Construction

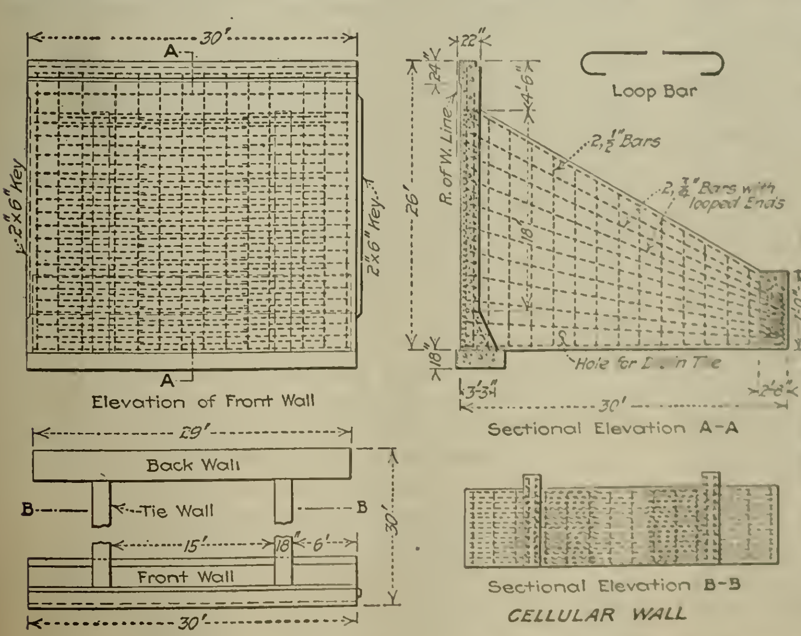
Methods and Plant—Before work was stopped in 1917 considerable progress had been made on the east side of the line, the retaining wall and part of the bridges being completed, and fill deposited for two tracks. Thus the present concreting is not affected as much by the very heavy traffic which was a difficulty in the earlier stages of the work, as described in *Engineering Record* of July 15, 1916, p. 75. The filling also will be done from the new third track, which is on a trestle. In accordance with the policy of the Chicago, Milwaukee & St. P. Ry. the construction work on this elevation is being carried out by the forces of its own engineering department.

Three concreting trains are operated, each consisting of a mixer car with 1-yd. mixer, having four or five cars of stone (or gravel) and sand coupled at one end and a box car of cement in sacks at the other end. On two of the trains, the materials are delivered to the bins on the mixer car by wheelbarrows operated on runways laid over the cars. The other train is equipped with a 200-ft. cableway operating a 1½-yd. dragline bucket, the cables being carried by steel folding towers on the mixer car and on a car at the rear of the train, the latter car carrying a steam hoisting engine. This equipment, with the rear car, is shown in Fig. 9.

The cableway method of unloading and handling material was developed some years ago for other track elevation work on this road (see *Engineering Record* of Nov. 15, 1913, p. 544, and *Engineering News* of Nov. 20, 1913, p. 1018). Its labor-saving advantage is of special importance on the present work, in view of labor conditions, for a gang of 16 men with the concreting train which has the cableway equipment can do as much work as the 30 men required for the train on which material is handled by wheelbarrows. No difficulty is experienced in obtaining a sufficient supply of both skilled and common labor and the labor turnover is relatively small. Electric motors operate the mixers in both cases. Progress has been retarded by the usual difficulty in maintaining an adequate supply of materials.

With the train placed on the third track, all concrete is spouted directly into place. Where the drop from the mixer is considerable, as in placing foundations and the lower parts of the walls, flexible pipe chutes are used instead of troughs. All form work is of wood, that for the walls and abutments being built up largely in panels which can be handled as units and used several times. The forms are left in place about four days, and fill is not deposited against the walls for at least twenty days.

No surface finish is applied to exposed concrete surfaces after the removal of the forms, but in placing the concrete care is taken to work the cement to the side which will be exposed. For the parapet walls of bridges, the face of the form is plastered with 1:2 mortar as the concrete is deposited. Only the simplest decoration is attempted, including beveled corners, small fillets on the



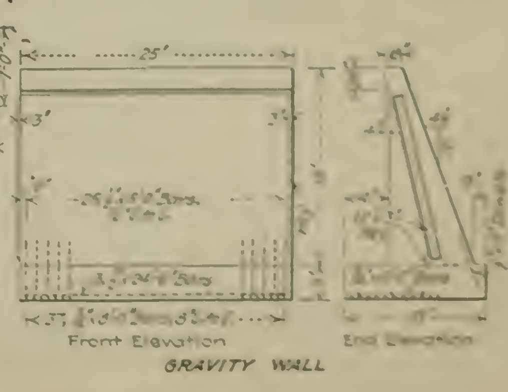


FIG. 8. CELLULAR AND GRAVITY RETAINING WALLS

columns of bents and large recessed panels on facia girders and parapet walls.

Cinders and refuse are used for filling, being deposited by gondola cars having side doors or drop floors. This filling is done from the trestle.

Construction work is in charge of T. H. Strate, engineer of track elevation. Structures were designed by C. N. Bainbridge, engineer of design. Both design and construction are under the general direction of W. W. K. Sparrow, assistant to the president. Charles F. Loweth is chief engineer of the Chicago, Milwaukee & St. P. Ry.

FIG. 9. CONCRETING TRAIN WITH CABLEWAY AND DRAGLINE BUCKET

Mississippi Levee Yardages

During the fiscal year ended June 30, 1920, a total of 12,537,564 cu.yd. of material were placed in the levees below Rock Island, on the Mississippi River. That amount brings the total amount of material in those levees, placed under the direction of the Corps of Engineers, U. S. Army, to 361,691,350 cu.yd. Considerable work remains to be done to bring these levees up to the standard fixed by the Corps. On June 30 the work contemplated under that standard was 76 per cent complete. These levees protect 27,116 sq.mi. of land.

In addition to the completion of this levee system it is believed by the Corps that a large amount of additional levee work must be provided for in the near future. Development in the State of Louisiana has reached a point where the Atchafalaya River either must be leveed or be divorced from the Mississippi River. The leveeing of that stream from the Mississippi to the Gulf would be a large undertaking. In the case of divorcement, the whole levee line on the Mississippi, from the Atchafalaya to the Gulf, would have to be materially reinforced. In this latter case, the engineering problem at the Passes, through which the Mississippi finds its way to the Gulf, would be made very much more difficult.

Preservative Treatment of Poles in Indiana

INCREASING use of preservative processes is shown by a study of pole conditions of the electric railway and other public utility services in Indiana recorded by R. V. Achatz in Circular 2 of the Engineering Department of Purdue University, at Lafayette, Ind. The conclusions presented may be summarized as follows:

A considerable percentage of the poles erected at the present time are receiving some kind of treatment, and the majority of companies using poles are either using such treatment or planning to use it on future work. Derivatives of coal tar are the most commonly used preservatives. Both the brush and open-tank methods of treatment are used, the latter either by simple dipping or by the hot and cold dipping process. Only the butts are treated, as a rule. Poles of the less durable woods treated by the pressure-tank process are more expensive than butt-treated cedar and chestnut poles, so that the former have not come into extensive use.

Under average conditions an increase in life of about two years will justify brush treatment, about 3½ years will justify the open-tank dipping treatment in hot creosote and about 7½ years will justify the hot and cold open-tank treatment. An increase in life greater than the above may be expected if these treatments are applied properly. For the lighter lines and for the smaller companies, or where first cost is an important consideration, the brush treatment offers some advantage. The open-tank dipping process gives greater uniformity and probably somewhat longer life than the brush treatment, which advantages are considered to overbalance the increased cost. The hot and cold bath open-tank treatment gives the greatest increase in life and is particularly suitable for heavy lines and permanent construction.

To increase the life of poles already in service, the most common method is to reinforce the weakened pole by driving a creosoted stub alongside it and binding the two together by wire. Another method is to excavate the earth from around the pole, clear away decayed wood and apply a brush treatment. Concrete reinforcement has been applied, but on account of the cost it can be recommended only for exceptional cases where the cost of replacement of the poles is very large.

Cost of Miami Flood-Protection Work

Total expenditures for flood protection to June 30, 1920, by the Miami Conservancy District have been \$24,035,823 instead of \$42,893,465 as stated in *Engineering News-Record*, Nov. 18, 1920, p. 979.

Use of Steel Reinforcement for Concrete Pavements

Behavior of Steel in Several Roads Leads to the Design of Two-Layer Reinforcement and Specification of Heavy Metal

By H. Eltinge Breed
Consulting Engineer, New York City

Steel reinforcing in concrete pavement tends, in the writer's opinion, to lessen cracking in the pavement, to render more innocuous those cracks that occur, to prolong the life of the pavement by relieving the fatigue due to tensile stresses, and to justify its cost by increasing the service of the road, decreasing its maintenance, and sometimes offsetting the necessity for additional depth of concrete. These opinions, though formerly held, have been strengthened by a study recently made for the National Steel Fabric Co.

Last year more miles of concrete were laid in the United States than of any other type of durable pavement. The growth of the popularity of concrete as indicated by the laying of 941,659 sq.yd. in 1910 and 52,000,000 sq.yd. in 1919, has been little short of phenomenal. In response to a request for suggestions for an ideal section of the Lincoln Highway sent out by the Lincoln Highway Association, twenty-four of the forty replies which indicated a preference for a certain type of pavement specified concrete and nine of these suggested steel reinforcement. It is obvious that in many localities the concrete road is the cheapest of the durable types of pavement, that its cost of maintenance is low, and that people like it because it can be depended upon for service 365 days a year. However, we still have far to go in the development of the perfect pavement. It is the quest of that perfect type that lures the road-builder on to fresh adventures and discoveries. One may always expect the advent of a new type far superior to anything existing. Meanwhile, we must work to make the present good—better.

Cracks, Greatest Defect

The defect of the concrete pavement today is the cracks that appear upon its surface. If we can prevent these, we shall increase greatly the desirability of the concrete road. Although they have so far proven less serious than many other defects that mar our roads, cracks weaken the integrity of the pavement, and in the effort toward improvement we want to eliminate them. The cracks are of two kinds—transverse and longitudinal. They are due, as far as we know, to these causes: (1) Poor workmanship or poor materials, either of which is intolerable; (2) contraction due to variations in temperature and moisture content; (3) settlement of the subgrade; and (4) overloading and impact. Settlement is caused by frost action, by consolidation of the subgrade and by volume changes in the subgrade. The first of these causes we can and must prevent; the others we must offset. The most effective means of offsetting them that we have yet discovered is, I believe, the use of steel reinforcement.

The longitudinal crack is the more serious because, being along the axis of the road, it may catch the wheels of traffic like a track, and carry them along its length. The traffic, of course, chips off and wears down the edges, and a gash results, which requires maintenance. Transverse cracks tend to develop unevenness, one side becoming depressed. Traffic bumps over the ridge, and the resulting impact crumbles the edges and starts spalling. A. T. Goldbeck, engineer of tests, Bureau of Public Roads, reports some interesting experiments to determine the force of impact upon concrete surfaces. He says, in the proceedings of the American Concrete Institute for 1920:

> We have conducted a number of tests, using trucks of different size, in order to determine something of the amount of impact exerted on concrete roads, and it is rather surprising to find out just how much this impact can be. For instance, say you have a heavy truck, a three-ton army truck, which is very often a five-ton truck, and that truck has a total weight on one rear wheel of 7,500 lb. when the truck is loaded with five tons. When one rear wheel of that truck falls through a height of ½ in. the impact on the road may be as high as 20,000 lb.; that is, the impact pressure produced may be as high as 20,000 lb., almost three times as much as the static load pressure. If the truck falls through a height of 3 in., which would, of course, mean an exceedingly bad road, you may get an impact pressure as high as 43,000 lb.

To build roads to withstand such impact as this last would be financially ruinous. What we can and must do is to build roads of such smoothness that there will be no intensification of the impact pressure.

It is perhaps well to suggest here that accidental cracking is not the only source of damage by impact. In the older concrete roads, metal-joint plates were used in the space between the slabs. Expansion and wear would gradually cause an unevenness at the joint. Then, while the hard metal remained intact, the less hard concrete on either side of it would suffer under the intensified punishment of traffic impact. In the new roads, metal-joint filler is no longer used. Thus one source of excessive wear is eliminated. The writer believes that wear due to accidental cracking may also be eliminated; first, by using every known precaution to prevent the cracking; second, where it does occur, by holding both sides level so as to prevent increased impact.

To hold the edges level and prevent the spreading of cracks where they appear is one function of steel reinforcement.

Road Stresses

Roads get stresses both compressive and tensile. Concrete will take compressive stresses, but it does not endure so well the tensile stresses generated by the impact of heavily-loaded motor vehicles. There has been much discussion about increasing the depth of concrete to withstand these so-called "shocks." The writer believes that impairment of a concrete pavement is due not so much to immediate shocks from above as to cumulative fatigue generated by intermittent tensile stresses. Another function of steel reinforcement is to take these stresses, lessen fatigue and thereby prolong the life of the pavement. The writer wishes that he might give definite, indisputable scientific data that would support these statements. He can not. He can only draw empirical conclusions from the studies and observations he has made.

Until 1918 he believed, with many other engineers, that the results gained from reinforcing did not justify its cost. He based this opinion upon the observation of concrete roads that were one to three years old. It has been offset by longer observation. For, while only a few cracks appear during the first year after a pavement is built, more develop during the second, and still more during the third, unless the pavement be reinforced.

Of the truth of this statement New York State Highway 5,314 is a good example. It was built in 1914 and a crack survey of it was made in April of 1915, 1916, and 1917. In two representative miles there were 1,479 linear feet of cracks in 1915; 3,210 in 1916, and 6,116 in 1917.

Need for Reinforcement Seen

The spectacle of this progressive cracking in this and in many other roads made the writer feel more keenly than he had prior to 1918 the need of a remedy. Further observation led him to believe that reinforcement would help certainly to an extent that would offset its cost.

Five hundred miles of concrete pavement were laid in New York State up to 1919. Seventy-five miles had reinforcement varying in weight from 22 to 25 lb. per 100 sq.ft. In some cases this weight of metal was doubled over bad soil conditions. The sections reinforced are in better condition today, under the same condition of soil, aggregates, etc., than the plain sections are. It is noticeable that with an increased amount of metal the cracks are fewer and the pavement surface is in better condition.

With this study in mind the writer, during the past two years, has been designing his pavements with reinforcement of 40 lb. per 100 sq.ft., decreasing in many cases the thickness of the pavement as the amount of metal has been increased, and thereby offsetting costs. For instance, a povement that would have been designed 9 in. thick without reinforcement on a 10 to 8 section, was designed instead 8 in. thick with a steel reinforcement of 40 lb. per 100 sq.ft. At $5 a square yard a 9-in. pavement is worth 55c. per inch of depth. Forty pounds of metal per 100 sq.ft. can be placed for about 25c. per square yard, figuring 6c. a pound f.o.b. shop, for the reinforcement. This would show a net saving of approximately $3,168 for a mile of pavement 18 ft. wide, exclusive of the saving in cost of an inch in excavation, and not considering the lengthened service of the pavement, or its decreased maintenance due to the reinforcement.

C. M. Upham, chief engineer, Delaware State Highway Department, said, speaking before the American Road Builders' Association in 1916 of the use of reinforcement in Delaware roads:

> With one exception, as the percentage of reinforcement increased the transverse cracks became fewer. The increased cost due to reinforcement was 9c. per square yard. If the reinforcement were not used, and the money were put into concrete, it would add but ½ in. to the thickness of the road.

Two-Layer Reinforcement

The writer's opinion is put into practice on a city pavement he is now constructing at Bennington, Vt., where he is using 40 lb. of metal per 100 sq.ft. on the narrow sections of the street on either side of the car track under medium to light traffic. The concrete is 6 in. deep and the slabs 8 to 9 ft. wide.

On this same contract in the main street of the city *he is using 75 lb. of material in two layers—40 lb. to the lower layer and 35 lb. to the top*, with a width of slab from 14 to 18 ft. The pavement is most of the way on a coarse gravel and sand foundation. In another small city where there is a considerable amount of ground water the writer has designed on a clay soil a 6- to 9-in. cinder base with drains on which there is to be placed a 7-in. concrete pavement with 45 lb. of metal per 100 sq.ft. along a 40-ft. street with a car-track in the center.

Recent inspections indicate that, other things being equal, the greater the amount of metal used the better will be the pavement. For those who want the evidence, a detailed statement of a few of the roads visited is given in appendices at the end of this article.

The writer has tried to enlarge his experience vicariously. The fact that reinforcing is still in the experimental stage makes it rather difficult to get definite opinions concerning it. Some questionnaires have been sent out with varyingly valuable results.

The committee on reinforcement for the second national conference of concrete roal builders prior to 1916 sent out letters to 844 engineers known to have laid concrete road or pavements. Of the 319 replies received 40 per cent furnished information about 300 miles of reinforced concrete roads and pavements. Partly on the basis of this information the recommendations of the committee were made.

They advocated the use of reinforcement on the following scale:

Width of road—ft.	Weight of of metal per 100 sq.ft.—lb.	Sectional area Transverse	Longitudinal	Ratio
16	40	.09	.03	3 tol
30	50	.12	.03	5 tol
40	60	.15	.03	5 tol

The committee report was not adopted, but a resolution was adopted the sense of which was that the reinforcing be left to the discretion of the individual engineer. The conclusion of the convention is well expressed however in the following recommended practice formulated by the committee on resolutions and adopted by the convention: "In general the use of reinforcement is advisable." This was one of the twelve fundamental principles adopted by this committee.

The committee on cencrete roads and pavements of the American Concrete Institute, of which the writer was chairman, selected engineers who, it was generally recognized, had had extensive experience in concrete road and pavement construction, and sent to them questionnaires in January, 1920. Sixty-six were sent out and twenty-three were returned. The main idea of this questionnaire was to get such information as would help the committee in rewriting its specifications and recommended practice. Of the twenty-three engineers who replied, thirteen used and believed in steel reinforcement. It is interesting to note that of those thirteen, eleven stated a preference for the wire type of reinforcement as it gives a better distribution of steel and increases the bond strength on account of greater superficial area.

A few practical suggestions for future use of reinforcing steel may not be amiss, in view of the large amount of it that is being specified. In New York and Pennsylvania alone there were put under contract in 1919 9,000,000 sq.yd. of reinforced concrete pavement.

1—One of the great dangers in using reinforcing steel is that road builders, given an additional factor of safety, may be tempted to use a leaner mix, poorer materials and poorer workmanship. Such construction would only defeat its own purpose. Reinforcing steel is in no sense an apology for poor materials or poor construction. It merely would be added waste to use it in poor work.

2—On account of the fact that transverse cracks are not as dangerous as longitudinal cracks, and as the latter are the ones to be eliminated if possible on account of the destructive effect of traffic running along them, it would seem wise to take a metal that has a ratio of from one, lengthwise, to from three and one-half to five, across the pavement. Many of the standard designs now have about this ratio and the writer believes it gives the best results. In city work, however, where transverse cracks are more detrimental, the ratio should be one, lengthwise, to from one to two and one-half, crosswise, depending on the length of the slab.

3—With the increased use of steel, slabs can be lengthened without the danger of transverse cracks.

Other Considerations—So far in all our road work we have been trying to build for the needs of the day. Always tomorrow has overtaken us unprepared. During the last 15 years every year has seen an increase in loading and in density of traffic. However, legislative restriction has now limited the total load to about 30,000 lb., and the design of most of the pavements being built today has that maximum loading in mind. We are gradually getting our highway problems into fewer variable terms, but we do not yet know how large a part steel will play in road building. Some have claimed that it will do for highways what it has done for structural building. This is improbable. Buildings and bridges are designed with certain definite, unyielding supports, with no supporting medium below certain parts of the slab; while in highway design all parts of the slab are supported with varying uniformity by a base estimated to give a certain amount of stability. It is this varying uniformity of base that precludes absolute accuracy unless one wants to design extravagantly for maximum weakness.

If a highway slab were reinforced heavily enough to take its loadings in the same manner as the slab design of the building, the cost would be excessive. This is not necessary. In building work failure is often disastrous, but on a highway it may be cheaper to allow one slab to fail and be rebuilt adequately to the poorer foundation, than uniformly to reinforce the whole roadway in accordance with the worst condition found. The future of highway development depends upon the economic use of present funds. To use steel rationally it will be necessary, even on the same highway, to build varying thicknesses of pavement with varying amounts of steel to meet varying conditions of foundation and traffic.

Conclusions

The analogy between the use of steel reinforcing for structural work and highways will not hold, but the writer believes that steel will be a factor in helping us build better roads. With the proper use of the right amount of reinforcing steel, pavements can be built to withstand the increased traffic that will be put upon them.

This article deals specifically with the concrete type of pavement but several other durable types of pavement which have for their base a concrete foundation can be effectually treated with reinforcing steel so as to put them in competition with the concrete pavement. Cracks are many times as destructive under these asphalt or mixed asphaltic concrete pavements to the pavement surface as cracks are to the concrete.

It is upon the observations given above, which are typical of many others that he has made, that the writer bases his statement about the two-fold function of steel reinforcing: It preserves the integrity of the pavement, and prolongs its life.

Appendix A

Long Island—Road 743 in Suffolk County, Long Island, N. Y., between Babylon and Bayshore was an old bituminous macadam pavement 16 ft. wide and 6 in. thick. In 1916 the section of this road from Sta 0 to 92 + 40 was resurfaced with a 1 : 1½ : 3 gravel concrete 20 ft. wide, 6½ in. thick in the center and 4½ in. thick at the outside edge. As the center line of the new work was on the center line of the old work it left an overhang of 2 ft. of concrete on each side that had as a support only gravelly sand soil, while the center 16 ft. had the advantage of the old macadam as its foundation. In order that these 2-ft. wings should not break off, mesh reinforcement was specified that should weigh not less than 0.25 lb. per sq.ft. This metal was to be 2 ft. wide and placed midway at the depth of the slab so that a foot of the metal would be over the old macadam foundation and a foot over the ordinary subgrade. At the western end of the pavement slabs are intact and no cracking appears over the point of change in the foundation material. In the latter half of this work, however, thirty slabs with a total length of 900 ft. have cracked at their edges close to the change in foundation condition. When we looked unusually hard for reinforcement in this latter part, it appeared as though it might not have been put in. The western end of the road which still shows no cracks, was, for a quarter of a mile, reinforced. Then the contractor ran out of reinforcing material and the work was carried on without it in order not to check progress. Cracking resulted.

Compressive Strength

The action of the section in which the reinforcement was used is particularly good considering the fact that the average strength of the concrete cube composed of mortar concrete taken from the mixer and tested at 28 days shows an average strength for the 1 : 1½ : 3 mix of only 2,[illegible]08 lb. This is unusually low, as most New York State road work runs well over 3,000 lb. per square inch, compressive strength. This low strength was due to the fact that local gravel was used which contained a large percentage of material from ¼ in. to ½ in. in size with only a small percentage of the material over 1 in.

A traffic census on this road taken from 8 A.M. to 8 P.M. on Aug. 21 and 22, 1920, shows a count on the first of these days of 2,384 vehicles, of which 180 were light-delivery trucks and 78 were heavy-delivery trucks. On Aug. 22 the count was 3,091 vehicles, of which 56 were light-delivery trucks and 23 heavy-delivery trucks. The traffic during 1917 and 1918 was much heavier because quantities of material for Camp Upton (as well as supplies for two near-by aviation fields) were hauled over this road.

Appendix B

New Jersey—New Jersey affords other instances. In 1914 a clay fill was made upon a marsh about [illegible] ft. above mean tide. Two sections of road were built over it which have had to carry extremely heavy traffic. The first section, on the Fort Lee Turnpike, built in 1917, was [illegible] ft. long. This pavement was 20 ft. wide and from 8 in. to 10½ in. in thickness of a 1 : 2 : 3 mix of concrete, using Cow Bay sand and trap rock as coarse aggregate. Forty-five pounds of metal per 100 sq.ft. were used as reinforcement and placed 2 in. below the top. The slab length was greater

ally 20 ft. The grades ranged from level to 2 per cent. There is only one crack in the entire length and that is over a culvert which held its position while the fill at both sides settled.

Fort Lee Turnpike Section

The other section, built in 1919 on the Fort Lee Turnpike, is 1,000 ft. long, 24 ft. wide and from 7½ to 10½ in. thick, of a 1: 2: 3 mix, in which Cow Bay sand and trap rock were used as coarse aggregate. Forty-five pounds of metal per 100 sq.ft. were used as reinforcement, and placed 2 in. below the top. The slabs are 36 ft. long. The grades range from level to 1 per cent and there are no cracks of any description in the pavement.

By way of comparison let us take a section of the Bergen Turnpike only two miles away. It is not reinforced. Under similar conditions as to soil, marsh, etc., this road was also laid in 1919 with even greater care than was taken with the other two sections. It is 3,450 ft. long, 18¾ ft. wide, uniformly 9 in. thick, of a 1: 2: 3 mix in which Cow Bay sand and trap rock were used as coarse aggregate. The length of slab is 36 ft. The grades here are level. Yet there are in this pavement 32 longitudinal cracks, 3 transverse cracks, and 3 diagonal cracks. Two cracks are spalled to a width of 3 in. The road has begun a yearly maintenance charge; the other two are practically intact. The conclusion is obvious.

Another piece of pavement which the writer inspected was the Kearney-New Jersey-County Road which runs from the Trexler Lumber Co. to the Plank Road. It was built in 1919. This is just off the Lincoln Highway. The length of the pavement is approximately 3,300 ft. The pavement is 24 ft. wide, and 10-12½-10 in thick. The mix was 1: 2: 3 using a ¾-in. limestone aggregate. One hundred and fifty pounds of metal per 100 sq.ft. were used as reinforcing, 75 lb. being approximately 2.5 in. above the grade, and the top layer from 5 to 6 in. above this. The slab lengths are from 36 to 54 ft., the average being about 40 ft. The road is constructed over filled ground on a cinder fill. There are no cracks in the entire length except at a point where the railroad track was placed diagonally across the pavement. Here the concrete shows a crack at a narrow section of the slab, which came when the pavement was broken through for the railroad. The traffic using this section is the heaviest kind of motor traffic that serves the industrial plants surrounding it.

Section in Ridgefield

Grand Avenue in Ridgefield, N. J., takes the heavy motor truck traffic from Jersey City northward through Nyack. It is 3,923 ft. long, 22 ft. wide, 7-10-7 in. thick, and of a 1: 2: 3 mix in which Cow Bay sand and trap rock were used as aggregate. Forty-five pounds of metal per 100 sq.ft. were used as reinforcement, which was placed 2 in. below the surface. The average slab length was 36 ft., some slabs being as long as 100 ft. This road was built in 1918 and is on a side hill. The soil is clay over trap rock. Drainage is provided for by tile upon the hill side. The grades range from level to 2 per cent. There is only one crack in the whole length, it being in one of the 100-ft. slabs which has a transverse crack near the middle.

The writer has seen many similar pavements without reinforcing which were badly cracked. It appears, therefore, that in this pavement the reinforcement has saved the cost of constant maintenance.

Another interesting piece of pavement was that on Totowa Avenue, Paterson, N. J. This is 600 ft. long, from 26 to 28 ft. wide, and 6-8-6 in. thick, of a 1: 2: 3 mix. Local sand and trap rock were used as coarse aggregate. Thirty-one pounds of metal per 100 sq.ft. were used as reinforcement, which was placed 2 in. below the surface. Slab lengths are from 15 to 30 ft. This pavement was laid in 1916. There are no cracks. The surface condition shows that the sand used was dirty, or of a poorer grade than that generally found in Jersey work, because it had worn down around the aggregate. This pavement is laid on a clay soil and on an 11 per cent grade and carries moderate city traffic. Considering its age and condition the metal reinforcement is probably the cause of no cracking.

Appendix C

William Penn Highway—Another pavement inspected was the William Penn Highway from Easton to Allentown, Pa. The pavement is seven miles long, 16 ft. wide, and 6-8-6 in. thick, of a 1: 2: 3 mix. The amount of metal used was approximately 0.25 lb. per sq.ft., placed 2½ in. from the surface. The slab length was 39½ ft. The soil is clay over limestone with a possible presence of ground-water pockets. Underdrainage was placed along the side to care for this condition. Although there are numerous cracks in the pavement the greatest width observed in any one was ¼ in., and the metal held the breaks to such an extent that the riding surface of the pavement was perfectly smooth and even.

In a number of cases a crack having started at the edges or in the center of the slab did not continue across to the outside edge of the pavement as it generally does when no steel is used. The amount of metal used seemed beneficial because it kept the broken sections of slab at a uniform level and saved the destructive effect of impact generated by unevenness. It has also held broken sections closely together and saved maintenance and upkeep costs. The condition of the pavement is much better than other pavements without reinforcement, both built under similar conditions as to thickness, mix, soil, age, etc.

Appendix D

Wayne County, Mich.—Grand River Road, Wayne County, Mich., built in 1910, 16 ft. wide and 6½ in. thick, of two-course construction, was widened to 20 ft. and resurfaced in 1916 with 3 in. of 1: 1½: 2½ concrete of washed sand and trap rock ¼ in. to 1 in. in size and reinforced with wire mesh weighing 28 lb. per 100 sq.ft. The writer was enthusiastic over the success of the experiment in widening and resurfacing when he visited the road in 1917. Another survey made last month showed that but very few cracks had developed in the three years, and those were negligible, showing neither spalling nor wear. This road has heavy traffic. A 14-hr. traffic count in 1920, taken as an average from seven consecutive days, showed 2,558 vehicles, of which 486 were motor trucks.

Truck Registration in the United States

According to reports of secretaries of state and estimates made by statisticians of the D. F. Goodrich Rubber Co., there were 953,093 motor trucks in operation in the United States at the end of 1919, says a recent issue of the official magazine of the Motor Truck Association of America. The 1919 figure represents an increase of 37 per cent over the estimate of 700,000 trucks in operation at the end of 1918. Ne exact figures are possible inasmuch as only 18 states of the 48 keep separate registration lists for motor trucks.

The following is the estimate of the Goodrich Co. by states: Alabama, 10,249; Arizona, 3,200; Arkansas, 5,600; California, 58,700; Colorado, 13,500; Connecticut, 19,799; Delaware, 2,100; Florida, 3,239; Georgia, 9,300; Idaho, 5,600; Illinois, 65,000; Indina, 36,000; Iowa, 42,500; Kansas, 27,800; Kentucky, 9,105; Louisiana, 7,100; Maine, 5,792; Maryland, 10,160; Massachusetts, 42,000; Michigan, 36,863; Minnesota, 34,300; Mississippi, 6,350; Missouri, 25,000; Montana, 1,000; Nebraska, 27,300; Nevada, 700; New Hampshire, 3,902; New Jersey, 20,000; New Mexico, 2,810; New York, 94,716; North Carolina, 9,150; North Dakota, 1,314; Ohio, 64,500; Oklahoma, 20,100; Oregon, 11,300; Pennsylvania, 64,200; Rhode Island, 7,000; South Carolina, 9,600; South Dakota, 14,205; Tennessee, 12,000; Texas, 42,250; Utah, 5,300; Vermont, 2,402; Virginia, 11,800; Washington, 23,600; West Virginia, 6,700; Wisconsin, 10,887; Wyoming, 2,900.

Functions of Rapid Transit Lines in Cities

Capabilities of Each Transportation Agency Outlined—Effect of Geographical Distribution on Transportation Conditions

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(Reprinted from the *Electric Railway Journal*)

THE average visitor and most residents if asked how the people habitually travel about New York City will answer, "The vast majority on the subway and elevated lines, a smaller proporton on surface cars and a few on buses." This popular conception of the situation is largely due to constant newspaper discussion of subway congestion and the vivid impression made by long crowded trains following one another in quick succession at subway and elevated stations during rush hours.

Studying the statistics over a period of years, we find, on the contrary, that the surface car has borne the great burden of transporting the bulk of the citizens of our large American cities and that only in the past few years has even New York carried one-half of the total daily passengers on its rapid transit systems. This division of the growing New York travel during the past forty years is interesting, particularly as related to the population of the city. Other cities in the United States are now approximating the size that New York was thirty or forty years ago and, growing rapidly, they have ahead of them the probability of the same or similar traction problems.

In 1880 we find that 79 per cent of the passengers on the transportation lines of what we now call Greater New York were carried by surface cars, the population then served comprising about 2,000,000 people.

In 1900, twenty years later, the ratio was still 70 per cent surface car passengers to 30 per cent carried on rapid transit lines, while the population served had grown to about 3,500,000.

Almost another score of years brings us to 1919, when, after the expenditure during this latter period of more than $550,000,000 for subways, third tracking and extending elevated lines and additional rapid transit equipment, we find 43 per cent of the passengers still paying their nickels for rides on surface cars. This condition is not peculiar to New York, as we shall see by a study of the history of transportation in other large cities.

In Chicago in 1906, with a population of about 2,000,000, 75 per cent of the revenue passengers were carried by the surface cars, and in 1919, with the population increased to about 2,800,000, 75 per cent of the people are still patrons of surface car lines.

In Philadelphia the Market St. elevated-subway line, with its free transfers between rapid transit trains and surface cars, makes a good showing in passengers carried per car-mile, but as part of the entire city lines it carries not more than 10 per cent of the passengers served by the whole system.

In Boston the surface-subway-elevated lines are so interconnected and the movement of passengers is so complicated by transfer privileges that a division is difficult. However, the proportion of the passengers actually handled here by surface cars is still large.

Turning to England, where the conditions of city development have been quite different, we see in London an even wider variety in the division of the passengers among the different classes of carriers, but still the rapid transit not in the majority. Here the motor bus (successor to the time-honored horsedrawn vehicle) assumes imposing proportions. The ration of passengers carried may be taken as about 27 per cent on tram or surface cars, 33 per cent on motor buses and 40 per cent on rapid transit trains.

WHERE ELEVATED, SUBWAY AND SURFACE LINES CROSS, 66TH STREET AND BROADWAY, NEW YORK

Greater London, with an area of almost 700 sq. miles and a population of about 7,250,000, carries one-third of its traveling public about the city in motor buses operated in crowded, heavily trafficked streets.

Greater New York at the other extreme, with a population of almost 6,000,000, distributed over about 327 sq. miles, or one-half London's area, carries 55 per cent of its city riders on rapid transit lines and not more than 2 per cent on buses.

Chicago, with a population of almost 3,000,000 and an area of about 200 sq. miles, carries 75 per cent of its travelers by surface cars, while Detroit and Cleveland, now at the 1,000,000 mark in popluation, are entirely dependent upon surface car transportation.

With such contradictory general facts before us we must apparently go to a more detailed analysis of conditions to draw any valuable lesson from past experience in the large cities of the world. In doing this the first question that presents itself is whether the study of existing systems will be of fundamental value in guiding us to a solution of modern transportation needs, in a large city in accord with present-day thought.

Here appears to be the crux of the question. The existing transportation facilities in large cities are the result of private initiative, building for years along lines where greatest pecuniary profits were to be reaped. Only recently has this guiding motive been supplanted by effective public control, and this has often been directed to meet certain specific needs rather than a general solving of the whole problem.

We are today at a point where a broader view must be taken of city transportation planning in the interest of the traveling public's needs and convenience. The public must pay for the service directly or indirectly, but it must get what it pays for. The idea of the most profitable type or location of lines is, therefore, no longer absolutely controlling and we are face to face with the problem of supplying transportation to our large cities as a recognized public necessity like water supply, paving and sewerage. The fact that an adequate circulatory system for a city's red-blooded working units is as necessary for civic growth and health as is a sound arterial system for the human body is becoming more generally recognized. In the solving of this problem city and company must co-operate to overcome successfully the physical, financial and legal obstacles that will be met.

The time has come when a hearing can be obtained for an analysis and discussion of the complex elements of transportation from the viewpoint of the needs of the city as a whole. The purpose of this article is to point out the uses of subway and elevated lines with such a broad view of the situation in mind, but in doing so reference to other forms of city transit are necessary to maintain a balance and completeness in the picture.

Analysis of City Travel

The real need for extensive transportation facilities in a large growing American city arises principally from the desirability, or often the necessity, for the individual workers to live beyond walking distance from their place of employment. By the term "worker" is meant any wage earner or person having regular employment or business and consequently regular habits of travel. The hauling of these people to and from their work constitutes the great bulk of the rush-hour traffic, hence a careful study of their riding habits is a valuable index to their transportation needs.

A canvass of the principal factories of the city of Cleveland showed that 52 per cent of their employees lived beyond the walking distance of 1 mile from their shops. Detroit showed 71.8 per cent, and a canvass in Chicago, locating the homes of 350,082 wage earners from all classes of shops, factories, retail stores and office buildings, showed 75.6 per cent living beyond 1 mile and therefore dependent upon transportation to earn their living.

An exhaustive detail study of the transportation habits of the people of a large city involves a great amount of work and the co-operation of many interests and has not often been undertaken. The most recent complete collection of data of this kind in contained in the report of the Chicago Traction and Subway Commission of 1916 and the figures there developed will here be used as illustrating the basis of the division of riders between surface and rapid transit lines and the causes influencing their choice of routes.

An analysis of the Chicago residential canvass, which covered all employment centers within the city area, showed a wide scattering of nearly all classes of workers over the many residential districts of the city. Thus it was possible to prove the almost universal need for transportation and also the great diversity of routes and combinations of car lines used by a people in a single residence district in reaching employment centers, and, vice versa, the widely separated localities from which the factories drew their workers.

The American wage-earning family averages five persons, father, mother and three children, of whom three are usually workers. Unlike families in England or on the Continent, the children in America do not as a matter of course learn the trade of the parents, but each follows his own bent, with the result that they travel from their home center in many different directions seeking employment. It is the aggregation of many thousands of such families which creates the diversity in the transportation demands of our large cities.

The Chicago residential canvass when compared with simultaneous traffic count on surface and rapid transit lines showed that the origin and destination of daily trips of 50 per cent of the individuals composing the rush-hour crowds had been determined. As an indication of the probable proportion of these rush-hour travelers who require rapid transit, a charting by ½-mile districts showed that 44.3 per cent made trips to and from work of more than 3 miles and 31.6 per cent of more than 4 miles. The rapid transit lines of the city carried 22 per cent of the total traffic against 78 per cent on the surface cars on the week-days checked, while for the calendar year the ratio was 25 per cent to 75 per cent.

Adopting the generally accepted idea that more than 3 miles constitutes a legitimate rapid transit ride, the inference is that the elevated lines were inadequate or some other elements influenced the result beyond the mere question of distance. It was found that the principal element was "time," and its closely related factor "direct routing." By means of transfers from line to line the surface system offered routes, particularly cross-town, which saved time over less direct although higher speed rapid transit lines.

To determine the time factor the Chicago Loop Dis-

trict was selected and 115,085 workers of all classes employed in this crowded city center were located as to residence, the data being shown on a chart on which each black square indicated by its size the relative number of workers residing in that ¼-mile area who were emplcyed in the Loop District. These, for our purpose, can be classified as indicated in Table 1.

TABLE I—OCCUPATIONAL DISTRIBUTION OF WORKERS IN CHICAGO LOOP DISTRICT

Occupation	
In office buildings	32,113
Department and Retail stores	32,755
Clothing manufacturers	10,045
Banks and general offices	26,622
Printers and engravers	3,304
Miscellaneous	4,378
Wholesale dry goods	5,868
Total	115,085

Transportation Used		Per Cent
Elevated Railroads	64,847	56
Surface cars	43,344	38
Steam suburban	3,921	3.4
Walkers	2,973	2.6
Total	115,085	100

Analyzed by distances from home to work, the division was as shown in Table 2.

TABLE II—CLASSIFICATION CHICAGO LOOP WORKERS BY DISTANCE TRAVELED

	Total	0–1 Miles, Per Cent	1–2 Miles, Per Cent	2–3 Miles, Per Cent	3–4 Miles, Per Cent	4–5 Miles, Per Cent	5–6 Miles, Per Cent	6–7 Miles, Per Cent	7–8 Miles, Per Cent	[illegible] Miles, Per Cent	[illegible] Miles, Per Cent	[illegible] Miles, Per Cent
	115,085	3.7	11.0	11.4	15.6	15.7	12.9	10.5	7.6	4.2	1.7	[illegible]
Accumulative total, per cent	.....	3.7	14.7	26.1	41.7	57.4	70.3	80.8	88.4	[illegible]	[illegible]	100

Deducting the walkers (2.6 per cent) in the last tabulation, it is seen that 39.1 per cent rode 4 miles cr less, which closely matches the surface car percentage shown above.

The analysis of this office and retail district canvass gave a good idea of the division of riding of the classes most easily attracted to rapid transit by reasons of ability to live in restricted residence districts and working short hours. A similar analysis of the immediately adjacent factory district west of the river including 31,670 workers, showed 16.7 per cent walkers, while 53.6 per cent lived within the 3-mile limit and 69.8 per cent within 4 miles of their shops, 83.3 per cent in this factory district being dependent on transportation.

The difference in these two sections lay almost entirely in the character of the people employed. The average for the whole city was: Walkers (under 1 mile), 24.4 per cent; those living within 3 miles from work, 55.7 per cent; within 4 miles, 68.4 per cent; the per cent of workers daily using transportation being 75.6 per cent. When rapid transit routes are laid out, therefore, the character of the population to be served is an important element to be considered.

A special inquiry into time-saving covering 6,000 of the above workers in the Loop District supplied the data for the curve, pg. 1238. The individuals inquired of for this purpose were selected because they were as conveniently located for reaching either surface or rapid transit lines. They were also distributed over a wide area and at varying distances up to 16 miles from the Loop. This chart therefore gives a good idea of how people of this class divide on the question of time saving in a city like Chicago, other conditions being substanially equal.

When the original Interborough subway was laid out many loud criticisms were made of the local and express transfer stations, voicing the idea that on short trips people would not trouble to change cars. Today exchanging from local to express trains and back again for a saving of even a couple of minutes is so common as to have become almost a vice of the New Yorker.

On one surface car line in Detroit a traffic count showed that 85 per cent of the passengers either transferred to or from other lines, only 15 per cent of those carried starting and ending their journey on the line itself. At the City Hall in Detroit the Woodward Ave. line received or delivered 57,817 transfer passengers daily who utilized ninety-two different combinations of routes at this point. A similar condition exists at the Public Square in Cleveland, where 79,451 transfers were observed in twenty-four hours, more than 100 different combinations of lines being used.

The Chicago investigation showed clearly that the transfer privilege at more than 545 intersections of surface lines was a great factor in determining the routing of passengers; from 10,000 to even 25,000 transfers occurred daily at single intersections. Many groups of large numbers each were found who took the first leg of their journey on a nearby surface line and transferred to another surface car, running parallel to a rapid transit line, for a 4, 5 or 6-mile ride.

Careful study of complete 24-hour checks of passengers on the surface and elevated lines of Chicago clearly demonstrated that these two large competitive systems serving a population of more than 2,500,000 distributed over 200 miles of territory, due to their lack of co-ordination, did not function in such a way as to give the best service of which they were capable.

When the problem of enlarging the Chicago city transportation system as a whole was attacked by the commission it became still more apparent that additions to the existing systems on a basis of unified operation not only gave mcre capacity for a given expenditure but provided a greater variety of convenient routes to riders and would also prove to be more economical to operate.

Transportation is a necessary function of a city's life as a whole. It is not confined to districts, classes of people or cccupations. It is as democratic and cosmopolitan as the population of the city itself. Such being true, a division into separate lines serving only portions of the city is purely artificial, and the result of a system of development of these facilities by individuals largely influenced by hope of profit and with capital limited by the assurance of a return on their investment has been piecemeal construction.

When taken up from the viewpoint of the interests of the entire city's traveling population the proper arrangement to accomplish a complete solution is a single unified system the elements of which will each give the maximum of service at the least cost, both capital and operating. It is not within the scope of this article to discuss the many legal, financial and other obstacles to accomplish a general unification of all transit facilities. However, the function of subway and elevated lines is so dependent upon their relation to the other modes of transporting city passengers that whether they should properly be considered as competitive independent systems or should function as part of a harmonious whole seems to warrant the foregoing discussions.

In order to consider the realtive value of these four kinds of service in a complete unified city system it is simpler to compare ratios of cost or performance freed from local conditions. Present cost of construction, operating expenses, etc., are so abnormal and are changing so frequently even on the same system that direct comparisons are misleading without a multitude of explanations. For our purpose the following general statistics are typical of good American practice on average large city systems:

Maximum Passenger-Carrying Capacity per Hour.—One way, one track: Bus, 1; surface, 1.7; elevated, 6; subway, 7. This means that large two-car units on surface lines will carry a little less than twice the bus line under similar street conditions. The elevated with eight-car trains will supply six times and a subway with ten-car trains seven times the bus line passenger capacity. This is on the basis of allowing for standees, large cars and maximum peak load conditions.

Speed in Miles per Hour.—Average city conditions (Fifth Avenue Coach Company, 8½ miles per hour): Bus, 1; surface, 1; elevated, 2; subway, 2. The surface cars and buses are about equal in average speed and the elevated and subway twice as fast.

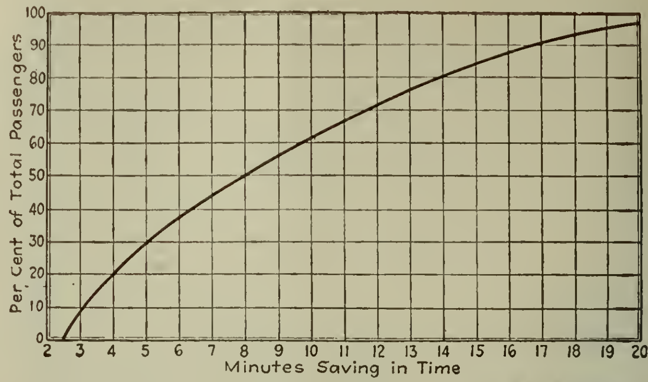
From these two items it is plain that where large crowds are to be handled and the haul is long the subway and elevated are immensely superior, having seven times the capacity of a bus line and twice the speed. As the presence of large passenger crowds means usually street congestion, these types have the additional advantage therfore of not occupying street space.

Cost of Operation per Car-Mile.—(Fixed charges excluded.) Subway, 1; elevated, 1.2; surface, 1.8; bus, 2. Here the economy of train operation with infrequent stops and on an easily maintained unobstructed right of way places the subway at the top of the list.

Operating Cost per Passenger Carried, 1919 figures —(Fixed charges excluded.) Subway, 1; elevated, 1.2; surface, 1.4; bus, 2.6. This proportion is taken from averages of the actual 1919 figures of American systems so far as they can be brought into direct comparison. In these figures there is of course reflected the length of haul, in which regard the rapid transit lines have the worst of the bargain as they carry their passengers probably twice as far as the surface and three or four times as far as the bus lines.

Capital per Mile of Line.—Bus, 1; surface, 2; elevated, 12; subway, 36. Here the bus line makes the best showing, with the surface line at double the cost and the subway three times that of the elevated.

On the face of these figures the subway costs thirty-six times as much as the bus lines and has only seven times the passenger capacity. If, however, the two are compared by requiring the buses to move the subway load, seven lines of buses would be required and a total street width of 230 ft., or four times the width of Fifth Ave. at 42nd. St., If this widening were charged against the bus system the cost would be fabulous. Similarly, if a subway were built to carry a load of 7,000 passengers per hour, one train every ten minutes would carry them and the fare would have to be ridiculously high to cover the enormous fixed charges. The fact is that such direct comparisons are futile and go to prove that each of these systems has a limited field of its own. Each type should be used for the service to which it is peculiarly adapted and if properly incorporated as part of a single system will reach its maximum effectiveness and efficiency.



USE OF RAPID TRANSIT FOR SAVING TIME WHEN SURFACE LINES ALSO ARE AVAILABLE

In view of these comparisons, it is quite apparent that subways should be confined to the main arteries of the city system and so far as possible to the densely trafficked districts. As the elevated form of structure supplies the same passenger capacity and speed as the subway the logical plan in the interests of economy is to come to the surface with the subway and extend the service by elevated wherever the building and property damage is not too great. Much talk was indulged in a few years ago advocating the taking down of the elevated railroads in New York, but today with the express service on the third tracks no one could conceive of abolishing this system and replacing it with subways at three times the cost.

When people speak of subways they visualize the New York ten-car train system in rush hours and when they mention elevated lines they think of the old Ninth Avenue, New York, or the Chicago Union Loop Lines with their unsightly appearance and noise.

It is a pity that this latter conception cannot be supplemented with more up-to-date possibilities. In a city like New York, with its multiplicity of traction companies, its narrow and infrequent north and south streets and its unprecedented volume of rush-hour traffic, four-track subways paralleling one another may be justified, but in other cities whose rapid transit history is still to be written quite another procedure is not only possible but necessary.

Subways as such have no inherent virtue. They are, as we have seen, three tims as costly to build as elevated lines and eighten times as costly as surface lines. Why then should we not take the surface line, which usually exists and which the subway will parallel, and leaving it on the surface of the street as a local service transfer vertically to the subway express service below.

Consolidation of Various Systems Desirable

By utilizing the surface lines as local and feeder lines and transferring long-haul passengers down to subway or up to elevated express trains a vast saving can be shown over the building of a competing rapid transit system. This latter, if competitive, must draw its patrons from the limited territory immediately adjacent to its own lines. This lack of transfer surface feeders is one of the causes of the beehive type of apartment housing in New York.

In a radial city like Chicago or Detroit the building of rapid transit lines to all outlying sections is financially impossible. The intermediate areas between trunk

lines will be well served by surface lines with transfers to these rapid transit lines.

Such a single system, it can be shown, will give greater facilities than two competing systems and at a far lower cost per capita.

The consolidation of city systems has been frowned upon by some people because it creates a monopoly, but with proper public control this is just the very element necessary for success in giving all classes of people the vast multiplicity of services called for by the activities of a big city.

The dismemberment of some of the consolidated New York Traction groups is an object lesson pointing the way in the opposite direction. Subways and elevated lines are necessary parts of the traction system of a great city, but they should have combined with them surface and bus lines as feeders, all functioning as part of a single system.

Military vs. Civil Control of Construction in War Time

An Army officer's objections to the conclusions of the civilian Board of Review, appointed by the Assistant Secretary of War to investigate the work of the Construction Division.

By Major C. L. Hall
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YOUR issue of Sept. 23, p. 590, contains an abstract of the report of the Board of Review appointed by the Assistant Secretary of War to consider the work done by the Construction Division during the late war. The writer was in France during the entire war and is, therefore, unable to comment upon the parts of the report dealing with the specific performances of the Construction Division, and with the recommendations of the board in regard to improvements in the form of contracts. The report contains, however, certain statements of opinion in regard to some phases of Government construction, which are, to say the least, arguable.

The statement is made that under peace conditions, and, to a large extent under war conditions also, nearly all construction and the engineering incident thereto is of a civil character. It is true that the construction of barracks and quarters in time of peace does not differ essentially from the ordinary building operations of civil life, but the total amount of such army construction is small, it involves no peculiar difficulty and its execution, so far as the writer knows, has been satisfactory. It is certainly true that if differences between the constructing personnel and the organizations which have to use the buildings when constructed were of an extra-departmental rather than an intra-departmental character, and hence required the ruling of the President on each specific case, the net waste in friction would far out-balance any theoretical advantages due to greater specialized experience of civil engineers.

The statement made by the board, that construction and the engineering incident thereto in time of war are of a civil character, is entirely contrary to fact. While its instructions limited this board to a consideration of the work done in the United States, and while it, therefore, apparently gave no thought and certainly made no mention of the work done in France, it is a fact that this latter work, which exceeded the amount done in this country, involved construction and engineering all of a military character. In France, no line was drawn between the quasi-civil and purely military construction, and an attempt to do so would merely have resulted in disorganization and confusion.

The whole reasoning and all the recommendations of this Board of Review are evidently based upon the assumption that in all future wars the actual fighting will be far beyond the continental limits of the United States and the conditions which will prevail will be similar to those which existed during the World War. No greater fallacy could ever be perpetrated and no reasoning based upon such a fallacy is worthy of a moment's consideration. All of our peacetime organization must be planned so that it will, so far as is humanly possible, meet any conditions which may arise. As nearly as can be now foreseen, the probability that our next war will be fought on this continent is at least as great as that the actual fighting will be done beyond our own continental boundaries. In any war on this continent the theater of operations will much more nearly resemble the situation in France, the gradation from semi-permanent work at the extreme rear to dug-outs at the front will be very gradual. Again, the conditions under which construction in war-time is done are essentially different from those in time of peace and it is very doubtful whether the experience gained in civil life can be as advantageous to the government as that gained by army officers who are accustomed to thinking of, and dealing with, war-time matters.

This board states that time does not permit a thorough and varied training in practical commercial work in the education of army engineer officers, and reasons that, therefore, they will be outclassed by civilian engineers in most construction work. This is entirely gratuitous, pure inference, and, so far as the writer knows, is unsupported by facts. The army engineer can point to many structures erected by him which it is believed will compare favorably with any similar work done by civilian engineers.

The board also recommends that, so far as practicable, the directing and executive engineers on all government construction work should be drawn from civil life. This is further evidence that it has again limited its study to a single special case rather than to the broader view which would embrace other contingencies. Most certainly all construction work in the theater of operations must be placed under the Chief Army Engineer. It cannot be done otherwise. Materials of construction are scarce and the allocation of them between the front line and the rear elements of the theater of operations is one of the principal duties of the military authorities and a duty which men without military training are utterly unqualified to perform.

The Board of Review argues that if the organization handling construction work were directed by the War Department it would be disrupted in war by the transfer of its personnel to military work. It may be pointed out once more that all of this construction work during war is essentially military work. Certain work of a civil nature, such as the river and harbor work of the Corps of Engineers, was not disrupted by the late war. Transfer of the personnel of many of the civil bureaus into the military service is to be expected in war-time as a matter of course.

The Board of Review then proceeds to advance a recommendation which is practically an argument for

the formation of a Department of Public Works. This is entirely by the way and has no place in a discussion of the advisability of having essentially military construction work done by a civilian bureau. The organization which the board recommends for a construction bureau is practically identical with that of the Office of the Chief of Engineers, U. S. Army, at the present time. Further comment seems superfluous.

The board argues delightfully that the War Department is an organization normally inert, which cannot expand to the full proportions necessary for meeting all army needs in a war emergency. According to proper military thought the War Department is organized to assure the efficient expansion of a small peace army into a large army in war. It must be organized on principles which permit of such expansion. If a War Department composed of trained military minds is not better fitted to control and supervise our expansion to a war basis than civilians having no military point of view, then we had better disband the army entirely.

The creation by expansion of a construction bureau is an utterly insignificant task compared with the creation by expansion of a field army. As a matter of fact, of all the departments of the government the War Department is by far the best fitted to handle emergency work in war-time, and, moreover, is the only one (except the Navy Department) whose personnel is habitually trained to study the subject and which is in readiness to bring about the proper, well balanced and immensely larger war-time organization.

The Board of Review states with some gusto that the results in war construction were accomplished largely by freeing experienced constructors from control by army officers. Once more it is dealing with a special case in the United States. Its conclusions certainly do not apply to the work done in France. There, one of the principal faults found with the untrained civilians was that when anyone of them was given anything resembling a free hand, he proceeded with his own work and sought to obtain all the material it required, with an utter disregard for the necessities of other departments or even of the front line. Furthermore, the work was largely successful in proportion to the degree of comprehension of military conditions by its directing heads. It is again emphasized that construction during any war on this continent will distinctly resemble the work done by the American Expeditionary Force in France.

It is believed to be very unfortunate that the writers of this report seem to have known nothing of the work done in France. Had they possessed this knowledge they would have known, first, that construction within the theater of operations is essentially a military problem, regardless of the precise nature of the work; second, that the theater of operations on land extends from the most remote base ports clear up to the front-line trenches; third, that however successful the Construction Division may have been in the late war, there is absolutely no evidence, judging from the work of the Engineers in France, that the work would not have been as well done if carried on under the direction of the Chief of Engineers, U. S. Army.

Attention is invited to the fact that these conclusions, upon military matters of the utmost importance, were arrived at without consultation with the General Staff or the Chief of Engineers; and without discussion (so far as known) with any military men except those whose activities were being investigated. Under such circumstances the recommendations of the board should have no weight either with the engineering profession or the American people.

Wide Streets and Roads Recommended By British Engineer

In discussing the planning and development of traffic facilities for towns and outlying districts, J. A. Brodie made several recommendations in his inaugural address as president of the British Institution of Civil Engineers, which are reprinted below from a recent issue of the *Surveyor*:

Many of our roads are too narrow to permit of motor vehicles passing bulky loads which are so prominent a feature in many country roads. When the more permanent road materials are being laid, it is also a great advantage to be able to construct one portion of the carriage-way while the remainder is used for the passing of ordinary traffic. It is probable, therefore, that no width of carriage-way less than 30 ft. will meet the requirements where any considerable amount of traffic is to be expected, and carriage-ways 36 ft. in width, with ample margins and separate foot paths, should in many cases be provided.

The time has probably arrived when the erection of any house or building immediately abutting the side of any main road should be prohibited by law. The question of how far buildings should be kept back is important, but, bearing in mind dust and noise, and the danger to children and domestic animals from passing traffic, the adoption of a universal building line for new erections not less than 60 ft. from the center line of the main road is to be strongly recommended. The land lying between the house and the road need not, in most cases, be added to the road, but when the house is built to the new line, such land might be made use of as gardens; alternatively, the land could be utilized for ordinary agricultural purposes until required by traffic.

When dealing with roads outside built-up areas some consideration should be given to the necessity for the construction of new trunk roads in this country, and there can, I think, be little doubt that a limited number of such roads should be laid out wherever the amount of traffic is likely to warrant their construction.

The surfaces should be capable of taking all the various types of land traffic at present in use, and it would appear that one double-track railway for goods, and also a double track for an electric passenger and goods service should be provided. At least a double track for heavy motor wagons in each direction would be required on such a route, as is shown by the large amount of traffic of this description which is at present making use of the main roads at certain times of the day, and a double track in each direction should be provided for light vehicles. The foregoing provisions would necessitate a width of at least 150 ft., and, as ample width for future requirements should be provided, it is probable that 180 ft. in width between fences would be looked upon as reasonable. The ordinary cost might, under existing conditions, amount to about $200,000 per mile.

With regard to surfaces for roads throughout the country, cases will no doubt arise where the amount of heavy traffic is so great that paved surfaces will have to be adopted The lighter surfaces provided by the different types of asphalt, tar-macadam, and pitch-macadam, appear to be more generally favored for ordinary traffic in this country.

A few lengths of road have been laid in England of the American type of concrete road surface, in which the wear is being taken by the concrete direct. The feeling among English engineers appears to be in favor of surfacing concrete roads with a slight coat of tar, pitch, or asphalt mixture, in the nature of a carpet.

Constructive Criticism of New York's Port Problem

Discussion of Control, Operation, Extensions and Improvements Before Local Section of Am. Soc. C. E Brings Out Recommendations for Bettering Conditions Generally Conceded Bad

CONSTRUCTIVE criticism of New York's port problem, based on broad and diversified aspects, was brought out at the meeting of the New York Section of the American Society of Civil Engineers, Dec. 15, which considered the subject, "The Port of New York." It was almost unanimously conceded that present conditions are bad and there was general agreement for the need of creating a port authority. The meeting was opened by Colonel W. J. Wilgus, president of the section, who broadly outlined the major subjects requiring consideration and the principal paper was presented by B. F. Cresson, Jr., chief engineer, New York-New Jersey Port and Harbor Development Commission. Mr. Cresson's paper was followed with discussion by ten engineers and port authorities and the reading of four communications, during which a debate took place between Murray Hulburt, commissioner of docks, New York City, and Julius Henry Cohen, counsel of the joint harbor commission, on the effect of the proposed port treaty between the two states.

An abstract of Mr. Cresson's paper and the discussion follows:

An Analysis of New York's Port Problem

By B. F. Cresson, Jr.
Chief Engineer, New York-New Jersey Port and Harbor Development Commission

PLANS FOR belt line railroads, terminal markets, the West Side Manhattan railroad problem, interconnection of rail lines over or under harbor waters have all been proposed, but little has been accomplished in respect to a general plan for the reorganization of the port of New York because of lack of administrative control and of exact knowledge of the problem. The solution should begin in the administration of the district. The problem is not local, since half the foreign commerce of the United States passes through the port. Neither New York nor New Jersey can work out the best plan by itself, and unless worked out jointly, the Federal government may step in, which would not bring a satisfactory solution due to jealousies of other ports.

The business of the port is so great and the problem so involved and so complex that no reorganization plan can be effected without knowledge of all of the factors, which include studies of the geography of the port, and adjacent populations; administration, political and legal considerations; previous history of individual endeavor; ocean shipping; port machinery; warehousing; trucking; layout of the port and railroad connections; lighterage; marketing of foodstuffs; barge canal terminals; ferries, and the study and planning of the port as a whole.

When the date for this discussion was fixed it was thought that the report of the joint commission would be before the public, but rather than postpone this paper it was thought wise at this time to lay before the Society a general statement of the fundamentals of the New York port problem, which is unique since the territory lies within two states with a total population of some 8,000,000 people—5,900,000 in New York, and 2,100,000 in New Jersey. The government of the waterfront of New York City is under the dock commissioner, the Board of Estimate and Apportionment, and the Commissioners of the Sinking Fund of the city. In New Jersey port jurisdiction is divided between perhaps forty municipalities. For lack of a central port authority, development has been along lines of individual endeavor, including the development of ocean-shipping terminals, railroad connections, lighterage, trucking and warehousing although some terminal companies have operated jointly, demonstrating the possibilities of economy thus possible.

Layout of the Port—Railroads and Shipping

In the main the principal railroads reach the port on the New Jersey side and rates cover delivery in New York City within the lighterage limits, the rails of only one freight carrier entering Manhattan by direct connection. But the principal shipping facilities are on Manhattan. New Jersey's frontage is mostly devoted to railroad and industrial occupation, while New York's is largely commercial. The new Staten Island piers and the projected Cunard terminal at Weehawken will be a great addition to present shipping facilities.

Development industrially of Queens and the Bronx has lagged for lack of convenient connection with the principal railroads since these reach the port from the west, with yards located immediately back of the New Jersey waterfront for the break-up and transfer to car floats or lighters. The cost and delays of such operations have been regarded as very great, but at the present time are unknown for lack of uniformity in accounting systems and methods by the various railroads. To arrive at a figure representing average cost per car and per ton for New York terminal service is an exceedingly laborious operation due to the complexity of the problem.

It has been proposed to bring cars from the West across the North River by bridge or tunnel to join the New York Central. Such a project must be thoroughly analyzed with respect to cost, return, amortization and public advantages. In addition, the problem of better railroad connections with other boroughs than Manhattan must be considered. New Jersey now has too much railroad waterfront occupation, necessary by reason of individual operation and accommodation for lighterage and car floating, and relief would be of the greatest value in Jersey communities to permit the development of the water front for shipping terminals. The advantages of the bridge plan must be weighed as an economic problem and other plans must be analyzed, such as the halting of cars in New Jersey and the movement of freight to and from Manhattan by motor truck, by special equipment or by a joint water service.

For a study of the shipping problem the volume and character of the business must be determined from the Custom House, the War Department, the Department of Commerce, etc. It is possible to assume that New York's shipping may be bettered by zoning. The character of the principal commodities handled must be determined in developing freight-handling machinery and the design of piers and warehouses in general. Lighterage must be considered due to the large volume of business so handled. It must be determined whether piers are used too intensively as warehouses, rather than transit sheds. The general method of handling cargo freight is burtoning, and there is little doubt that additional machinery within the piers is needed as well as cranes.

Marketing and Trucking

Bound up tightly with the railroad problem is the marketing situation and the handling of highly perishable commodities for the 5,900,000 New York population, requiring a plan fairly considering the interests of producer and shipper with quickest delivery and minimum expense to consumer. The study involves determination of volume and character of commodities, method of shipments, where they originate and the process by which they finally reach the consumer. It has been the general opinion that great sums are lost through delays to trucks caused by congestion and inability to deliver and discharge freight promptly, and a careful analysis of the entire situation is necessary. With

the development of the motor truck it is possible to relieve the railroads of a considerable amount of short-haul business. New York's trucking problem, not only within Manhattan, but also in outlying boroughs and in New Jersey communities must be studied. With such facts indicating the extent of possible relief or congestion in railroad and steamship terminals it will be possible to lay out a more uniform system of truck operation that will save money and time to producers, carriers and the public.

In New York there is a deficiency of warehousing and storage accommodations, since the problem has not been considered a part of the transportation problem but rather as a separate business, so that waterfront terminals are limited in operation by lack of readily accessible storage space, resulting in slow turn-around of ships and holding of railroad cars for purposes of storage. The problem is a very important one, and by proper solution deliveries can be speeded up and demurrage of ships and cars reduced. A thorough canvass of location, capacities, facilities, etc., must be made to provide additional and more accessible warehousing.

There is the possibility of greater efficiency in the use of lighterage equipment by consolidation and unification of operation in the movement annually of about 60,000,000 tons by this method. Other subjects which must be studied are barge canal terminals; canals and waterways; private terminals; stevedoring operations; tariffs, charges and rates; ferries; handling of fuel, grain and building materials; channels and dredging; banking and commercial operations, and electric power supply. But these do not complete the list of subjects.

Planning the Port as a Whole

Not until suit had been brought before the Interstate Commerce Commission, which if granted would involve a differential railroad rate within the port itself, did commercial interests awake to the momentous situation and as a result the Governors and Legislatures of the two states created and financed a commission to study the port problem as a whole without respect to political boundary lines. After a preliminary study a report was made to the legislatures declaring that two years and an expenditure of $400,000 would be required to complete the work. The commissioners realized that no plan involving changes in operating conditions and large expenditures of money can be put into effect unless based upon economic proof of financial and operating soundness. It has been sought by analysis to determine the actual facts of the case.

The proposed treaty between the two states already recommended by the joint commission will adequately protect the municipalities in the investments and facilities already made and created, and there is to be no pledging of public credits for development but merely the creation of a central body with sufficient authority and power to encourage private or public initiative to construct modern terminals as part of an organic whole.

Discussion of the Problem

IN OPENING the meeting Colonel Wilgus expressed the hope that those to take part in the discussion would not hesitate to advance views that would be helpful in later discussing the solution that the joint commission is expected to propose in the forthcoming report and that the major points for consideration were: (1) channels and slips; (2) the effect of the railroad and seaboard rate structure on more efficient freight interchange; (3) pier dimensions, general design and equipment; (4) handling machinery; (5) liaison between piers and shore facilities; (6) co-ordination and unified management of the railroads of the port in conjunction with a belt line, and, (7) more effective means of local distribution and collection of freight. Colonel Wilgus emphasized the experience of the war as demonstrating so clearly the wisdom of proper port planning.

The secretary read two communications from Pacific Coast port engineers—G. F. Nicholson, chief engineer, Port of Seattle, and G. B. Hegardt, engineer, Commission of Public Docks. Portland. Mr. Nicholson telegraphed that the ideal administration for the Port of New York would be a commission of seven members including representatives of shipping and railroad interests and terminal engineers, appointed for life by the Governors of the two states or by the Federal government. Publicly owned terminals should be publicly operated. A 40-ft. channel depth is sufficient for efficient operation, but engineers should design pier and dock facilities to permit a 50-ft. depth at a future date. Piers should be wide enough to accommodate two shipside tracks on either side and two storage sheds at least 120 ft. wide on either side with four depressed tracks in the center. When supporting long warehouses and grain elevators are needed, they should be just to the rear of the transit shed in the quay development, and in the pier development the latter should be widened to 550 ft. and warehouses placed between the sheds. All terminal trackage on the harbor side of the classification yards should be under control and operation of a harbor commission.

Another Pacific Coast Opinion

Mr. Hegardt, in his telegram, stated that the following points for a satisfactory solution of New York's problem should be considered: (1) Satisfactory channels; (2) convenient connection to railroads and belt line; (3) terminal site of dimensions and trackage adequate to permit of most rapid loading and discharge; (4) piers and slips constructed with quay feature retained, and vessels berthing along only one side of pier, whether single or double, and piers to be filled where practicable and to have flush tracks at front and depressed tracks in rear; (6) one-story transit shed big enough to permit discharge without change of berth (from experience in Portland 180-ft. width has been found most practicable); (7) slip-side platform of pier 32 to 34 ft. wide for double track and gantry crane service and rear platform 12 to 14 ft.; (8) where filled piers are used, slips should be 250 to 300 ft. wide; (9) standard mechanical equipment including cargo masts, locomotive cranes in the absence of pier cranes, electric trucks, tractors, piling and stacking machines, one- to two-ton electric cranes and conveyors, for the transit shed; (10) provision for the construction of modern pier cranes; (11) sufficient space for adequate trucking and rail trackage, as well as site for switching track; (12) turning back vessels with the greatest dispatch is the objective that should be accomplished. This cannot be attained with narrow piers and inadequate trackage.

A communication from Capt. F. T. Chambers, chief engineer, Port Facilities Commission, United States Shipping Board, stated that co-ordination and unified control of the port as proposed in the treaty between the two states should be effected and that regulation of the railroads points to harbor regulation. If New York refuses to enter such an agreement New Jersey has the means to develop ocean and rail terminals. A belt railroad system should be begun without delay and the Jamaica Bay propect should be pushed. Additional storage facilities as a part of the transportation system should be established to prevent the use of cars for warehousing as at present; the Interstate Commerce Commission is likely to issue an order against the existing practice. If the public were sufficiently enlightened there would be separate terminal charges for New York, which would thus lose business.

Opinions from Philadelphia and Montreal

George S. Webster, chief engineer, Department of Public Works, Philadelphia, emphasized the necessity of wide piers and stated that he was "convinced that in a port where railways lead to the waterfront wide piers should be constructed." In Philadelphia there is no waiting of trucks at the wide piers as at the narrow piers. Particular attention should be paid proper rail and truck connection to piers to tie in waterways with other means of transportation. Mr. Webster was followed by John Meigs, consulting engineer and former director, Department of Wharves, Docks and Ferries of Philadelphia, who said that present facilities at New York are on the wrong side of the Hudson River for efficient distribution to the hinterland. New York is the most expensive port in the country and dray service is particularly costly. The present rate structure for free

delivery in New York is at the center of the problem and there is a possibility of an Interstate Commerce Commission order that will so regulate rates as to force business to New Jersey. The question must be approached with caution.

F. W. Cowie, chief engineer, Harbor Commissioners of Montreal, said that New York had two distinct problems on account of physical separation by the Hudson River, each being of essentially different character. The city should operate the New York facilities, and the nation, the New Jersey facilities. Mr. Cowie emphasized the advantages of centralized location, citing the successful development of the ports of Liverpool, Montreal, and Hamburg.

A. W. Robinson, mechanical engineer, Montreal, said that the whole question was one of prime importance to railroads and ship owners and that the problem was to build and manitain such ports and port facilities as would result in the quickest dispatch of full cargoes to and from the largest ships that are economical to operate.

E. P. Goodrich, consulting engineer, New York City, said that it hardly seemed necessary to design the entire port for very large ships since these constituted such a small portion of the whole. He defended the Port of New York with the statement that Montreal and Philadelphia shippers had been known to ship through New York, with transfer to rail and truck. It is sometimes better to pay ship demurrage than interest on expensive pier equipment and narrow piers are better for lighterage. Open tracks along pier fronts are sometimes wasteful in requiring longer trucking distance from ships to sheds. Store-door delivery in New York is possible and would be advantageous. "Think what the advantage would be," said Mr. Goodrich, "if cars could be unloaded on the Jersey Meadows into motor trucks for Manhattan."

A Railroad Viewpoint

"The port that grew up and then 'blew' up during the war" was the characterization of the present New York situation as expressed by J. J. Mantell, terminal manager, New York district, during the Federal control, and now general manager, Eastern region, Erie R.R. "If the wastefulness that exists is not checked," said Mr. Mantell, "it will bring ruin to the port." It now costs more to move freight from Hackensack into New York City than it does to haul it from Cleveland or Pittsburgh. New York terminal cost to the railroads on the west side of the Hudson River, for which they are allowed as much as 80c. per ton on some classes of freight, is estimated at $2.50 per ton not including major overhead charges. Narrow slips hamper railroad lighterage. New York should have a "rail-head port" and the principal requirements for relief are: (1) a belt line railroad and multiple storage in New Jersey; (2) development of store-door delivery; (3) double-deck bridge across the Hudson River; (4) the taking over and electrification of existing steam suburban passenger lines. "The vehicular tunnel," said Mr. Mantell, "will be overloaded a year after it is built."

A statement was read from F. W. Williams, state engineer, New York, outlining the aims for developing traffic on the New York State Barge Canal. Mr. Williams would be inclined to favor Federal control of the port, except that the necessary, immediate and vital interest would be lacking. New York State is vitally interested in the port problem because of state land holdings, and the State Barge Canal will benefit New York City more than any other locality. He emphasized the necessity of proper handling machinery at the Port of New York for canal barges. Ship, rail, barge, and truck transportation can be co-ordinated by proper machinery.

The work of the engineering staff of the joint commission was praised by J. Spencer Smith, member of the Commission and chairman of the Board of Commerce and Navigation of New Jersey. The port problem does not center on shipping but is a railroad and distribution problem. "The railroad problem must first be solved," said Mr. Smith, "but it cannot be solved by co-operation alone, since unity of action is needed." New Jersey by the action of its legislature has acted and agreed to the treaty and asks no favors, and public opinion should be so awakened as to bring about like action by New York. The rate case was brought by New Jersey only to bring the matter to a head so that New York would take action.

Murray Hulbert, commissioner of docks, New York City, said that he wished to refute the statements of some of the previous speakers as it was evident that they had given consideration only to "the theoretical side." He said that long-term leases of piers is the factor that has prevented modernization since, according to the City Charter, plans are prepared to suit the tenants and piers must be leased in advance before construction could be undertaken. He said that it was necessary "to do more than discuss the problem from a theoretical standpoint."

The Proposed Port Treaty—Pro and Con

Mr. Hulbert took exception to statements that have been made in the press in regard to the new Staten Island piers and said that engineering plans *had* been prepared. He said that ultimately there would be more space for ocean shipping on Staten Island than on Manhattan and that the Staten Island piers now under construction would determine by their operation the best future design. Commissioner Hulbert said that the Jamaica Bay development, the South Shore Flushing Bay terminal, and the terminal on the east shore of the Bronx should go forward and that the removal of the New York Central tracks on the west side of Manhattan would knit together the boroughs of the city.

Commissioner Hulbert, who is a member of the joint commission, said that the commission's proposed treaty would be fatal because it would split authority, because the votes of five out of six members of the commission would be necessary to carry. Exception to this statement was taken by Julius H. Cohen, counsel of the joint commission, who said that the proposed treaty would accomplish exactly the things Commissioner Hulbert wished to accomplish and that it was a treaty of co-operation only as the first step. "Some source of power" is needed. After a sharp debate with the commissioner on legal points at issue, involving the debt limit of the city of New York and bonds secured by city property, Mr. Cohen said that the problem must be treated as a whole, but that it would not be possible to get such unified authority as at New Orleans or Montreal. He said that the fact that engineers are taking up such problems broadly is a "splendid augury that they are coming to play their part in great public services."

Smoke Ordinance for Salt Lake City

Elimination of the smoke nuisance at Salt Lake City, Utah, which is made a particularly difficult problem by local atmospheric conditions, is the purpose of an ordinance passed by the City Commission Nov. 1. This ordinance had been prepared in connection with a report submitted by Osborn Monnett, consulting engineer, after an extended study of the situation. It provides that the City Commission shall appoint a chief smoke inspector and may appoint four deputy inspectors, an advisory committee of seven members and a board of appeals of three members. The annual salaries are not to exceed $3,000 for the chief inspector, $2,400 for the two engineer deputies, and $1,800 for the two inspectors who are not engineers. The members of the advisory committee and the board of appeals will serve two-year terms without pay.

Plans and specifications for construction and alteration of boiler plants and furnaces must be approved by the smoke inspector, fees of $2 and $5 being required for residences and business places respectively. Emission of "dense black smoke" is limited to one minute, or not more than six minutes in any one hour, and this latter only when the furnace is being cleaned or charged. The penalty is a fine of $10 to $299 for each offense.

Status of Government Inland-Waterways Experiment

General Hines Gives Particulars Regarding Mississippi-Warrior River and New York Barge Canal Routes

THE status of the U. S. Government's experiment in inland-waterway transportation, since the war, was reviewed in one of the papers at the transportation session during the annual meeting of the American Society of Mechanical Engineers, in New York, Dec. 9. The presentation was made by Frank T. Hines, late brigadier-general, U. S. A., now chief of transportation of the government's inland and coastwise waterway service.

General Hines, after outlining the wartime development, familiar to the readers of *Engineering News-Record* through repeated references in its pages, pointed out that the operation of these lines by the government had been a hard, uphill fight. In no instance until the present summer had they shown actual operating profits in any one month. Construction of the new equipment, particularly power units, had been delayed far beyond the original delivery dates, which had in turn prevented the movement of traffic with the regularity, dispatch and economy which had been hoped for.

On the service between New Orleans and St. Louis the average monthly deficits up to October, 1920, have been \$50,000. On the Warrior line these losses have been slightly less, yet averaging over \$30,000 each month. On the New York Barge Canal, however, with the delivery of the new types of power units during the present season, actual profits have for the first time been earned. For the whole year, however, taking into consideration the five months during which these boats must be tied up, the total earnings will be little more than the expenses.

The carrying of continued losses can be justified, in General Hines' opinion, only because of the benefits which may be derived by commercial interests of the country from the establishment of an efficient, co-ordinated network of transportation lines on inland waterways, capable of transporting coarser commodities at cheaper rates than can existing rail facilities. Whether this can be done is still doubtful, but many authorities believe that it is possible. Before this end may be accomplished, however, there remain to be worked out many problems which it seems can only be solved by the Federal Government. Congress, therefore, directed that these barge lines be retained and operated by the government even after the war.

Two problems in particular need to be solved, namely: The provision of terminal plants for transferring freight between car and barge, and the establishment of interchange products between land and water carriers, so that shipments may be routed by the shipper for movement part way by water and part way by rail. These problems being solved will enable the waterway to serve not merely communities located upon it, but inland communities as well.

Congress has already appropriated \$2,000,000 to be spent within the next year in building necessary terminals, particularly along the Mississippi and Warrior rivers for the handling of waterway freight. These projects once under way must, in the opinion of General Hines, stimulate similar construction by private capital and will go far toward reducing the cost of transferring freight between car and barge.

For the New York State Barge Canal the government contracted for a fleet of 92 boats, consisting of fifty-one steel barges, twenty-one concrete barges, and twenty combined towboat and cargo barges. All of these have been delivered, with the exception of one steam barge.

For the Warrior River three steel towboats have been ordered, to be used in conjunction with twenty wooden cargo boats, capable of moving in all 10,000 tons of cargo. This equipment will be supplemented by four steel self-propelled barges, capable of transporting coal between Mobile and Violet, La., under their own power.

For the Mississippi River between St. Louis and New Orleans, the government contracted for six new power boats and forty steel cargo barges, having an aggregate cargo capacity of 80,000 tons. Some of this equipment has been delivered, but it will probably be early spring before all of the towboats will be in operation, and even then considerable time will be required in schooling crews in running them most efficiently.

The Recent Typhoid Fever Epidemic at Salem, Ohio

Water-Borne Outbreak Caused 866 Cases and 23 Deaths — Sanitary, Medical, and Nursing Activities—Downstream Protection

THE recent outbreak of typhoid fever at Salem, Ohio, attributed to the infiltration of polluted ground water into a gravity tile pipe had resulted in 866 cases and 23 deaths up to Dec. 10, when it was believed that the epidemic was at an end. The following concise résumé of the epidemic and the measures for controlling it and for the care of the sick, taken by the State Department of Health, with the co-operation of federal and local health agencies and of the Red Cross, has been prepared by the Ohio State Department of Health and sent to this journal for publication:

On Oct. 13, 1920, the health commissioner of Salem, Ohio, reported that diarrhea and enteritis was quite prevalent in Salem and environs. Dr. Charles Armstrong, epidemiological aide to the State Department of Health, was sent to Salem to investigate the source of the disease. Dr. Armstrong reported on the 16th that after very careful investigation he had found approximately 7,000 cases of a non-specific diarrhea and enteritis which were possibly due to the public water supply. An engineer from the department was at once detailed to prepare outfits for bacterial analysis, and to proceed to Salem to make a thorough examination of the water supply. On Oct. 19 E. I. Roberts, the engineer detailed for this work, reported that his analysis showed that the water supply was contaminated, and that the probable source of the contamination was located. A warning to boil all water was issued the same day to residents of Salem. At the same time F. H. Waring, another engineer of the department, started for Salem with chlorination apparatus which was completely installed and operating on the afternoon of Oct. 20. On the same day Messrs. Roberts and Waring advised the City Council to take immediate steps to permanently correct the water supply contamination. On Nov. 9 seven members of the staff of the State Department of Health were sent to take charge of the local situation. Dr. F. G. Boudreau and four members of his division were given charge of epidemiology and medical activities, while W. H. Dittoe and two members of his division had charge of water supplies and sewage disposal. R. E. Tabett, sanitary engineer, was sent by the U. S. Public Health Service to co-operate with the State Department of Health. Miss Hulda Cron, state supervising nurse, was sent later to take charge of nursing activities. The local health commissioner, Dr. R. M. Schwartz, co-operated in every way with state and federal officials, and this was true also of the local public health nursing service under Miss Donsing, and the local chapter of the Red Cross, in charge of Mrs. Smith. The local board of health, the citizens committee, and the Chamber of Commerce also co-operated fully and proved of great assistance. Other city officials, and particularly the mayor and the directors of service and safety, gave every possible aid to the campaign of prevention.

Five cases of typhoid fever occurred in Salem during August and September. These cases were widely scattered; at least two received their infection from sources outside the city, and no common source for the others was dis-

coverable. Four cases were reported between Oct. 1 and 19, but it was ascertained afterwards that over a hundred patients had taken to bed during this period. Cases came in rapidly after the 19th, and the peak of the epidemic occurred during the last week of October and first week of November. On Nov. 1 fifty-four persons took to bed with typhoid fever. After the first week in November the number of cases reported dwindled rapidly, until, during the early part of December, only scattered cases were occurring, and many of these were traceable to contact infection. The total number of cases which have occurred in the epidemic to Dec. 10 is 866, and the total number of deaths, 23. As the population of Salem is now approximately 10,000, the attack rate to date is 86 per thousand. The case fatality rate so far is less than three per cent. Eight per cent is a usual case fatality rate for water-borne typhoid fever, but it is not expected that the rate in Salem will be so high.

The Water Supply

The water supply of Salem is drawn from three groups of deep wells. Water from these wells flows by gravity into three reservoirs from which it is pumped into the city mains. One group of wells is situated in a built-up portion of the city, and the gravity line leading from these wells is of vitrified clay pipe. This line was laid in 1900, and portions of it had to be cleaned about five years ago, because of roots which had grown into it and obstructed the flow of water. The gravity lines receiving the flow from the two other groups of wells are composed of cast iron. Engineers of the State Department of Health, when examining the water supply in October, found that the water from the various groups of wells was pure, but the water in the reservoir and the distribution system was contaminated. By a process of elimination it was determined that the probable source of contamination was in the gravity tile line The water was immediately chlorinated, and the tile line was cut off above the point where a cast-iron pipe from another well entered it. Water from the wells which ordinarily discharged into the tile line was pumped directly into the mains, and the lower end of the tile line below the junction of the cast-iron pipe was replaced with a cast-iron line as promptly as possible. The reservoirs were cleaned, the distribution system flushed and all other possible precautions taken to make the public water supply safe. It must be emphasized, however, that previous to 1920 all examinations and analyses of the public water supply of Salem had shown the water to be of good quality and safe for domestic use.

Measures to Prevent the Spread of Typhoid

The following are the steps taken to control the epidemic:

(a) Sanitary Measures—1. Emergency chlorination of the public water supply. This was accomplished on October 20.

2. Installation of a permanent chlorine machine. This was done to release the State Department of Health machine for emergency purposes, and because Salem needs a permanent machine in case of any accident to the water supply.

3. Chlorination of city sewage. The sewage of Salem passes through a disposal plant but effective purification does not take place. The sewage was chlorinated to protect individuals and communities situated on the watershed below Salem.

4. All privies were disinfected by the free use of chloride of lime.

5. Use of the tile gravity line was discontinued.

6. Cast-iron pipe was laid to replace the lower end of the tile gravity line.

7. All dug wells on properties having city water service were disinfected by the free use of chloride of lime.

8. A sanitary investigation of all premises was made to determine the number of cases of typhoid fever, the number of cases of diarrhea and enteritis, the number and kind of wells, the number and kind of privies, the presence of water and sewer connections, and other useful information. This was accomplished by the war workers organization, which functioned efficiently and rapidly.

9. Inspection of all places selling food was made by the aid of six volunteer sanitary policemen. Many improvements resulted.

10. All milkmen selling raw milk ordered to have their supply pasteurized by the holding method. This was done at one of the local plants, which is large and modern in every respect.

11. All milk bottles and utensils were thoroughly sterilized at the same plant. Pasteurization of milk and sterilization of utensils were in force three days after the situation was placed in charge of the State Department of Health representatives.

12. Milkmen were forbidden to leave milk bottles at premises where typhoid fever existed. Such householders were required to place receptacles for milk on the door step.

13. All shops were forbidden to sell milk in the original containers over the counter. A notice to this effect was placed in every store where milk was sold.

14. Every house in which typhoid existed was placarded with a printed sign.

15. A printed notice to boil all water was placed in every home.

16. A printed notice on the disinfection of discharges was placed in every home.

(b) Medical Measures—1. The State Department of Health supplied large amounts of triple anti-typhoid vaccine. A sufficient amount was supplied to inoculate at least half the population.

2. The local health department provided free inoculation service.

3. Through a sum of money appropriated by the State Board of Control, at the request of the State Department of Health, free medical consultation service was provided. The internists who came to Salem for this purpose were Dr. Henry A. Christian of Boston, Drs. C. F. Hoover and Blankenhorn of Cleveland, and Dr. W. H. Bunn of Youngstown. Drs. Christian and Bunn remained in Salem as long as there was any need of consulting service. The local physicians made free use of the services of the consultants.

4. Free surgical consulting service was also provided. The medical profession of Salem was quite capable of coping with any surgical emergency, but blood transfusion was advised by the medical consultants in some cases, and surgeons from the service of Dr. G. W. Crile at Lakeside were secured to group donors and perform transfusions.

5. A private duty nursing registry was provided so as to keep an adequate supply of nurses in Salem. All nurses for private duty service were required to report at the registry upon arrival at Salem and before departure. Nurses were placed in homes without regard to the financial resources of the householders. Dr. Christian commented favorably upon the fact that poor and rich alike received adequate nursing service. An incomplete census of nurses showed that at least 250 were in Salem at one time or another during the epidemic.

6. Free laboratory services were provided by the establishment of a branch state laboratory. This laboratory was established within five days after the arrival of State Department of Health representatives, and in two weeks more than 800 specimens had been examined. The work was so arranged that physicians merely telephoned requests for examinations of specimens and a technician took the specimen and sent the report to the physician. Examinations consisted of blood counts, Widals, blood cultures, urine and miscellaneous examinations.

7. A number of the patients seen by consultants were suffering severely from loss of blood, so that transfusion was advised. An appeal was put in the press for volunteer donors, and as these reported to the health department their blood was grouped and a record made of the name, address and grouping.

8. Ten actual blood transfusions were performed by members of the surgical consulting staff.

(c) Investigations—1. A sickness survey of every home in Salem was made to determine the number of cases of typhoid fever.

2. Physicians of the department investigated all reported

and unreported cases of typhoid fever for the purpose of securing epidemiological histories of each.

3. A study of the outbreak of diarrhea and enteritis was made to determine its chronology, distribution and extent.

4. The typhoid fever epidemic was studied epidemiologically as to geographical, chronological, age and sex distribution and as to possible common factors, such as public and private water supplies, milk, food and contact.

5. The municipal water supply was thoroughly investigated.

6. A study was made of the municipal sewerage system.

(d) Advice—1. Council was advised to notify riparian owners along the Little Beaver of the danger of using water from this source.

2. Council was advised to employ a competent sanitary engineer to study and plan the development of the municipal water supply.

3. Council was advised to pass and enforce ordinances governing tapping of sewers.

4. Council was advised to require the licensing of plumbers and sewer tappers to prevent careless work and the destruction of the sewerage system.

5. Municipal officials were advised to prepare and adopt regulations providing for the abandonment of dug wells where water connections are available.

6. Municipal officials were advised to adopt and enforce regulations providing for the abandonment of privy vaults where sewers are available.

7. The board of health was advised to adopt regulations governing the handling of food.

8. Advice was given to various organizations concerning the nursing situation.

9. Advice was given concerning relief measures.

10. The board of health was advised on financial measures.

11. Advice was given to various organizations concerning the hospital situation. The local chapter of the Red Cross had established three emergency hospitals. On the advice of health officials, a fourth was established. There were approximately 180 beds available for typhoid fever patients at the height of the epidemic.

By means of the measures detailed above an attempt was made (1) To abate the primary source of the epidemic. (2) To prevent the spread of typhoid fever through secondary sources. (3) To reduce the mortality by the provision of adequate nursing, medical and hospital facilities. (4) To improve permanently the sanitary conditions of Salem so as to prevent the occurrence of a similar epidemic in the future.

It is too early to decide whether all measures taken were effective, but it is possible to state that the first three objects mentioned above have been achieved. The future history of Salem will show whether the fourth item has been accomplished.

We are informed by W. H. Dittoe, chief engineer of the Ohio State Department of Health, that the City of Salem has adopted the department's recommendation as to starting plans for improvements to the water supply and that the city has engaged Morris Knowles, Incorporated, for the purpose.

Railway Work in New South Wales

About 630 miles of government railway now under construction are listed in the report of the railway commissioners of New South Wales, Australia, for the year ending with June, 1920. This mileage is divided between sixteen lines of 20 to 95 miles each, work in several cases having been interrupted for two years or more on account of the war. Shortage of explosives, cement, ties and other materials is delaying progress considerably. Preparatory work is being done for the electrification of the suburban lines near Sydney. Double tracking and four tracking of portions of the main lines is also under way.

Proposed Hudson River Bridge

Its Capacity and Cost, Compared With Tunnels, and Its Influence on New York's Transportation Problem

By Gustav Lindenthal
Consulting Engineer, New York

(Abstract of paper read before annual meeting of American Society of Mechanical Engineers, New York, Dec. 9.)

The Hudson River is a barrier which must be crossed daily by 700,000 passengers, by 3,000 freight cars and by 8,000 to 10,000 vehicles. Of the passengers about one-half come through six submarine tunnels, four of the Hudson & Manhattan R.R. and two of the Pennsylvania R.R. All of the rest of the passengers, all vehicles and all railroad cars come over, as they did 80 years ago, on floating equipment along a river front of 12 miles. The congestion and the delays act as a deterrent to the spreading of population into New Jersey, where there is ample room within one hour's travel from New York for at least 4,000,000 people to live in surburban comfort. The two vehicular tunnels just started will, when completed in three or four years, add only four lines of traffic for vehicles, a mere drop in the bucket. The two tubes with approaches will be 10,000 ft. long and cost $28,000,000.

Compare with this backward condition the crossing facilities over the East River, for a population of 2,500,000 on Long Island. There are here besides numerous ferries four large municipal bridges (ignoring the Hell Gate railroad bridge) with, together, thirty-six tracks for rail cars and sixteen lines for vehicles, besides sixteen subway tunnels—all together, 52 lines of traffic, along a river front of only 6 miles. Two additional bridges and sixteen additional subway tunnels across the East River are under contemplation.

It is easy to see that if the 2,000,000 people in New Jersey are to be accommodated in the same proportion we must have across the North River, in addition to the above-mentioned railroad and vehicular tunnels, at least fourteen railroad tracks and twelve lines for vehicles. If put into tunnels these twenty-six lines would require twenty additional submarine tubes.

Let us assume that all these twenty tunnels would be about the same length and have the substantial construction of the Pennsylvania tunnels, or as proposed for the vehicular tunnels just started. That would make the cost of the twenty tunnels about $240,000,000.

But the higher shores of the North River above 23d Street would require most of these tunnels, with approaches, to be much longer than 10,000 ft. Some of them would have to pass under the Palisades on the New Jersey side, like the Pennsylvania tunnels, making them, with approaches, 15,000 to 16,000 ft. long, so that the total cost of these twenty tunnels would be nearer $400,000,000.

Proposed Bridge

Now let us compare these tunnels with the cost of an equivalent bridge over the North River located at or below 59th Street, where the shores on both sides are high and favorable for bridge construction.

The bridge structure and approach, beginning at Ninth Ave. and terminating on top of the Palisades, would be about the same length as the vehicular tunnels with approaches (10,000 ft.). It would have two decks, 180 ft. wide. The lower deck would accommodate eight railroad tracks, and two tracks for a moving platform, and the upper deck, for highway and local traffic, four lines of rail, twelve lines for vehicles and two sidewalks. The eight railroad tracks would connect with a two-story elevated railroad on the West Side, with the New York Central tracks along the river front, and also with a union passenger station.

The total cost of the bridge, liberally estimated, is $100,000,000, or only about one-third to one-fourth the cost of twenty equivalent tunnels.

But the bridge besides handling passenger traffic would also bring relief to seven railroad systems for the freight transfer across the river, now is exclusively done on floats.

Let us first see how the passenger traffic pouring over the bridge would be distributed at the Manhattan end so that no congestion of traffic would take place at the end of the bridge. One of the most effective means to that end would be the moving platform, requiring two tracks on the lower deck. It would be enclosed on the bridge and have a loop on the New Jersey side. Passing under 57th Street, it would have the eastern loop near the East River, adjacent to the Queensboro Bridge. It would interset every line, in subway, on elevated or on surface, running north and south, to which a passenger may change. This moving platform would take care of the local passengers within a radius of 10 min. walk on the New Jersey side.

Moving Platform Capacity

Such a moving platform at the moderate speed of 9 miles per hour would cover the distance between loops 3 miles apart in 20 min. or across the bridge in about 8 min. with a carrying capacity of 40,000 passengers per hour in each direction.

That will be sufficient in rush hours for passengers from the district at the western end of the bridge within 10 min. walking distance, when that New Jersey district should become as densely built up with tall buildings as is the lower part of Manhattan. That same distance consumes now nearly an hour, and we need not wonder that the wonderful location on top of the Palisades is so neglected. The moving platform is therefore a most important and indispensable feature of the bridge across the North River.

The eight heavy railroad tracks connecting with seven large railroad systems on the New Jersey side could be used for rapid-transit cars, for through trains of the railroad trunk lines or for freight cars, as needed.

During the rush hours these eight tracks could be used exclusively for passenger traffic. They are intended to connect with a two-story elevated marginal railroad along the west side of Manhattan down to the neighborhood of Cortlandt Street. To obtain the largest carrying capacity for these tracks they should be looped at the ends.

Later an inclined approach from the first story of the elevated railroad down a 5 per cent grade to two tunnels under the Hudson River, located near the Battery, would form a loop from the west side railroad back to the railroads in New Jersey.

The upper four tracks of the elevated railroad could in the future be continued as a marginal railroad along the East River and return to the bridge in a two-track tunnel located under the moving platform tunnel on 57th Street, above mentioned.

The transportation capacity on all railroad and rapid-transit tracks in the rush hours would be 200,000 passengers per hour. There would be on the bridge a potential transportation capacity of 500,000 000 passengers per year, not including highway passengers. On the west side elevated railroad, during the night, when travel is thin, one track each way would suffice for passenger traffic, leaving three tracks each way free for freight.

The local passenger traffic out to a distance of 20 to 30 miles in New Jersey could be kept separate without interfering with the through passenger traffic on the railroad lines, the through traffic being accommodated in a union passenger station located close to the New York end of the bridge. The rentals for offices and other accommodations would make this union station more than self-supporting.

Freight Transportation

The present number of freight cars crossing the North River averages about 3,000 per day, carrying 15,000,000 tons of freight per year, including coal. This freight traffic is growing similar to the passenger traffic, at the rate of over 10 per cent per year. At least 60 per cent of the food for a population of 6,000,000 people is brought on these railroads from the Western and Southern States. There is no room for additional railroad yards in Manhattan. Therefore it is necessary to handle that freight on the principle of the greatest expedition in unloading and loading the cars on their arrival at destination. This can be brought about through a unified management of freight delivery from all the railroads. A large classification yard would be located in New Jersey on the west side of Bergen Hill into which all the railroads would deliver their freight cars, such cars, loaded with l.c.l. freight, to be unloaded directly into motor trucks. Freight would be carried on these trucks over the bridge to points of delivery in the shortest time.

Car-load freight would be taken over the bridge in short, frequent trains to elevated freight stations, not over a mile apart, located along the west side of Manhattan from the Battery to Inwood, a distance of about 14 miles. Each car being announced in advance as to time of arrival and contents, it can then be switched to short sidetracks and swiftly unloaded with facilities held ready for it. For outgoing freight such cars can at once be reloaded. Market halls, warehouses and shipping piers would also be connected to the marginal railroad.

The capacity of the bridge and stations would be sufficient to handle 2,000 freight cars per day each way, which leaves a large margin for growth. About one-third of the freight tonnage intended for Manhattan would be brought across the bridge on motor trucks. The roadway on the bridge, 140 ft. in the clear, would permit a truck movement of 6,000 tons of freight per hour in each direction, or a total of over 30,000,000 tons per year, without discommoding the tremendous automobile traffic that must be expected for passenger transportation.

Surface Car Tracks

The surface tracks on the upper deck of the bridge are intended to connect with the surface tracks on the streets and with the subways and elevated railroads in Manhattan. Their transportation capacity would be governed by the capacity of the rapid-transit lines now existing or yet to be built in Manhattan. The Ninth Avenue elevated railroad would be able to run its trains directly over the bridge into New Jersey and connect there on the Palisades with existing lines, so that residents in that section could reach the Manhattan theaters and the office and business section without changing cars.

Railroad tracks from the bridge to the tracks of the New York Central R.R. would have grades not exceeding those in the Pennsylvania tunnels. The west side elevated railroad would eliminate the so-called death avenue trouble; that is, the railroad tracks on the surface of Eleventh Avenue could then be entirely removed. Trains from the bridge would be able to turn north over a loop and without back switching to the New York Central R.R. tracks toward Inwood and Yonkers. This would be an important advantage for the delivery of coal and local freight from the railroads in New Jersey.

In laying out these plans it is expected to have the cooperation of the city authorities, who are especially interested in building market halls at short distances from each other, where the public could buy fresh food cheaply and with great convenience.

The plan here submitted looks not only to the solution of the New Jersey problem but also to the future development of the railroad terminals in Manhattan as a harmonious part of the port problem. The river piers along the Manhattan shore and along the New Jersey shore now used and occupied by railroads as passenger terminals or for freight yards would be released by the bridge and west side elevated railroad, and thus become available for ocean shipping, for which there is a great scarcity of pier accommodations along the North River. At 1[illegible]th Street a connection from the New York Central tracks (connected to the North River Bridge as already stated) can be had with the Putnam division of the New York Central by tunnel near 156th Street under Audubon Park. By this short tunnel and a bridge over the Harlem River a connection can be had with the New Haven railroad system over the tracks of the Harlem division of the New York Central.

Letters to the Editor

Prohibition Discussion Closed

Sir—The letter by F. C. Finkle in your issue of Nov. 11, p. 957, ought not to go unchallenged. Mr. Finkle couples enlightenment with the rum bottle. The Bible and the rum bottle were carried to backward and savage races by the white race simultaneously, but one who attributes the enlightenment that ensued to the rum bottle is affected with blindness of the worst type.

On the other hand, the Koran and prohibition may have been handed to a race, as Mr. Finkle cites in the same package. The Koran countenances the greatest looseness in sexual morality (or immorality) with the result that home is a vanishing quantity or non-existent.

No argument is needed. Just a record of a few facts. But engineers, of all men, ought not to get their causes mixed. EDWARD GODFREY.

Pittsburgh, Pa., Nov. 29.

[The discussion on prohibition that has been running in these columns for some months started from a short editorial note suggested by the possible relation of prohibition in the United States to the labor supply, as the latter was affected by immigration and by the return of former immigrants to their native countries. The labor and immigration situations have both changed materially since the note was written and the letters on prohibition received and published have been getting far afield from the original note—the point of which was merely that the relation of prohibition to immigration deserved study. It therefore seems best to close the discussion, or at least to confine it closely to the original question.—EDITOR.]

The Writing of Engineering Reports

Sir—As a young engineer I have followed with much interest the discussion of Prof. Mead's recent article on the writing of engineering reports (See *Engineering News-Record*, Nov. 4, p. 891 and Nov. 11, p. 947). It has been very thought-provoking and not the least pertinent question arising therefrom is why such a discussion in the leading journal of the profession is necessary at all.

It is difficult to conceive of the leaders of the legal profession for instance, engaging in a discussion on such a subject in the columns of one of the national reviews of that profession. The lawyer is fully aware that the power of effective thought expression is his most important tool and takes for granted a thorough knowledge of its use. Why is it, then, that this question arouses so much interest among engineers who certainly occupy as important a position in our social structure and have as many points of contact with the business world as do the lawyers?

That there is a lack of understanding among engineers as to how to present facts effectively is common knowledge. One needs only to wade through the usual technical report or become acquainted with the correspondence files of the average engineering office to realize that there is such a lack of knowledge concerning the use of English as a medium of lucid expression. Certainly the discussion has been timely, but one wonders what the cause of this condition may be.

There is no magic touch required in formulating a technical report. Technical writing, like every other kind of serious writing, has as its avowed purpose the conveying of information and the influencing of the reader to adopt a definite mode of thought or action. As such it is grounded on the same fundamental principles of composition as any other kind of exposition. A salesman would probably express these principles as "the selling point of view," which rests on two commonsense propositions, first, knowing ones product or subject and second imagining oneself in the position of the probable reader or client. The first requisite insures clearness. Clear and logical statement of facts results only where there is clear and logical thinking. The second insures effective arrangement of facts in the form most convenient for the client. The writer should keep constantly in mind that the report is for the client's use and the arrangement should be decided upon with a view to making it less difficult for him to arrive at an intelligent conclusion, which, after all, is the real purpose of the report.

A working knowledge of these fundamental principles is the primary aim of every English course in our schools and universities and it would seem that if the engineer lacks understanding of this important part of his equipment there has been something lacking in his education. It seems a little unfair perhaps to blame our already overburdened technical schools, but since they are the chief agency in the training of engineers they must assume some of the responsibility. Recently, the writer had occasion to look through the curriculum of a half-dozen or so of our representative technical schools and found that no radical change in the arrangement of the course of study has been made in the several years since he was more intimately acquainted with one of them as an undergraduate. In only one of those examined did he find a study of the "King's English" given more prominence than a few cursory hours in the freshman or sophomore years. This notwithstanding the fact that the engineer's non-technical principal will judge him and his success will be largely determined by his ability to give clear and effective expression to his thought. With this slight on the part of those who form the courses of study is it any wonder that the average undergraduate in a technical school has a contempt for such study and that he frequently leaves school with a pathetic lack of knowledge as to how to express his thoughts effectively? We cannot expect to find a man fresh from the technical school a finished engineer, but it is not too much to expect that he have a good educational and cultural background for his engineering knowledge which, in any event, he will have to supplement in large measure by experience and subsequent study. Without these fundamentals and possessing an indifference toward acquiring them he may still become a skilled craftsman but will hardly be credited by his associates with being a member of a learned profession.

It will be interesting to note as our system of technical education develops, how our engineering schools will cope with this reality; whether by giving these subjects more prominence at the expense of more technical studies; whether by a lengthening of the course of study beyond the limits of the customary four years or whether as has been resorted to by leading schools of other professions, by making as a prerequisite for entrance the completion of certain work in a college of Liberal Arts.

Engineers have a right to expect our technical schools to actively interest themselves in the advancement of the interests of the profession not only by developing and disseminating technical knowledge but by giving the young engineer that professional pride and vision which will make him ashamed to show an ignorance of the art of effective thought expression. How they function in bringing the young engineer to realize the relative importance of this useful art will have a great deal to do, it would seem, with determining whether or not engineering is to be recognized and respected as being on a par with the other so-called learned professions. W. N. MITCHELL,

Assistant Engineer, the A., T. & S. F. Ry.

Topeka, Kan., Dec. 10.

Taking Advantage of Truck Accidents

To reduce coal-trucking costs George S. Pope, chief engineer of the Government fuel yards in Washington, D. C., has instituted the practice of taking pictures of the mishaps which his trucks suffer and posting them on a bulletin board at the fuel yards as an object lesson to the drivers. That the lesson is effective is evident from the fact that the truck drivers early in the work referred to the pictures as "the rogues gallery." In future the driver who meets with the accident will be required to stand in front of his truck so that he will be pictured along with his unhappy situation.

Hints for the Contractor

Heavy Bar Bender Devised From Old Steam Shovel Parts

By Arthur H. Lynch
Brooklyn, New York

With the air cylinder, rack and spur wheel from a discarded steam shovel the bar-bending machine shown by the illustration was devised for the steel yard of the navigation canal and inner harbor works at New Orleans. Bars from the stock shed at the far end of the view move ahead on roller tables to the shears and thence to the bar bender. A heavier timber table carries the bending machine. Essentially this consists of a rotating horizontal spur wheel, with an upstanding hub and an attached dog between which the bar is bent. The spur is rotated by compressed air through the agency of the cylinder and rack. Variation in the diameter of the hub collar and the position of the dog provides for different radii of bends. Most of the steel used is $1\frac{3}{4}$-in. diameter round bars and these have been bent successfully in great numbers.

JOB-BUILT BAR BENDER FOR HEAVY WORK

Steam Shovel Sparks Cause Premature Blasts

Blasting rules have been formulated by the U. S. Bureau of Mines to avoid danger of premature explosions by sparks from steam shovels. Accidents due to this cause have been frequent and from a study of them precautions are suggested as follows:

(1) The general principle should always be followed that workmen should never be allowed at the base of a quarry face within the zone of possible danger from falling rock after the work of loading the hole has begun, and the presence of workmen in the area between the line of holes and the face should be avoided.

(2) Before loading is begun, the steam shovel and locomotives should be withdrawn from the face of the quarry to such a distance that under no circumstance could sparks from them be carried to the explosive in the holes or on the ground above or around it, or if such equipment is not removed it should not be operated.

(3) If there is any unavoidable danger from sparks or cinders, a canopy should be provided which will protect the explosive from flying sparks. A covered hopper may be used for black blasting powder.

(4) Where an unexploded charge is uncovered by the steam shovel, operations should cease until all of the explosive has been recovered and removed to a safe distance.

(5) Every piece of paper or other inflammable material should be removed from the vicinity where explosives are placed during loading operations.

(6) Primers should be kept in a portable metal box with a hinged cover and should not be stored close to the explosive, especially while the holes are being loaded.

(7) Unopened boxes of explosives should not be stored close to the hole being loaded, but should be opened at a distance from it and brought up as needed.

Gravity Track Distribution Reduces Cost of Earth Fill

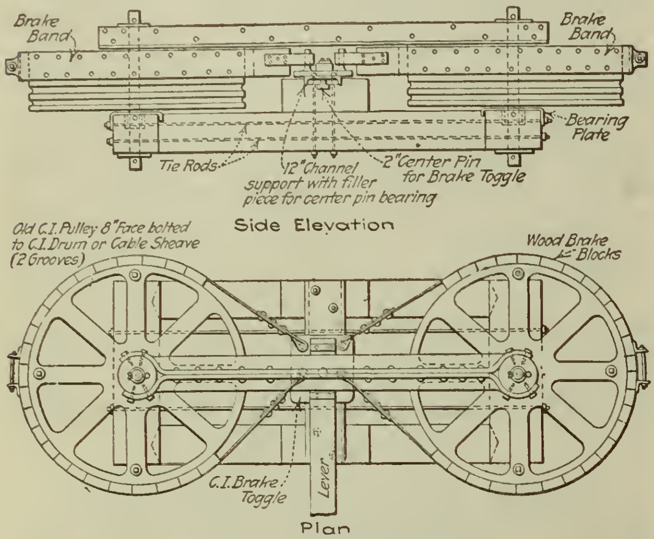
By Donald G. Coombs
Office Engineer, Braden Copper Co., Rancagua, Chile

Distribution of 50,000 cu.yd. of earth from a cut at high level to a fill at lower level, was successfully accomplished by a cube incline and gravity tracks, in building the smelter for the Braden Copper Co., at Caletones, Chile. The construction required the excavation of approximately 300,000 cu.yd. of material from four different levels. The fifth, or lowest level, was entirely fill, 90 per cent being from the second or 5,139-ft. level. Unlike the 5,073-ft. and 5,105-ft. levels, where the cut and fill nearly balanced, the 5,139-ft. level was practically all cut. With railroad or team equipment available, the greater part of the excavated material could have been used for extending this and the 5,150 ft. level and in making other levels or "canchas" east of the cut. But, with the only available equipment consisting of some few 24-in. gage, $\frac{3}{4}$-cu.yd. capacity V-body, Koppel cars and a dozen 30-in. gage, 4-cu.yd. standard Western dump cars, the most economical procedure seemed to be that of a gravity incline from the 5,139-ft. level cut to the 5,061-ft. level fill.

For this purpose an incline brake was borrowed from the Mining Department and set up at the head of the incline on the 5,139-ft. level. This brake is shown in detail by the sketch. As the incline had an 11 per cent grade, the loaded car going down furnished a surplus of power over that required to pull up the empty, so that considerable braking was necessary to control the speed. Forty-pound rail was used, and being scarce, a three-rail track was laid, with the middle rail common to both the up and down tracks excepting for the passing tracks at the middle point of the incline. By the use of spring switches the full and empty cars automatically took their respective tracks. (The more automatic devices one can install the less provocation one will have for wanting to take a pick handle to the South American laborer.)

In beginning the cut, two 18-ton, revolving, traction-type steam shovels were employed and the four-yard cars were moved to and from the head of the incline by horse and man power. Later, as the cut deepened and one shovel was used elsewhere, the cars were

spotted and loads hauled to the incline by means of a two-drum steam hoisting engine set at right angles to the incline. Curves in the pit tracks were negotiated by means of snatch-blocks anchored to deadmen, and by using one drum for the loaded and the other for the empty cars, it was seldom necessary to take the cable out of the blocks excepting for moves and track



GRAVITY INCLINE BRAKE

changes. Until it was learned, from experience, that the success of an incline is directly proportional to the amount of work put on the track, derailments were frequent. The economical operation of a gravity incline requires a well-ballasted and aligned track. No one was allowed to ride the cars. From the foot of the incline the cars were handled on the dump by two-horse teams equipped with special "stretchers."

With one shovel, an average of sixty 4-cu.yd. loaded cars per 9-hour day was handled over the incline and there were a number of days when a rate of 15 cars an hour was maintained. The material varied from loam through clay and boulders to hard-pan and shattered rock, so that considerable drilling and blasting was required. For this reason delays in the pit, rather than the capacity of the incline, were the limiting factors.

AVERAGE COST OF EXCAVATION AND FILL FOR SIX MONTHS EXCLUSIVE OF OVERHEAD

Detail	Labor	Material	Total
Drilling and blasting	$0.06	$0.04	$0.10
Steam shovel excavation	.09	.21	.30
Operating hoist and brake	.02	.06	.08
Laying and maintaining track	.04	.02	.06
Operation and maintenance of dumps	.13	.02	.15
Drainage	.01	...	.01
Field superintendence	.01	...	.01
Maintenance of equipment	.03	.06	.09
Plant Arbitrary	...	.10	.10
Cost per cu. yd. in fill	$ .39	$ .51	$ .90

For six-months' operation, the average cost by items of material in the fill is given by the accompanying table. The crew was in charge of a shovel foreman at \$175 a month and he had two sub-foremen, one on the dump and the other in the shovel, pit. The average wages paid at that time are, in Chilean currency (exchange 3:1):

Common laborer..		$4.50	Shovel runners...	$16.00 to $18.00
Pitmen..........	$5.00 to	5.50	Shovel firemen...	6.00 to 8.00
Hand drillers.....	5.50 to	6.00	Shovel cranesmen	6.00 to 9.00
Teamsters, 2-up...	5.00 to	6.00	Hiost engineers...	7.00 to 8.00
Special laborers...		5.00	Cabos...........	10.00 to 14.00

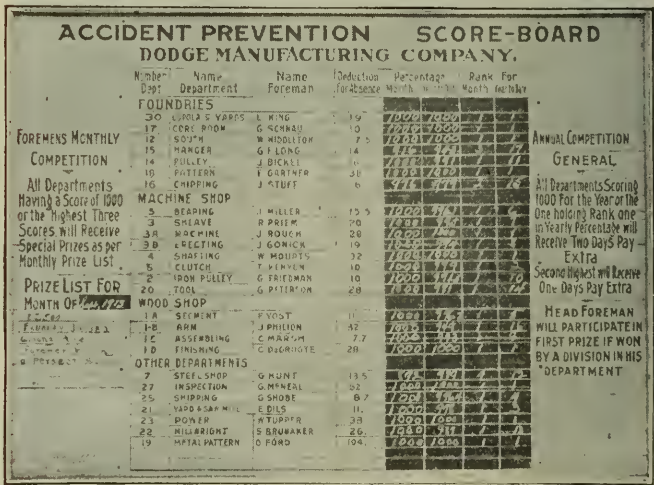
Coal (briquetted) averaged \$32 per ton; lubricating oils 90c. per gallon 4 in. x 6 ft. sawn Roble ties 85c. each; track spikes and bolts 20c. per pound (when one could get them); and other supplies in proportion. The material prices are given in all cases in United States currency.

The entire construction program was under the supervision of Mr. E. H. Baldwin, assistant consulting engineer, with R. E. Post, division engineer in charge of the Caletones construction. J. G. Johnson, general foreman, had charge of all steam-shovel excavation. The writer was assistant division engineer.

Score Board Record Reduces Industrial Accidents

COMPETITION in accident prevention, between different factory departments of the Dodge Manufacturing Co., has been materially increased by using the score board illustrated. To display the record and names the board was made large (24 x 17 ft.) and was located at the main factory gate. A simple scoring mechanism was sought: (1) The starting point is 1,000 for both year and month; (2) each division is penalized according to its accidents; (3) each day's absence bears a percentage charge in proportion to the total number of man-days per month per division. A feature is a system of reward, which has helped to maintain interest.

It is stated that as a means of preventing accidents the score board has rendered excellent service. It is no



SCORE BOARD FOR RECORDING ACCIDENTS

uncommon occurrence to have 10 divisions out of 26 showing perfect scores. Included in some of the perfect scores is the steel foundry where castings weighing as high as 50 tons are made. This work is usually classed as hazardous. Some divisions have perfect scores year after year and there is hardly a single division that has not shown a marked decrease in accidents during the past eight years.

German Reinforced-Concrete Water Tank

Elevated water tanks of reinforced-concrete have been built recently in Germany. As described in a German paper, the largest of these has a total height of 200 ft., made up of a 164-ft. tower and a top tank 36-ft. high. In addition to the upper tank there is a tank at the ground, the bottom of which forms the footing base for the tower. There are also intermediate tanks. The bottom tank has a capacity of 132,000 and the next succeeding tanks have capacities of 17,000, 53,000, 132,000 and 262,000 gal. respectively.

NEWS OF THE WEEK

New York, December 23, 1920

Federation's Board Meets, With Hoover Presiding

Committees Named — Immediate Program Considered—Sum of $1,000 Authorized for Publicity

Herbert Hoover, president of the Federated American Engineering Societies, presided at the executive board meeting of the American Engineering Council of that organization, held in New York, Dec. 17. Every member of the Council was present, with the exception of A. M. Greene, and two new members of the board were elected, W. B. Powell, of the Buffalo Engineering Society, representing District 1 (New York and New England States), and Gardner S. Williams, Grand Rapids Engineering Society, representing District 2 (Michigan, Wisconsin and Minnesota). The president appointed the following standing committees:

Procedure — Calvert Townley, chairman; Herbert Hoover, ex-officio; W. E. Rolfe, D. S. Kimball, J. Parke Channing, L. W. Wallace, L. P. Alford.

Constitution and By-Laws—W. B. Powell, chairman; C. F. Scott, D. S. Kimball.

Publicity and Publications—L. P. Alford, chairman; H. W. Buck, H. E. Howe.

Membership and Representation—J. F. Oberlin, chairman; L. W. Wallace, A. S. Dwight.

Finance—William McClellan, chairman; E. Ludlow, C. Townley, L. W. Wallace, ex-officio.

Public Affairs—J. Parke Channing, chairman; Fred J. Miller, L. B. Stillwell.

In discussing the program of the Council immediately ahead, Mr. Hoover stated that he had called engineers together in various cities he had visited lately and that he found that the general desire of engineers everywhere was to join the federation movement, but that the trend was for territorial organization, as distinguished from national organization. One of the stumbling blocks in the way of these territorial organizations joining the national organizations was the question of dues. Another complexity was that individuals hold memberships in more than one society. For example, the Western Society of Engineers has about 4,000 members, of which 3,000 are already members of national societies who have affiliated with the federation. Mr. Hoover also stated that there had been some opposition to the federation based on the constitution, but that the question of territorial organization was the most important, and he suggested that

(Continued on p. 1253)

State Highway Officials Urge Federal Aid

Appear During Washington Convention, in Hearing Before House Committee on Roads—W. S. Keller, Elected President

DEFINITE progress in securing continued federal aid in highway construction was made at the annual meeting in Washington, D. C., Dec. 13-16, of the American Association of State Highway Officials. Traffic problems, including regulation of vehicle loads, classification of roads and road types in relation to traffic service value, were constructively discussed. Foundation design and structure were emphasized as the primary construction problem of the future. Delegates from 35 state highway departments participated in the proceedings.

Federal Aid Promoted

Inspiration to the legislative work of the meeting was received in the opening address of the Hon. E. T. Meredith. Secretary of Agriculture. In his annual report just completed, Secretary Meredith announced, he had urged Congress to enact immediate legislation to continue federal aid beyond June 30, 1921, when the aid provided by the present act terminates. Specifically, he had recommended that, beginning with the date named, $100,000,000 a year be expended in federal aid for five years under substantially the terms of existing legislation. The necessity of this legislation he had considered to be immediate, so that there might be no break in the program of road improvement and so as to permit of participating legislation by the forty state legislatures to be in session this winter.

Developing the statements of Secretary Meredith, Thomas H. MacDonald, Chief of the Bureau of Public Roads, summarized the federal-aid work. An even greater accomplishment than the absorption of the present appropriations by construction completed and in progress and by projects approved, he said, had been the development of state highway legislation and the creation of public sentiment favoring highway development.

A resolution submitted by C. M. Babcock, Minnesota, called upon the executive committee, with the aid of a supplementary committee of five, to urge upon Congress the enactment of federal-aid legislation. At a meeting of this committee on Dec. 14, a program of action was planned, speakers were appointed and on Dec. 15, the committees, supported by a delegate from each highway department represented at the meeting, appeared before the Congressional Committee in formal argument for the legislation requested. The prompt action of the association and its favorable reception was the outstanding constructive work of the convention.

Traffic Problems

Traffic in its relation to highway planning, construction and maintenance proved a subject so interesting that its consideration had to be curtailed because of time limitations. A paper on "Traffic Census," by A. N. Johnson, Maryland, presented at the opening session, was the forerunner of a series of papers and discussions which occupied the entire five hours' session of the second day of the meeting and then had to be terminated by the chairman's gavel.

Prefacing an appendix which summarized traffic census methods and results in the several states and reviewed practice in foreign countries, Mr. Johnson commended in particular the practice in Maryland, which is distinguished by the careful classification of vehicles, some twenty classes being recorded.

Criticism of this elaborate classification was made by A. W. Dean, Massachusetts; it was too complex, he believed, to be recorded accurately by the character of census takers ordinarily employed and in the time available. Five classifications, he considered, would furnish all the information obtainable from mere enumeration and would be all that the census takers could record with any degree of accuracy. In any event, weight of traffic and not the number and class of vehicles was the fact to be determined. In Massachusetts weights were ascertained using loadmeters to determine separately the rear axle and front axle loads. These weight records had shown that overloading was common practice; in some instances the overload was as much as 250 per cent. Under such conditions any classification of vehicles on the basis of assumed loads gave census records of comparatively small value. Finally a traffic census was of slight usefulness in deciding on types of surface

Uniform state laws limiting the loads on vehicles were urged in a paper by C. J. Bennett, Connecticut. With uniform laws enacted, the second step was to enforce the laws. In discussion, Thomas Maddock, Arizona, expressed general agreement, but he pointed out that it might be better to put money

into roads which would carry heavy traffic than into policemen to prevent heavy loads from being carried. Speaking in a similar mood, J. N. Cole, Massachusetts, urged that in considering load limitations, the economic outlook should not be confined to load effects on road structure. He instanced occasions last winter when, owing to railway blockades, heavy trucks, which undoubtedly damaged the roads, were the only means of preventing mills with thousands of employees from closing because of lack of dyes. Road officials, he thought, should be careful not to acquire the habit of thinking of highways as sacred to all but defined traffic.

Two methods of regulating vehicle loads were proposed: First, to charge a license proportional to the damage and, second, to limit weights by law. High fees, said J. A. Mackall, Maryland, had never prevented the use of heavy trucks. The only preventive was to set limits of weight and enforce the regulation. In Maryland, trucks were weighed, compelled to take off the overload, even if it had to be piled on the roadside and then were fined. Where formerly 50 or 60 overloaded trucks were apprehended each day, now the arrests were one or two or none. By shifting the weighing operations from one road to another, without notice or regularity, no extensive policing force was necessary.

Road Structure

Discussion of papers, by A. T. Goldbeck, Bureau of Public Roads, on researches leading to the adequate design of road surfaces for heavy motor trucks; by C. M. Upham, state highway engineer, Delaware, on study and treatment of subgrade and foundation; and by A. R. Hirst, state highway engineer, Wisconsin, on relative service values of different types of pavement (see *Engineering News-Record*, Dec. 16, p. 1187) indicated a pronounced trend of thought toward greater consideration of foundation construction and less concern about types of surfacing.

Road design, stated W. D. Uhler, Pennsylvania, had to be based on foundation conditions. Sub-grades must be studied in respect to drainage, soil treatment to reduce capillarity, compactibility of soil, and treatment of variable materials. Service studies were superior to laboratory tests. Capillarity of soils as a foundation problem, was further stressed by C. M. Upham, Delaware, and Clifford Older, Illinois. Mr. Upham believed that when subsoils had this property to a high degree stability could be secured only by replacing the original soil with a foundation of stable material or by so treating the original soil as to render it stable by reducing its capillarity.

Observations and tests of soil capillarity in Illinois were cited by Mr. Older as indicating that a safe pavement slab could be designed only on the assumption that it was a floating structure. With the best possible drainage, capillary seepage of water would, with two to four days' rain, render the subgrade surface directly beneath the slab practically a liquid in respect to its function as a pavement support. An experimental road had been built and a series of observations and tests planned for the purpose of arriving at definite determinations.

Transportation Conditions

There is a fair possibility that there may be improvement in the railway transportation of road materials during 1921. Speaking for the railways, a representative of the car service commission stated that the coal situation being now in hand, there was a surplus of cars resulting (1) from more efficient operation and (2) from the stagnation in business. "It seems reasonable to assume," he said, "that road builders will have improved railway service next season."

Cost-Plus Contracts Advocated

Modification of contract requirements to meet present conditions was urged by W. R. Neel, Georgia, in reciting the successful experience this season with a cost-plus contract. An outline of this experience will be published in a future issue of *Engineering News-Record*. In discussion, F. S. Greene, New York, took a positive stand in favor of cost-plus contracts and state purchase of materials, wherever the state laws would permit these practices. There was a shortage of contractors; contractors must be encouraged, and the cost-plus contract, Mr. Greene said, promised to do this and in addition offered opportunities for economy.

Federal Aid Resolutions

Three resolutions were passed all calling for federal aid of some sort. (1) Continuance of federal aid on the basis of present legislation with certain modifications (McArthur bill); (2) appropriations by the Secretary of Agriculture of money for research on the basis of equal appropriations by the state; (3) legislation providing for further distribution of surplus war materials.

Yards and Docks Bureau of Navy to Spend $21,000,000

The public works program of the Bureau of Yards and Docks of the Navy Department calls for the expenditure of $20,993,500 during the next fiscal year. The larger items are as follows: For repairs and preservation, Navy Yards and station, $5,000 000; marine barracks, San Diego. $500,000; naval base, San Diego, $250 000; naval base, Hampton Roads, $145,000; permanent training station, San Diego, $1,000,000; depots for coal, $1,836,000; naval ammunition depot, Pearl Harbor, Hawaii, $342,000; naval station, Pearl Harbor, $1,946,000; naval station, Guam, $1,499,000; naval station, Cavite, $964,000; Navy Yard, Philadelphia, $730,000; Navy Yard, Norfolk, $315,000; naval station, Key West, $800,000; Navy Yard, Mare Island, $480,000.

Protection for City Engineers Against Investigators

A decision involving the right of inspection of public records has just been returned by the District Court of Appeals for the First Appellate district of California, which is regarded as a victory for the San Francisco city engineer's office. Commenting on the decision, M. M. O'Shaughnessy, city engineer, says: "This indicates that there is more or less protection for engineers and other officials engaged in public work and assures them of an opportunity to at least complete their investigations and studies and to make a formal report thereon before citizens or professional investigators can gain access to the data they have collected for the purpose of criticism or attack."

The case came up in connection with work on the Hetch Hetchy project on which preliminary and uncompleted data, maps, plans and specifications relating to the construction of dams and tunnels had accumulated in the city engineer's office. Prior to the time the data had been finally passed upon or approved and transmitted to the board of public works for formal action, the Municipal Research Bureau demanded the privilege of inspecting this data. The city engineer, saying that he was "somewhat suspicious of the methods of the petitioning bureau and its incorporators," refused to grant the privilege and an appeal was made to the court for a writ of mandate.

Claim was made by the attorneys for the city that certain of this data was in the nature of privileged communications involving matter to be used in litigation. The trial court granted the petition for writ of mandate for inspection but excepted data which was in the nature of privileged communications to attorneys. Both sides appealed, the city officials claiming that none of the preliminary and unapproved data should be considered as a public record.

The decision of the Appellate Court upholds the city's contentions with reference to the character of the preliminary and unapproved data, but also holds that the language of the court excepting all data claimed as privileged communications was too broad. However, as all of the data which was in dispute comes within the preliminary and unapproved category, the net result of the judgment sustained the city engineer in his refusal.

Gift for Engineering Research

A contribution of $200,000 has been made by an anonymous donor to the Engineering Foundation, which organization is trustee for the fund of $300,000 given by the late Ambrose Swasey as the beginning of an endowment for research work in science and in engineering. The Engineering Foundation, of which Charles F. Rand is president, and Arthur D. Flinn is secretary, is proposing to increase the endowment fund to $5,000,000. It amounts at present to $500,000.

Moving Pictures for Highway Transportation Show

Moving pictures are to feature the highway transportation show which is to be given under the auspices of the Motor Truck Association of America in the 12th Regiment and the 1st Field Artillery Armories, New York City, January 3-8, 1921. Among the pictures to be exhibited are those depicting the workability of the motor truck; the various uses to which the motor truck is put in highway transport; the construction of roads; tests upon motor trucks for the determination of impact and weight distribution; the care, repair and adjustment of truck parts; and the abuses to which pneumatic and solid tires are put.

Federation's Board Meets

(Continued from p. 1251)

a committee should be appointed to canvass and help the situation. This question was discussed and referred to a special committee, which will include the six district delegates.

As a step forward in co-ordinating various inter-society activities already established, the necessary action was taken to make it possible for certain of the activities of Engineering Council to be taken over by the new organization. Section 9, Paragraph 6 of the by-laws was amended so that members of committees can be selected from societies other than those at present members of the federation. Civil engineers and engineers in other bodies not at present affiliated with the Federated American Engineering Societies can, because of this action, co-operate in the committee work.

The four so-called founder societies in addition have been associated in a common employment service and the American Engineering Council has offered to take over this service as a part of its function.

The American Engineering Council voted not to affiliate with the United States Chamber of Commerce. It was the thought of the meeting that the Council could make its best contribution to the public by acting independently.

The Council authorized the appropriation of $1,000 as an initial fund to carry on publicity work, and the committee on publicity and publications was given authority to set up a board of engineering editors.

It was voted that full expenses of members of the executive board for attendance at meetings would be paid.

A special committee reported on candidates for permanent executive secretary of the organization, but no final action on the appointment of this officer was taken at the meeting.

There was a general feeling expressed that the meetings of the board should be held at different centers, and the place of the next meeting, which will be held Feb. 11, was left to the discretion of the president.

New York Section of Am. Soc. C. E. Discusses Port Problem

The problem of the port of New York was broadly discussed by ten engineers and port authorities at the meeting of the New York Section, American Society of Civil Engineers, Dec. 15. Communications from four others were read. The meeting was presided over by Colonel W. J. Wilgus, president of the section, who outlined the subjects requiring consideration. The principal paper was presented by B. F. Cresson, Jr., chief engineer, New York-New Jersey Port and Harbor Development Commission. In the discussion which followed a debate took place between Murray Hulbert, commissioner of docks, New York City, and Julius Henry Cohen, counsel of the joint commission, on the effect of the proposed port treaty between the two states. A report of the technical discussion and an abstract of Mr. Cresson's paper appear elsewhere in this issue.

Hold Conference for Operators of Iowa Sewage Plants

To encourage better operation of sewage disposal plants in Iowa and to stimulate and train operators was the purpose of the second state conference on the operation of sewage disposal plants held Dec. 9 and 10 at Iowa State College under the auspices of the department of engineering extension, for which R. S. Wallis is municipal engineer. The papers related to the more ordinary features of sewage problems. Prof. J. H. Buchanan spoke on "The Composition of Sewage"; R. S. Wallis on "The Methods of Sewage Disposal" and on "Upkeep"; Dean Anson Marston on "The Relation of Sewage Treatment to Water Purification"; P. F. Hopkins on "Grit Chambers"; Prof. C. S. Nichols, on "Sewage Screens" and "Industrial Wastes"; Langdon Pearse on "Sewage Sedimentation Tanks and Their Operation" and on "Modern Plants"; L. E. Rein on "Sewage Dosing Chambers and the Care and Operation of Sewage Siphons"; C. H. Currie on "The Construction of Intermittent Sand Filters"; Prof. Max Levine on "The Role of Bacteria in Sewage Disposal"; Lafayette Higgins on "The Operation of Intermittent Sand Filters" and on "Sludge Disposal"; Prof. J. H. Dunlap on "Inspection Experiences"; Prof. M. L. Evinger on "Construction and Operation of Trickling Filters and Contact Beds."

In addition to the discussion of the papers operators stated their experiences in scraping and maintaining sand filters and quick tests for good drying sludge. A demonstration of sewage bacteria was given in the laboratory.

Albert A. Bowman Sought

It has been requested that *Engineering News-Record* publish the following note: The friends of Albert A. Bowman, formerly of 2 Charter Oak Ave., Hartford, Conn., desire to get in immediate touch with him.

Civil Engineers Reverse Action On Engineering Council

After having passed on Nov. 9 a resolution opposing the discontinuance of Engineering Council, the executive committee of the Board of Direction of the American Society of Civil Engineers, at a meeting held Dec. 6, reversed its prior action and authorized its representatives to join with the majority of the member societies in terminating the existence of Engineering Council. The resolution of Dec. 6 is as follows:

Whereas at its meeting Nov. 9, 1920, the Board of Direction instructed its representatives on Engineering Council to express to Council its hope that Engineering Council, for the present, continue to carry forward its work; and

Whereas it now appears that the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers may, as a consequence of their having joined the Federated American Engineering Societies, discontinue their participation in the work of Engineering Council:

Be it resolved, That the representatives of this society on Council are hereby authorized to join with a majority of the member-societies in action to terminate the existence of Engineering Council at the end of the present calendar year, with the provision that in case of termination of Council the interests of the society shall be properly secured in whatever disposition may be involved of Council's property and records.

Bridge Committee Appointed by Civil Engineers

In response to requests from the membership the Board of Direction of the American Society of Civil Engineers has created a special committee on bridge design and construction, to consist initially of the following members: Howard C. Baird, J. E. Greiner, C. W. Hudson, M. S. Ketchum, B. R. Leffler, A. F. Robinson, H. B. Seaman, F. E. Turneaure, and J. R. Worcester. The committee "shall, as need develops, make recommendation to the board of additional members' required.

Effective correlation of the work of this new committee with bridge specification work by other societies is expected. The Board of Direction in a special resolution expressed its desire that the committee should confer and co-operate with similar committees of other societies, naming specifically the American Railway Engineering Association and the Engineering Institute of Canada.

Civil Engineers Announce Annual Meeting for Next Month

The sixty-eighth annual meeting of the American Society of Civil Engineers will be held at the headquarters of the society, 33 West 39th Street, on Wednesday and Thursday, Jan. 19 and 20, 1921. The business meeting will be called to order at 10 o'clock on Wednesday morning. The annual reports will be read; officers for the ensuing year elected; members of the nominating committee appointed; reports of special committees presented, and other business transacted.

The arrangements for excursions and entertainments will be announced later.

Municipal Engineers of New York Give Dinner to N. P. Lewis

In recognition of the retirement of Nelson P. Lewis, chief engineer of the Board of Estimate and Apportionment of New York City for the last eighteen years and in the service of that city and of Brooklyn for thirty-six years (see *Engineering News-Record*, No. 18, p. 1011), the Municipal Engineers of New York gave a dinner on Dec. 18 which was attended by some 350 members and guests. Addresses were made by F. H. La Guardia, president of the Board of Aldermen, by the Rev. Dr. Berg, pastor of Mr. Lewis' church, by George McAneny, formerly president of the Board of Aldermen and acting mayor, and Charles Whiting Baker, until recently consulting editor of *Engineering News-Record*. The speakers laid stress on Mr. Lewis' high character, tact and conspicuous engineering ability.

Dr. Berg and Mr. McAneny dwelt on Mr. Lewis as a city planner, active in New York City and prominent nationally and internationally. Mr. Baker, in speaking of Mr. Lewis as an engineer, defined an engineer as "a man who sees the end from the beginning" and said that the definition was particularly applicable to Mr. Lewis.

Pittsburgh Society Affiliation Under Discussion

In Pittsburgh the various engineering societies are now considering proposed by-laws for an organization to be known as the "Associated Engineering Societies of Pittsburgh." It would be composed of the Engineers' Society of Western Pennsylvania and of the Pittsburgh sections of the national societies of civil, mechanical, electrical and of mining and metallurgical engineers. Thus far, the civil and mechanical sections have approved of the proposed by-laws and so has the board of the Engineers' Society of Western Pennsylvania. The purpose of the organization would be to secure joint action on matters of common interest. Other engineering organizations would be eligible for affiliation later.

Official Population of the United States Announced

The population of continental United States as of Jan. 1, 1920, has been announced by the director of the census as 105,708,771 and of its outlying possessions as 12,148,738, making a total of 117,857,509. Of the outlying population the Philippine Islands (as of Dec. 31, 1918) has 1,035,640 population; Porto Rico, 1,299,809; Hawaii, 255,912; Alaska, 54,899; Virgin Islands of the United States (Nov. 1, 1917), 26,051; Panama Canal Zone, 22,858; Guam, 13,275; American Samoa, 8,056; military and naval service abroad, 117,238. The population of continental United States in 1910 was 91,972,266 and in 1900 it was 75,994,575, the percentages of increase for the corresponding decades being 14.9 and 21 per cent.

Engineers' Club of Baltimore Reorganizing

The Engineers' Club of Baltimore is reorganizing to include, in a membership of 600, not only technical engineers, but also business men in firms doing work involving engineering. The local sections of the following societies have already affiliated with the engineers' club: American Society of Civil Engineers, American Association of Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, and American Chemical Society. New quarters have been secured in the Merchants & Manufacturers Building. According to announcement of the club it will undertake consideration of civil problems, including industrial and shipping growth of Baltimore, harbor development, housing, city planning of annexed districts, water supply and other public utilities.

Open-Shop Combine Charged Against Steel Producers and Erectors

Evidence that various steel fabricators had during the past year followed a policy of refusing to sell structural steel to any but those who would erect under open-ship conditions produced the outstanding feature in the past week's investigation of housing conditions in New York City by the Lockwood joint legislative committee on housing. Among the steel fabricators mentioned in the testimony taken on this subject are the United States Steel Corporation, the American Bridge Co., a subsidiary of the steel corporation, the Bethlehem Steel Corporation, and others. It is alleged that this open-shop combine existed between these various fabricators and erectors associations, including the National Erectors Association and the American Erectors, the two leading national steel erectors, associations.

It is estimated that at least two weeks will be consumed yet in the investigation of labor and construction conditions in the building industry before the Lockwood committee will be able to take up banking and insurance features. It is likely that an investigation will still be made of the Building Trade Employers' Association and its connection with organized labor, and of alleged combinations of dealers and contractors in glass, plumbing supplies, terra cotta, pipe, electrical supplies, and lumber.

Another Chicago Subway Project

An 18-mile subway system proposed by the Chicago traction commission would begin in the business district and extend west under Madison St. to Ashland Ave., where lines would diverge to the northwest and southwest sections, with loop terminals at Lawrence Ave. and 63d St. respectively. Plans have been prepared by G. W. Jackson, engineer for the commission.

Bottom of Depression Nearly Reached, Says Chamber of Commerce

The bottom of the present business depression will be reached in the next thirty days, in the opinion of Archer Wall Douglas, chairman of the committee on statistics and standards of the Chamber of Commerce of the United States, in his monthly report on general business conditions, made public Dec. 21 in *The Nation's Business*.

"Advances of any moment in the prices of agricultural products," says Mr. Douglas, "will materially change the situation for the better, and reductions in the prices of commodities are likely to cause increased business in all industrial sections." Acute phases of the present depression will wear away steadily as the public adjusts itself to changed conditions brought about by a return to normal. Unfavorable agricultural situations, especially, have an unexpected way of remedying themselves.

"From the unfounded fears of last spring of bread lines in the cities and shortage of food everywhere, we are awakened to the startling realization of a harvest so great that we cannot at once find an adequate market for our surplus products. So there ensues that inexorable law of supply and demand which decrees that overproduction is always accompanied by falling prices.

"There is a general belief that there will be a revival of building in the spring, because conditions will be more favorable, and the necessities of the situation are more pressing."

Board of Estimate Recommends Contracts Be Cancelled

The Board of Estimate and Apportionment of New York City has approved the recommendation of Corporation Counsel O'Brien for the cancellation of three public school heating and ventilating contracts held by Gillis & Geoghegan, the ground for the cancellation being that the firm, through its alleged association in the John T. Hettrick "Code of Practice," was in collusion with other bidders. The three contracts total $333,260.

Will Consider Housing Problems

Most of the sessions of the Chamber of Commerce of the United States at Washington Jan. 27 and 28 will be devoted to housing problems. The three main topics will be: The social and civic effects of housing shortage; effects of building stagnation on business conditions; and the housing of employees by industrial concerns. John Ihlder, formerly field secretary of the National Housing Association, is head of the newly created Civic Development Department of the Chamber of Commerce of the United States, the headquarters of which are at Washington.

New B. & O. Bridge Placed Over Allegheny River

Replacement of the Allegheny River bridge of the Baltimore & Ohio R.R. at 33rd St., Pittsburgh, was successfully completed Dec. 20 with a series of rolling and jacking operations by erecting forces of the American Bridge Co. The new bridge is at a higher level than the old structure built in 1884.

Ohio Highway Commission Asked To Reduce Road Estimates

Governor James M. Cox of Ohio has requested the Ohio Highway Commission to reduce the estimates on all highway construction jobs after Jan. 1 by 20 per cent. He maintains that reduction in costs of labor and materials justify such reductions. Contract bids exceeding the estimates are not accepted, thus estimates are held to be a criterion of the cost of the work.

Dilution of British Building Trades Operatives Blocked

According to recent dispatches from London the British National Federation of Building Trades Operatives has decided not to accept the invitation of the Labor Minister to discuss a scheme for absorbing 50,000 unemployed ex-service men in the building industry. In view of the fact that the building trade is in need of many thousands more workers the government had been negotiating with the unions concerned for the purpose of arranging for the dilution of labor by the introduction of unemployed ex-service men. The government's plan has been readjusted several times to meet the objections raised by the unions and the final proposals were discussed at a recent meeting, ending in the indicated refusal of the building trades workmen to have their personnel diluted.

Senate Reconstruction Committee to Broaden Scope

The senate committee on reconstruction, of which Senator Calder, of New York, is chairman, has been given, through recent Senate action, permission to employ counsel, with the limitation that the salary to be paid shall not exceed $5,000. The action of the committee in broadening its scope and increasing its powers has been the result of recent developments made by the Lockwood joint legislative committee on housing, which is investigating the building situation in New York City. It is the intention of the Senate committee on reconstruction to continue its nation-wide investigation of the housing problem and to include an inquiry of the building trade situation in practically every state in the Union.

It is understood that the Senate committee has the power to grant immunity to witnesses, a power which the Lockwood committee does not directly possess. It is also understood that the Senate committee is considering Samuel Untermyer, counsel for the Lockwood committee, as its counsel.

New York Cut Stone Contractors Plead Guilty and Are Fined

When arraigned before Justice McAvoy, of the criminal branch of the Supreme Court, New York, last week, the thirty-one members of the New York Cut Stone Contractors Association, indicted by the grand jury as a result of evidence produced by the Lockwood joint legislative committee on housing, pleaded guilty to the charge of collusion in bidding and were fined $5,000 each.

California Highway Finance Board Is Organized

Organization of the California highway finance board, which was created by an amendment at the November election, as announced in *Engineering News-Record*, Nov. 11, p. 962, was effected on Dec. 14. Governor W. D. Stephens is chairman; F. W. Richardson, state treasurer, is vice-chairman; and N. D. Darlington, chairman of the state highway commission, is secretary.

To clear up all matters in connection with the sale of the bonds a friendly suit is to be entered at once in the Supreme Court. Meantime the state treasurer is to prepare the bonds so that they may be offered for sale when the decision is rendered.

Pennsylvania Builds 410 Miles of Concrete Roads in 1920

The State Highway Department of Pennsylvania during the 1920 construction season built approximately 410 miles of 18-ft. concrete roadway. In 1919 253 miles were completed. Illinois makes the closest approach to Pennsylvania's record, having put down approximately 339 miles of concrete during the present season.

The maintenance forces of the state highway department during 1920 entirely resurfaced 377 miles of macadam highway and surface treated 1,480 miles of the same type. In all, the maintenance forces maintained 9,503 miles of roadway. Of this mileage 463 miles were in boroughs and an state-aid roads.

Pennsylvania now has under construction approximately 350 miles of concrete roads, the completion of which will be impossible this year because of the lateness of the season. The department plans the awarding of contracts for an additional 350 miles of concrete roadway early in 1921 and hopes to be able to complete not less than 600 miles of durable highways next year.

Water Supply Paper Wins Prize

The prize committee of The Municipal Engineers of the City of New York has awarded the prize for the most meritorious paper read before the society in 1919 to Frank E. Hale, chief chemist Department of Water Supply, Gas and Electricity and director of the Mount Prospect Laboratory, New York City, for his paper on "The Safeguarding of the Water Supply of New York City.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City, Jan. [illegible], 1921.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. [illegible].

ENGINEERING INSTITUTE OF CANADA, Montreal; Toronto, Feb. 1-3.

The Engineers' Society of Milwaukee was addressed Dec. 15 by T. Chalkley Hatton, chief engineer, Milwaukee Sewerage Commission, on "The Progress Made on the Sewage Disposal Plant to Date."

The Minnesota Joint Engineering Board at a meeting Nov. 27 elected the following officers: President, Adolph F. Meyer; vice-president, H. T. Downs; secretary-treasurer, Hans J. Meyer. Six societies have ratified the constitution of the proposed Minnesota Federation of Architectural and Engineering Societies.

The Mohawk Valley Engineers' Club, Utica, N. Y., at its annual meeting elected the following officers: President, Byron E. White; first vice-president, Horace B. Sweet; second vice-president, William B. Foster; third vice-president, Charles T. Myers; secretary, George I. Putnam; treasurer, Clifford Lewis, Jr. The meeting was addressed by O. J. Childs, chief engineer, O. J. Childs Fire Extinguisher Co., who gave facts about fire losses.

The Illinois Section, Am. Soc. C. E. and the **Chicago Engineers' Club** were addressed Dec. 10 by S. T. Henry, vice-president, Allied Machinery Co. of America, on "Opportunities for American Engineers and Contractors in Latin America."

The Engineers' Club of Baltimore is planning to occupy new quarters in the Merchants and Manufacturers' Association Building.

The Florida Engineering Society will hold its annual meeting at Lakeland, Fla., Feb. 7 and 8. Matters of interest to engineers to be brought before the State Legislature will be discussed and action taken.

The Washington Society of Engineers on Dec. 15 elected the following officers: President, R. L. Faris; vice-president, Lieut.-Col. F. W. Albert; secretary, A. C. Oliphant; treasurer, G. P. Springer.

The Engineers' Club of Trenton, N. J., has elected the following officers: President, C. R. Waller; vice-president, H. F. Harris; second vice-president, J. W. Thompson; secretary, J. E. English; treasurer, J. H. Johnson.

The Providence Engineering Society at a meeting Dec. 7 was addressed by Dr. Katherine M. H. Blackford, character analyst, on "Reading Character at Sight."

The Duluth Engineers Club recently received from its committe appointed to examine the proposed Minnesota Registration Act a report endorsing such legislation, but pointing out certain undesirable features of the Joint Engineering Committee's bill, particularly section 2 which would authorize non-registered individuals to conduct professional work The report was signed by D. E. Woodbridge, chairman, T. W. Hugo, Park Fuller, F. H. Fitzgerald and H. J. Underhill.

Personal Notes

MAURICE A. LYNCH has resigned as acting district engineer, Pennsylvania State Highway Department, with headquarters at Smethport, Pa., and is now with the Kohler Co., Philadelphia, Pa., manufacturer of enameled plumbing ware and power and light installations.

FAY M. RAYMOND, recently with Burns & McDonnell, consulting engineers, Kansas City, Mo., as supervising engineer on the water-works improvement work at Erie, Kan., has accepted a position as supervising engineer in charge of paving work in Neosho County, Kan.

JOHN KLORER, for eight years assistant state engineer, La., has been appointed city engineer, New Orleans, La.

A. M. EVANS has resigned as city engineer of Norwich, N. Y.

CAPT. M. L. WORRELL, who for three years has been serving in the Utilities Section, Construction Division, U. S. Army, has received his discharge from the army and has taken a position with the U. S. Bureau of Public Roads as highway engineer.

O. H. DRAPER has entered the employ of Anniston, Ala., to be associated with Assistant Engineer E. L. Woods on paving work.

DR. CRAIG ARNOLD has been appointed engineer for the State Highway Department of Georgia.

C. P. C. BERESFORD has, after seven years on the West Coast of Africa, resigned his position as general manager of Prestia Co., to take up the post of consulting engineer to the Patino Interests in Bolivia, with head office at Oruro.

F. C. WYSE has resigned as city engineer of Columbia, S. C., to enter the engineering and contracting business.

W. S. TOMLINSON, formerly head of the Tomlinson Engineering Co., has been appointed city engineer of Columbia, S. C.

JOHN K. HARRIS has been appointed borough engineer of Sharon, Pa.

HUNTER A. HAMMILL, formerly an instructor in civil engineering, University of Pennsylvania, is now connected with the engineering department, Bell Telephone Co. as engineering assistant.

DANIEL B. GOODSELL, recently an advisory engineer on roads to the Construction Division, War Department and formerly assistant engineer, Bureau of Highways, Borough of Manhattan, New York, has been appointed field engineer of the Portland Cement Association for the Tidewater District of Virginia with headquarters in Richmond.

HOWARD H. GEORGE, who has been connected with the Public Service Railway Co., Newark, N. J., since 1906, has been appointed engineer maintenance of way. During the World War he commanded Company A, 55th Engineers and served with them in France in charge of building construction of the Chateauroux storage depot project, and on railroad construction at Le Havre.

E. R. DAVIS, formerly assistant city engineer, Newport News, Va., has been promoted to the position of chief engineer.

CHARLES A. POHL, a member of the firm of Bogart & Pohl, consulting engineers, New York, has been appointed chief engineer of the Niagara Gorge Railroad Co.

MAURY NICHOLSON, formerly chief engineer, Chickasaw Utilities Co., Birmingham, Ala., has been appointed highway engineer for Mobile County, Ala.

GEORGE COTTINGHAM, JR., formerly roadmaster, Northern Pacific Ry. at Carrington, N. D., is now engineer maintenance of way, Eastern Division, Chicago Great Western R.R., with headquarters at Chicago.

R. W. WILLIAMS, assistant to the chief engineer, Southern Railway at Washington, D. C., has been appointed engineer maintenance of way and structures of the Southwestern district, with headquarters at Chattanooga, Tenn.

F. H. MOYER, chief engineer, Cambria Steel Co., has resigned to accept a position as works manager, Pittsburgh Crucible Steel Co., Midland, Pa.

ALBERT W. DILLING, acting engineer of bridges, Department of Public Works, Chicago, has been appointed chief engineer of the Sanitary District of Chicago, succeeding E. J. Kelly, who has held the position since George M. Wisner resigned in May. Previous to his present position which he has held since April, Mr. Dilling was engineering assistant to the commissioner of public works for three months, being assigned to look after the city's interests in connection with the Union Station development. Mr. Dilling's first five and one-half years of engineering experience was gained with the Chicago, Milwaukee & St. Paul Ry. Co. Thence he went with the Universal Portland Cement Co. for two and one-half years as assistant engineer, and finally as field engineer in the promotion department. While in railroad service he studied law and has been admitted to the bar. He is a member of the board of directors of the Western Society of Engineers and has been active for a number of years in its affairs.

Obituary

JOHN SCOTT, for several years active in Canadian railway enterprises, died Dec. 6 at Winnipeg, Canada. He was a designer and builder of bridges, took part in the Hudson Bay road building and was also connected with provincial drainage operations.

CHARLES J. McDONOUGH, division engineer, New York State Highway Department, died in Buffalo last week. He was born in Buffalo in 1883 and was graduated from Rensselaer Polytechnic Institute, 1897. From 1898 to 1904 he was with the Bureau of Engineering, Buffalo, on paving work, first as leveler and later as assistant engineer in charge of pavement maintenance. He then entered the service of the state as assistant engineer on barge canal work. In 1907-1909 he acted as first assistant engineer in charge of contract from Tonawanda to Pendleton and then in 1910 was named resident engineer. Important projects which were directly under his supervision were the erection of seven highway bridges across the canal, excavation, culverts, docks, guard-gate and lock walls.

JOSEPH H. CUNNINGHAM, hydraulic and civil engineer, died Dec. 5 at Portland, Ore.. He was born at Danville, Ill., 1863. From 1883 to 1885 he served an apprenticeship under the city engineer and county surveyor of Danville, Ill.; 1886 to 1887, resident engineer, Mobile & Birmingham R.R., Ala., in charge of construction of from 30 to 60 miles; 1888 and 1897 to 1898, asssitant engineer, city engineer's office, Los Angeles, Cal.; 1889 to 1891 in general practice, Portland, Ore.; 1892, assistant engineer, Bear Valley Irrigation Co., Cal., and later with the Washington Water Power Co., Spokane, Wash. During 1894 and 1895 he was assistant U. S. Engineer, Williamette River surveys and improvements; 1896, assistant engineer, city engineer's office, Salt Lake City, Utah, in charge of sewers and steam gagings. Since January, 1899, he had been in general practice as civil and hydraulic engineer in Portland.

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—James H. McGraw, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

Volume 85 — NEW YORK, THURSDAY, DECEMBER 30, 1920 — Number 27

Engineers in Port Planning

IN SPITE OF such attempts to relegate the engineer to a position as day laborer under the "practical" shipping man, as that recently made by Director Sproule, of Philadelphia's Department of Docks, the place of the engineer in harbor-terminal planning is firmly established by results in ports where he is the directing mind. Elsewhere in this issue is published a discussion, by an engineer, on the type of harbor planning that will be necessary to maintain supremacy in world trade. Here Colonel Wilgus ably demonstrates the vital importance of engineering considerations, as opposed to political and "practical" shipping considerations. Following Colonel Wilgus' paper appears the "policy" of the Port Development Commission of Baltimore, of which an engineer is chairman. At the port of New York policies are not now guided by engineers but by politicians and "practical" shipping men, with results that have made local port conditions the subject of national criticism. The policy of the Baltimore commission is so broad and clear that we publish it in full. Incidentally it emphasizes the dominance of the engineer in port planning.

Rental Charges for Equipment

DISPUTE invariably arises between engineers and contractors whenever there is occasion to determine rental charges for construction equipment. The engineer prone to regard averages as representing the facts, the contractor knowing that an average may represent a profit under one condition and a loss under another condition and neither being in possession of authoritative records of either extremes or averages, there is naturally a broad field for battle. Particular value, therefore, lies in the schedule of rental charges published on page 1288, which has been worked out after almost two years' study by the Associated General Contractors of America. There are few records of construction data which have been subjected to a more general and at the same time a more detailed scrutiny, item by item, than has this schedule which is now made public. It is therefore, definitive, as far as such lists of figures may be. There can never be, however, a final set of averages nor a set of averages which will apply under all conditions. These are facts which engineers and contractors must always keep in mind and be prepared to modify the schedule values as sound judgment, taking into consideration the attending circumstances, may dictate.

Protecting Roads in Spring

NOT so long ago highway officials felt that they were helpless to keep heavy traffic off the highways during the spring break-up. Their ideas, however, have changed radically within two years. What was regarded an impossibility in 1917 is established practice in some states now, while universally there is insistence that powers be given the state highway departments and to county officials to keep heavily loaded vehicles off the less-well surfaced highways during the period when the frost is coming out of the ground. The matter needs fresh and urgent consideration at the present time because most of the state legislatures will be in session this winter and the powers needed by the highway officials to protect the public's investment in roads can be secured. The highway sentiment is so strong at the present time that there is no difficulty in convincing a legislature that the community's investment should not be ruthlessly destroyed during the two or three short weeks of post-winter subgrade softening. The sort of enabling legislation should be extremely broad, merely conferring on the appropriate officials power to make such regulations as in their judgment are necessary to preserve the integrity of the roads at this critical period. If there be those who oppose the legislation they should be very ruthlessly exposed. No matter how great their seeming influence, they cannot withstand a plain statement of the primary rights of the community. The public is prepared to support sound highway policy.

Study of Ethics

AS ONE of the last items of the year's news concerning professional development comes the announcement that two national societies will co-operate in the attempt to write a new code of ethics. The American Society of Civil Engineers has just appointed a committee to co-operate with a committee of the mechanical engineers in the work. We welcome the attempt as a hopeful sign of progress, not because it will produce the best code of ethics—or indeed any code whatever—but because it will increase the thought which engineers of many pursuits will devote to the ethics of their relation to public and to colleagues. It is inevitable that each one of these engineers will, by virtue of such reflection, become more keenly conscious of the special public trust with which he is charged by virtue of his profession's place in community existence. So, even without the production of a code—and only a few weeks ago we stated our belief that civil and mechanical engineers can not easily find common ground for conclusions on professional ethics—co-operative study of the subject will yield benefit to the public as well as to the profession, by quickening the professional conscience and recognition of the duty of service. Beyond this, however, it is broadly true that any movement which aims to re-formulate basic principles of just conduct is of very special value at the present time. And, as the engineer's objective attitude is most essential to the world's reconstruction, it is fitting indeed that his profession should be among the first to enter upon this work of leadership.

Engineering and a Naval Base

WITH the selection of the site for a naval base the engineer as a rule has little to do. Leaving aside some elementary precautions as to foundations, the engineer will be able generally to build such a base wherever the military authorities decide is proper from the viewpoint of policy and strategy. This is not true of the San Francisco repair and supply base, the alternative locations of which are noted in the article on another page. Here the military requirements are equally, or almost equally, satisfied in any one of three locations and the proper selection unquestionably hinges on engineering details. The brief résumé of the advantages of the respective sites were much amplified in the hearings before the congressional committee, which must make the ultimate decision, but the publicity which has been given those hearings in the West does not, in our opinion, emphasize as it should the one superior quality that Mare Island possesses. That is the utilization of the costly and complete equipment of the Navy Yard existing there. Our naval authorities assert that speed in the construction of the new base is essential, if our Pacific naval policy is to be continued, and yet the advocates of San Francisco and Alameda would virtually scrap the Mare Island yard and proceed to the duplication of the most part of its equipment which will be necessary for the new base. Some years ago the channel defects at Mare Island were urged against it. Today those criticisms have been answered. Foundation difficulties at Alameda are great; San Francisco itself is ill-advised in wanting to give over for all time a large part of its not too long shore line, which, with Boston and Brooklyn before it as examples, it should want to reserve for commercial use. Mare Island and Vallejo, with no voters to speak of, can only stand on the engineering merits of their claim for preference. It will be interesting to see how much influence they have on the congressional committee.

Safety Factors for Columns

SOME recent Bureau of Standards studies of spruce struts afford a new demonstration of the fact that well-executed breaking tests of columns plot very satisfactorily in curves of the Rankine-formula type. The same fact has been shown to hold for other brittle materials—and when column behavior is in question, wood must be classed as a brittle material, since it lacks plasticity. Tests of steel and wrought-iron columns follow the same law fairly well in the upper range of length, while in the case of short lengths, where plastic deformation enters as a factor, it is at least open to question whether the point of elastic failure is not also in conformity with a Rankine curve. If it be granted that the formula for allowable loads on columns should be adapted to the breaking-load curve (which means that columns of all lengths are to have a uniform factor of safety), the case for the Rankine-Gordon formula is much stronger than the popularity of straight-line column formulas would indicate. But any theory of a uniform factor of safety fails in the face of the practice of fixing a maximum length-ratio for columns with a view to obtaining safe and substantial construction. Moreover, safety factors are matters of engineering rather than mathematical reasoning, so that a working formula can hardly be "derived" by so simple a process. It is fair to consider, therefore, whether there is any method by which test data can be utilized directly in determining a working formula for column design. The method, it would appear, must base on a study of safety factors. Hitherto column formulas have been selected by judgment in such a way that their correlation with test results has been uncertain. But if an analysis of service conditions and hazards will lead to reasonable conclusions as to the varying degree of safety desirable for different column lengths, application of these conclusions to test data will make it practicable to devise a column formula of maximum simplicity and economy of result combined with reliability.

Hydro-Electric Leadership in California

PERHAPS it is the pioneering spirit of the forty-niners reappearing in somewhat different form with the present generation, or it may be sheer necessity for leading the way in electrical fields, but whatever the reason, certain it is that the power companies of California are showing a progressive and courageous policy in their present water-power development program. A dozen or more large projects undertaken almost simultaneously could perhaps be accounted for wholly on the basis of delayed development and increasing demand for power, but new ventures in design, as described elsewhere in this issue, indicate a high degree of technical skill and the ability to convince capital that money spent on units and systems greatly in excess in size to previous practice will be a safe and profitable investment. Some of these ventures are a 165,000 and a 220,000-volt transmission line, an 806-ft. head on a reaction turbine, 40,000 hp. from a single vertical-shaft reaction turbine and 30,000 hp. from a double-overhung impulse wheel under a 1008-ft. head.

For years California has led other states in the amount of electrical energy consumed per capita. In view of the time and money spent there to bring hydro-electric development to a high degree of efficiency, it is to be expected that valuable lessons could be learned from California's experience. For example, the present trend is toward wholesale interconnection of transmission lines to make the continuity of service more certain and to make possible the exchange of "off-peak" power with the attendant improvement in load factor. All this tends to keep the companies working together harmoniously, which, in the end, benefits the consumer.

Another excellent feature of California practice—logical but none the less worthy of emphasis—is the practice of considering at the very outset, along with preliminary surveys of sites, elevations, etc., the relation of each proposed plant to existing or possible future developments. Such practice has developed because in times past there have been difficulties with plants and systems which were laid out on the old selfish basis of the greatest income from the immediate investment and with little or no consideration for later interests. Fortunately, the lesson was learned in time to be of advantage in the extensive program now under way.

In some states it has been proposed that water-power development should be permitted only after approval by a state commission which could co-ordinate the various units in a generally advantageous scheme. California has secured just that result without special legislation, apparently because the companies have found that what profits one can profit all if harmony prevail.

What About the St. Lawrence Waterway?

ACTING under instructions from the United States and Canadian governments, the International Joint Commission is now going across the two countries holding hearings on the feasibility of the proposed St. Lawrence River waterway. In time, let it be hoped a short time, it will digest the arguments made before it and, supported by the technical facts gathered by the engineering attachés, will present a report from which engineers may draw a concerted conclusion. Meanwhile, practically all discussion is partisan, because those who talk or write about it are predisposed, either by local influences or by retainer, toward one side or the other. Nevertheless, independent engineers ought to be thinking about the project, not only as citizens because they may be called upon to pay their share toward the huge sums which it involves, but also as members of a profession to which the country looks for unprejudiced and expert advice.

Until the report is available, it would be hasty to take a definite stand on the Lakes-to-the-Sea waterway. The problems are too involved and the sums to be expended too vast for an opinion built up only on assumed bases. It is worth while, though, to set down the fundamental questions that will have to be settled before a concerted judgment can be formed.

The proposal is that the St. Lawrence River from Lake Ontario to Montreal be deepened, dammed, or canalized to such an extent that deep-water navigation—25 to 35 ft.—is made possible. This involves some means of bypassing Niagara—presumably by the new Welland ship canal—the deepening of the other lake connections, the ultimate deepening of all lake channels and harbors, and the construction of port facilities to take care of the traffic for which the whole project is designed. It involves, also, the development of enormous amounts of power in the river, although such development is in no way dependent on the navigation scheme but will only be made cheaper by certain structures common to both navigation and power projects.

The issues are fairly clear, though their solutions are not. The advocates of the waterway see the freight of the world brought to the wharves of the Great Lakes cities by through ships, so that the lake cities, and with them their rich hinterland, will take on the size and importance that world-wide commerce brings. They see, too, as a necessary part of the canalization of the river, the construction of great reservoirs from which large amounts of hydro-electric power can be generated cheaply because of the joint assumption of the cost burden by the navigation and power developments. On account of the reduced cost to the Middle Northwest of transporting its products to world centers, and the reduced cost of power to the Northeast, they see a sectional prosperity which will spread over the whole country, manifesting itself sufficiently in lowered prices to make equable the spreading of the cost burden on all the people of Canada and the United States.

For these benefits they think the whole United States and Canada should be willing to expend a sum which has not yet even been estimated. The first datum that must be established is this cost. Estimates, based merely on guesswork and not even on preliminary engineering surveys of the situation, range from two hundred to three hundred million dollars. Everyone knows that the first rough estimate for public work extending over a large area and a long time is always too low. A reference to the history of such projects will confirm this. Prices tend always to increase; scope is always enlarged and never diminished; unknown and unexpected factors invariably enter. So it is safe to say that even an expert preliminary estimate may be added to materially for an indication of the real cost. The St. Lawrence project, including the necessary deepening of many harbors and channels and the construction of terminals may well run up to two or three times the estimates now given.

Such an expenditure may be warranted by the accrued benefits, but a thorough analysis of the costs and benefits, reduced as nearly as possible to dollars, must be made available before going ahead. Consideration must be given to other mammoth plans that call for national expenditure. The Mississippi and Ohio River advocates want a lot of money for their work and in the Far West far-seeing people are beginning a strenuous campaign for funds to turn the arid and over-wet lands into food-producing country. The Columbia River Basin project alone will cost nearly $300,000,000 and it certainly is a fair question whether it would not benefit the country at large much more tnan the St. Lawrence waterway.

Another question on which engineers will want knowledge is the possibility of a ship being built which can operate economically on both lakes and ocean. This is a critical issue. If bulk has to be broken anywhere along the line, say at Montreal, the benefits of the waterway will be materially reduced and may not be greater than those from the New York Barge Canal. True, the total carriage from the Lakes to northern Europe will be shorter and there will be one less transfer, but once bulk is broken the advantage of a single break over a double break is probably not sufficient to warrant the large expense involved.

The probable cost and the possibility of through navigation are the two big elements that must be studied but there are several others to be considered, though they are subordinate. These include the possibility of international complications, which involves, too, the distribution of cost between the United States and Canada and the fact that this is, on account of ice obstruction, is only a seven-months' waterway. Neither Canada nor the United States is a unit in demanding the improvement, so the certain charges from both sides of the line that this is a selfish national proposal may be discounted in advance, but the possibilities of dispute and trouble in so large a joint undertaking must certainly be weighed. As for the part time use of the waterway, there is much point in the accustomed reference to Montreal's successful seven-months' port.

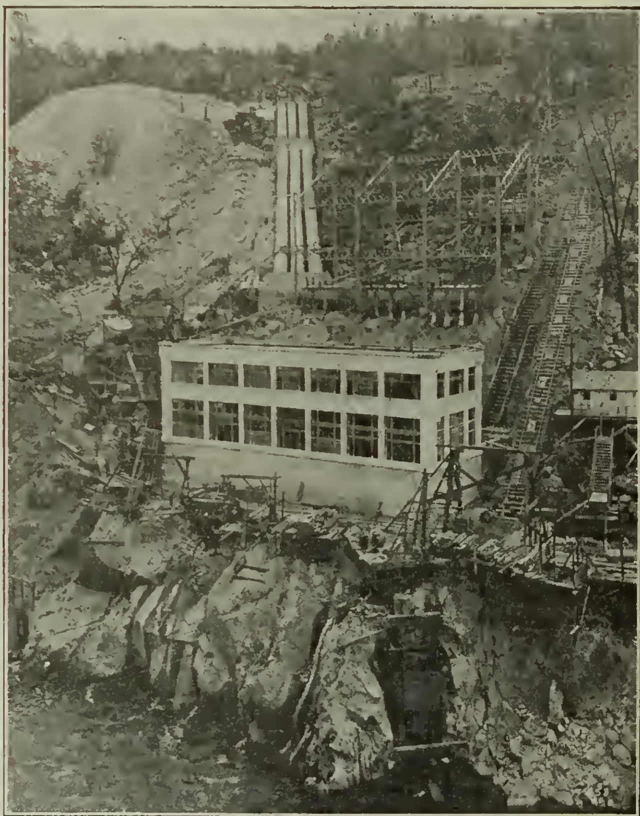
Finally, the possibility of hydro-electric development must not be overemphasized. Power is unquestionably needed in the St Lawrence district and nothing can stop its production there. The question to be decided is whether the saving made by tying in that power development to canalization is worth the extra cost the navigation improvement entails.

These are the essential elements in the St. Lawrence scheme. It is the greatest engineering problem now before the American people, for, make no mistake, the Middle Northwest is aroused in favor of it and will fight for its adoption. Engineers who look beyond their daily job should be studying its possibilities and difficulties.

Forward Steps in California Hydro-Electric Designs

Unusual Features Include 200,000-Volt Transmission Lines and Larger Units and Higher Reaction-Turbine Heads Than Have Previously Been Used

THIS is a day of great hydro-electric development on the Pacific Coast. In California, particularly, many large projects have been undertaken since the war and a group of thirteen now under way there, of which all but two are to be in service by January, 1922, will develop the large total of 522,600 hp. Numerous problems have arisen which called for pioneer work, and several new records have been established. Typical of these are the 40,000-hp. single-runner units for the Fall River plant, the 806-ft. head on reaction turbines at Kern 3 and the 220,000-volt power line that is to bring Pit River power to San Francisco. Apart from considerations wholly within the field of design, very definite progress has been made in the development policy. Preliminary studies are now made so comprehensively that ordinarily before construction work is started on any one plant the interrelation of all the others which may later be built in the same basin is analyzed in the light of the ultimate unified system. This idea, carried out between systems as well as between units, has united more than a hundred steam and hydraulic generating stations in a synchronous power network that extends the full length of California and thence well up into Nevada—a total of 1,400 miles from end to end. How thoroughly these main trunk lines are supplemented by branches and laterals is shown by the fact that the interconnected network has a total of 7,200 miles of high-tension line.



KERCKHOFF PLANT ON SAN JOAQUIN RIVER

During the war there was practically no hydro-electric development in California, but the power demand was steadily increasing. The increase averaged about 11 per cent per annum for these four years. Overlapping the latter part of the war period came three consecutive seasons of drought, which decreased the supply of hydro-electric power far below normal. Thus in a period when the industrial demand was very urgent the power shortage very effectively emphasized the need for a greater margin of hydro-electric power. This power was needed not merely because there was demand but to conserve fuel oil for such uses as were not adaptable to electric power—in ships, aircraft, etc.

After the war, and when the financial situation was finally such that construction could proceed, developments were begun simultaneously in many sections of the state. In planning these additions to the power system it was assumed, in a number of instances at least, that the power demand for the next five years might be expected to increase 12 per cent per annum. In this connection it may be noted that the total hydro-electric power that can be economically developed in the State of California is now estimated at 3,000,000 hp. Of this only about one-fifth of the better primary sites have thus far been utilized.

In developing this small percentage, however, an excellent foundation has been provided on which to carry out the more extensive plans. Seventy-five hydro-electric plants in the state are interconnected, the total power aggregating about 470,000 hp. At various points on this network the service is supplemented by forty-seven steam standby plants that can supply a total of 315,000 kw. The load on this system has been built up in such a way that the load-factor on the entire network is between 60 and 65 per cent.

An example of the pioneering policy pursued in these California developments is found in the system of the Southern Sierras Power Company, which has built a transmission line 400 miles long and delivers the major part of its 20,000-hp. load this distance.

Topographic and Climatic Conditions.—For the most part the hydro-electric power sites are in the high mountain region on the eastern edge of the state, while the centers of consumption are in the lowlands of the valleys or along the coast. Under the widely varying conditions in the northern and southern districts a variety of problems has arisen, which has naturally led to pioneering ventures. Typical of the divergent conditions is the fact that in the Pit River basin no storage is required, while in those developments in the central or southern parts of the state it is customary to provide enough storage to supply the full flow for about half the year.

Neither the Hat Creek nor the Fall River developments (Pit River Basin), which are to develop a total of 181,600 hp., are being provided with storage because of the remarkably equable stream flow they utilize. The geological formation in this entire section, some 5,000 sq.mi. in extent, is such that the precipitation on a large area passes through underground lava beds and reappears in large springs, almost perfectly regulated. The streams of this area are regarded as ideal for

PRINCIPAL CALIFORNIA HYDRO-ELECTRIC PROJECTS UNDERTAKEN [illegible]

Name of Plant	Distance via Transmission Line to Distribution Center	First Installation in Hp.	Date of Completion	Head in Feet	Type of Wheels	Ultimate Installation in Hp	Transmission Voltage	Company
Pitt River Basin:								
Fall River No. 1..		80,000	Aug. 1921	430	Two 40,000-hp vert [illegible] runner reaction [illegible] Allis-Chalmers	80,000		
Pit River No. 1...	245 miles to center of San Francisco Bay District....	80,000	July, 1922	335	Two 40,000-hp. vert single-runner reaction turb.; contract not awarded......	80,000	110,000 [illegible] 220,000	[illegible] Elec. Co.
Hat Creek No. 1..		9,300	Jan., 1921	215	One vert. single-runner reaction turb.; Wellman-Seaver-Morgan	9,300		
Hat Creek No. 2..		12,300	Jan., 1921	195	One vert single-runner reaction turb.; W.S.M.	12,300		
Caribou Plant......	195 mi. to San Francisco (N. Fork Feather River	60,000	Feb., 1921	1,008	Two 30,000-hp double overhung impulse wheels; Allis-Chalmers	12[illegible]	165,[illegible]	[illegible]
Moccasin Creek....	140 miles to San Francisco (on Hetch Hetchy project).....	75,000	Probably 1923	1,300	Three double-runner 25,000-hp impulse wheels; contract not awarded	15[illegible],000	154,[illegible]	[illegible]
Levining Creek......	400 miles to Riverside......	15,000	Oct., 1921	1,595	One single overhung impulse wheel, contract not awarded	15,000	87,500 [illegible] to 14[illegible]	[illegible]
Spring Gap........	130 miles to San Francisco....	9,500	May, 1921	1,860	One single overhung impulse turbine, Pelton........	9,500	11[illegible]	[illegible] Co.
Kerckhoff Plant....	40 miles to Fresno (San Joaquin River)..............	45,000	Aug., 1920	335	Three 15,000-hp. vert. single-runner reaction turb.; Allis-Chalmers	50,000	11[illegible]	[illegible] Lt. & Power Co.
Big Creek No. 2A (new unit).......	240 miles to Los Angeles....	22,500	Jan., 1921	2,400	One 22,500-hp. double overhung impulse wheel; Pelton	22,500	Now	
Big Creek No. 8....	240 miles to Los Angeles......	25,000	Jan., 1922	717	One 25,000-hp. vert. reaction turb., I. P. Morris	120,000	150,000	[illegible] Cal. Edison Co.
Kern River No. 3...	130 miles to Los Angeles....	45,000	Feb., 1921	806	Two single-runner vert. reaction turb., Pelton.	45,000	to be raised to 220,000	
San Francisquito No. 2............	50 miles to Los Angeles (on L. A. Aqueduct).............	44,000	Aug., 1920	530	Two 22,000-hp. vert. reaction turb.; W.S.M........	61,500	110,000	City of Los Angeles

power development and it is estimated that about 500,000 kw. could be developed upon this watershed without providing reservoir storages.

A very different condition exists south of the North Fork of the Feather River. Here there is very little ground storage, and stream flow must be supplemented by reservoirs. The snow pack in the high Sierras, which is the source of summer stream flow, is ordinarily melted off by midsummer, and the chief factor in economic power sites in this district is the question of practicable reservoir sites. Ordinarily, good practice prescribes development here for about 75 per cent of the normal stream flow, and for safety it is regarded as highly desirable to be able to supply the full flow from storage for 150 to 200 days. The question of silt does not enter into the storage problem because, with the exception of the Colorado River, none of the important California power streams regularly carry any considerable amount of silt.

Some California streams have large power possibilities. Figures on four of the rivers having important power sites are given in the following table:

Drainage Basin	Recently developed or under construction	Proposed for development in next five years kw.	Possible economic development (estimated), kw.
Pit River................	181,600	200,000	500,000
Big Creek................	100,000	300,000	500,000
Feather River............	100,000	200,000	300,000
Colorado River...........	......	......	200,000

The widely diversified conditions in different parts of the state have greatly increased the advantages of connecting the transmission lines. Not only have tie-ins been made at practically every feasible point but choice of location for new power plants is influenced materially by present and prospective developments and their transmission lines. The desire to deliver, in the ultimate system, the greatest amount of power for the minimum investment is tempered by the need for assuring continuity of service, and where necessary plants are built for this express purpose.

SAND TRAP AT HEADWORKS, KERN RIVER NO. 3

Characteristic of the developments now under way is the repeated use of the same water in a series of power houses. The plants are built in whatever order fits in best with existing power demand and financial conditions, but the relation of each plant to the others is carefully studied before any program is adopted. In fact, not only are the relations of all possible sites on a basin studied comparatively but the bringing in of additional water from other drainage basins is also considered. On the Big Creek system a 10-mile tunnel is being driven to bring the waters of the San Joaquin River into Huntington Lake, thus diverting a large steady flow into the upper end of a series of eight plants, several of which have already been built, in which a total fall of 5,950 ft. is utilized.

Design of Hydraulic Units.—The development of water power on this extensive scale has brought about changes and progress in the design of hydraulic units. As longer transmission lines have come into vogue and the amount of power developed on a single system has increased there has come a demand for larger generating units. In fact, the size of the units is now consid-

PENSTOCK FOR NEW UNIT, BIG CREEK NO. 2

ered as having a direct relation to the size of the system. It is considered desirable to have each important generator large enough to provide charging current for the entire transmission line which it serves, so as to avoid danger of current surges back through the generator. Units of smaller size are believed to be less efficient in voltage regulation, or might even be burned out by surges. Thus electrical reasons have really brought about the steady increase in the size of hydraulic units. Though the trend has been in this direction for some time a step that exceeds all previous records is being made in the Kern 3 plant (which is to go into service next February) by using reaction turbines under an 806-ft. head. This plant will be watched with keen interest, because it is expected to have a decided effect on the design of hydraulic turbines.

In the light of recent experience reaction turbines of the future, manufacturers affirm, will certainly be built not only for still larger power outputs but also for even higher heads than that at Kern 3. Thus the reaction turbine is entering a field which heretofore has been considered the exclusive province of the impulse type. With moderately high heads, the use of reaction turbines of larger capacity and higher speeds will tend to keep down machinery costs and secure a higher operating efficiency. The costs of reaction and impulse types (particularly when their settings are considered) vary with conditions too much to permit of comparing figures, but a fairly definite comparison may be made on the basis of efficiencies. The reaction turbines ordinarily show, according to manufacturers' records, an efficiency of about 90 per cent as compared to about 86 per cent for impulse wheels.

In the Kern 3 plant the 22,500 hp. on the single runner is more than could be put (in the present stage of the art) on any impulse unit operating at the same speed. Hence the general opinion that this plant marks a step, the success of which will open up great possibilities in the attainment of more ideal hydro-electric development.

Advance is also being made in the design of impulse wheels. Although the reaction type has been making more rapid progress of late there is reason to believe, the manufacturers point out, that these advances will be very closely followed by progress in impulse wheel design, which will adapt waterwheels of this type to service not before attempted.

Summarizing the tendencies that stand out prominently in the very active hydro-electric field in California they are (1) a readiness to make comprehensive, relative studies of all the power sites, regardless of ownership, that can be economically developed on an entire stream or basin, with a view ultimately to connecting them electrically; (2) a steady increase in the maximum heads considered feasible for reaction turbines; and (3) a rapid increase in the size of hydraulic units it is considered practicable to build.

Table of Corrections to Obtain Back Azimuths

By S. W. Tay

Sanitary Engineer, Honolulu, T. H.

THE following table of corrections to obtain the back azimuth of a line was prepared with the view of assisting the surveyor while in the field in the Hawaiian Islands. A similar table can easily be compiled for the general locality where survey work is to be carried on and where the azimuth method is used. The method by which the table is used is as follows:

TABLE OF CORRECTIONS TO OBTAIN BACK AZIMUTH

For Easterly Departure, Add Dz
For Westerly Departure, Subtract Dz

Departure, Feet	Correction in Seconds for Latitude 19° to 22°						
	19° 00′	19° 30′	20° 00′	20° 30′	21° 00′	21° 30′	22° 00′
1,000	3.39	3.49	3.59	3.68	3.78	3.88	3.98
2	6.79	6.98	7.17	7.36	7.56	7.76	7.96
3	10.18	10.47	10.76	11.04	11.34	11.64	11.94
4	13.57	13.96	14.34	14.72	15.12	15.52	15.92
5,000	16.97	17.45	17.93	18.41	18.90	19.40	19.90
6	20.36	20.93	21.52	22.09	22.68	23.28	23.88
7	23.75	24.42	25.10	25.77	26.46	27.16	27.86
8	27.14	27.91	28.69	29.45	30.24	31.04	31.84
9	30.54	31.40	32.27	33.13	34.02	34.92	35.82
10,000	33.93	34.89	35.86	36.81	37.80	38.80	39.80
11	37.32	38.38	39.45	40.49	41.58	42.68	43.78
12	40.72	41.87	43.03	44.17	45.36	46.56	47.76
13	44.11	45.36	46.62	47.85	49.14	50.44	51.74
14	47.50	48.85	50.20	51.53	52.92	54.33	55.72
15,000	50.90	52.34	53.79	55.22	56.70	58.20	59.70
16	54.29	55.82	57.38	58.90	60.48	62.08	63.68
17	57.68	59.31	60.96	62.58	64.26	65.96	67.66
18	61.07	62.80	64.55	66.26	68.04	69.84	71.64
19	64.47	66.29	68.13	69.94	71.82	73.72	75.62
20,000	67.86	69.78	71.72	73.62	75.60	77.60	79.60
21	71.25	73.27	75.31	77.30	79.38	81.48	83.58
22	74.65	76.76	78.89	80.98	83.16	85.36	87.56
23	78.04	80.25	82.48	84.66	86.94	89.24	91.54
24	81.43	83.74	86.06	88.34	90.72	93.12	95.52
25,000	84.83	87.23	89.65	92.03	94.50	97.00	99.50
26	88.22	90.71	93.24	95.71	98.28	100.88	103.48
27	91.61	94.20	96.82	99.39	102.06	104.76	107.46
28	95.00	97.69	100.41	103.07	105.84	108.64	111.44
29	98.40	101.18	103.99	106.75	109.62	112.52	115.42
30,000	101.79	104.67	107.58	110.43	113.40	116.40	119.40

Given: Azimuth, and distance from point A to point B and the approximate latitude.

To find: Dz, or back azimuth.

Let the forward azmuth of the line $AB = 200° 20'$; the distance A to B 24,000 ft., and latitude 19° 10.′ Then, the departure $\sin 20° 20' \times 24{,}000 = .3475 \times 24{,}000 = 8{,}340$. Interpolating in table with departure 8,340 and latitude 19° 10′ we obtain a correction of 29 seconds to be added to the forward or original azimuth, which result added to 180° 00′ gives the true back azimuth equal to 20° 20′ 29.″

Primary-Road Maintenance by the State Asked in Washington

In his biennial report, James Allen, highway commissioner of the State of Washington, asks that maintenance of all primary highways be placed under the direct supervision of the state highway department, and that a sufficient appropriation be made for such maintenance. The commissioner also recommends that counties initiating work upon state highways first submit plans to the commission for approval. Re-appropriation of $1,000,000 as a revolving fund from which to make advance Federal-aid payments, is also asked.

Observations on a Pacific Coast Trip

By Frank C. Wight
Associate Editor, *Engineering News-Record*

Portland

EVERY morning now the Portland newspaper carries a black-face box on its first page showing the previous day's bank clearings for Seattle and for Portland. Every day Portland is a million or so ahead of its northerly and larger rival. When, or if, the balance turns, interest in the figures may not be so great but for the present they express very well Portland's hope that the race is not always to the swift. For Portland has never been a boom town. It was founded many years ago at the confluence of the rich Willamette and Columbia valleys and, regardless of gold strikes or wars, has built itself upon the sure sources of wealth in its prolific hinterland and the excellent, though constricted, passageway to the sea. Age and sure growth make for a conservatism which is reflected in its people and its buildings and which in these days of general slackness comforts itself with the knowledge that reaction and action are apt to be equal or, to translate into less polite terms, "the bigger they come, the harder they fall."

Oregon's great industries are lumbering and farming. The current depression is reflected in the former but agriculture is not a fluctuating trade. The Columbia River basin and the stock country to the south continue to contribute to the world's necessary supply of food. Because of these conditions engineers in Portland—outside of those working strictly in city work—are largely interested in irrigation and drainage. All over the state are located districts which never figure in any but local news, where the engineering details of design, construction and maintenance require expert and constant attention.

Mainly as a result of this sort of practice, there is heard here with extra emphasis the complaints of the northerly cities against government usurpation of the private engineer's function. This complaint is not only against the Reclamation Service and the Bureau of Public Roads but also—and perhaps mostly—against the drainage investigation service of the Agricultural Department, which is also under the Bureau of Public Roads.

The criticism of these three governmental activities is different for each. It is common talk throughout the Northwest that the Reclamation Service discourages irrigation by the superfineness of its work. There is such a thing as being too careful and of building too strongly, of insuring too much against the future. This habit of the Government is natural, for it is a perpetual institution and its bureaus must be prepared for all contingencies; but some of the engineers who are trying to develop small areas are hampered, they think, by the, to them, unnecessarily high standards the Government sets. They feel, too, that the money could be spent to better advantage to the community if spread over more work.

Comment was made in my Spokane letter regarding the too great centralization of the Federal road aid and this criticism is also found in Oregon, though not so generally expressed. The main trouble here seems to be with the drainage investigators who, according to several independent observers, are going hither and yon throughout the country making reports—none too accurate or careful—on possible developments and are thereby depriving those in private practice of their principal means of support as engineers. These reports are not on Government work but are rendered free to any who ask. The average farmer apparently believes that the adage that "what you get for nothing isn't much" does not apply to free Government engineering.

Society Activity

Engineering society conditions are complicated in Portland. In fact, the national situation is duplicated on a minor scale. There is a large, active and very strong Oregon Chapter of the A. A. E., functioning particularly in discussion of public questions; there is a cohesive section of the Am. Soc. C. E., somewhat in opposition to the A. A. E., but with many members in common, and there is the prototype of Engineering Council in the Oregon Technical Council, composed of representatives of the national, civil, electrical and mechanical engineering societies, the American Institute of Architects and the National Electric Light Association. Just as in the national situation, it is difficult to get unbiased opinion on how the thing will work out but unless they come to open warfare it does seem as though Oregon's engineers ought to be brought sufficiently before the public eye.

In two or three recent state issues the engineers took decided stands and received columns of newspaper publicity. The extent to which their campaigns were carried and the material success they achieved makes one wonder whether such campaigns may not be dangerous. There is a widely held theory that on any given question that concerns them, engineers will hold the right view. This presupposes, first, that there is always an absolute right and an absolute wrong and, second, that engineers will unanimously support the right. The first assumption is ridiculous and, although we may not care to say so except among ourselves, the second is equally so. However, that theory is the basis for public campaigns and the result may well be that a misinformed or misguided small majority, in control of an engineering society, will propagate in the name of the profession views to which a substantial and perhaps more expert minority dissent. According to some guarded remarks, such a condition has existed in Oregon, but the issue was not of sufficient importance to call for public remonstrance. The possibilities of danger are sufficient to make the enthusiasts for public service careful.

Engineering Work in City

In the city itself engineering work is quite active or at least prospects of work are good. The Columbia Slough sewage diversion, whereby a channel is being cut between the river and an adjoining slough to facilitate sewage movement and to reclaim land, is under way and preparations are being made for the construction of a two-million dollar bridge at Burnside Street across the Willamette. The city is on both sides of this navigable and sizable stream and more bridges will undoubtedly be required in the next few years. Then, too, steps are being taken to reclaim much of the river district and to reconstruct the old wharves in the central part of the city as well as

to improve street conditions near the wharves. By misunderstanding probably, the rest of the state overruled Portland's vote at the recent election to unify the port control, which is now divided between a State port authority, a city dock commission and the city government itself. The same initative bill included an ambitious scheme to reclaim for industrial purposes a large overflow area near Swan Island, in the Willamette, and to build a new dock area and dredge a new channel. The proposition will now go to the legislature and has a fair chance of going through.

The new No. 4 Terminal, formerly called St. John's Terminal, where is located the grain elevator which caused some worry by its subsidence about a year ago, is an admirable piece of work, quite the most modern and efficient river terminal—for ocean going vessels—on the continent. Here again in a minor port one sees the latest and best ideas of port development worked out in a successful manner. The grain elevator is now complete and, thanks to the extra outside piling, seems to be stable.

As I went through the station on my way to take the train for San Francisco I ran into one of the engineers with whom I had lunched at a group meeting that day. He was in mackinaw, riding breeches and boots, en route up-country to some project or other. I thought his dress a fair example of the difference in engineering conditions in the big cities of the West and of the East. Out here they are close to the big outdoors. The wilds and the natural problems in the rough are part of their daily work and yet not all of that work. They have the comparative physical ease and creature comfort of the city office, with its association with other men and other trades, which the engineer entirely in the field lacks and which he needs for a full rounding of his knowledge and his attitude toward things. At the same time as a part of their regular task they do get out into the country where their theories are practiced.

A month ago I ran into a prominent New York engineer on Fifth Avenue in muddied clothes and flannel shirt and he apologized for them. In these Northwest cities such an apology is neither expected nor giver. Every one of these cities is framed in mountains. From the streets of any of them one can look up into the hills, stretching on into the back country where the engineer does his work. There is something to look at besides the bricks and stone of the plains cities or the eastern seaboard.

Can one wonder that men living here take on some of the qualities of the open spaces?

Notes on Iowa Sand Filters for Sewage

In the discussion of the operation of Iowa sewage sand filters at the recent conference of operators at Iowa State College, C. H. Currie advised a 3-in. dose on a 2-ft. bed, which is the minimum depth in Iowa practice. Lafayette Higgins advised dividing the beds into units by sand ridges and making a gutter along the edge of the beds to retain surface wash. For winter operation he urged scraping into piles 8 to 10 ft. apart rather than the furrow or ridging method. With settled sewage a loading of 2,000 people per acre could then be obtained with 50 to 100 gal. per capita flow. In many Iowa cities the ground water is close to 50 gal. per capita.

Considerations in Design of Heavy-Traffic Pavements

By Prevost Hubbard
Chemical Engineer, The Asphalt Association, New York

[Paper presented before the Engineers' Club of Philadelphia, Dec. 21, 1920.]

THE load-carrying capacity of any type or design of pavement must of necessity be influenced by the support afforded the pavement from below. Such support is furnished by that portion of the earth directly below the pavement, known as the subgrade. The supporting value of natural subgrades varies enormously, as illustrated by the two extremes of muck or quicksand and solid rock. Most subgrades consist of soil lying between the extremes mentioned but still varying greatly in supporting value depending not only upon type but upon their moisture content and degree of compaction. With very few exceptions any well-compacted soil will of itself support the heaviest conceivable traffic if its moisture content is properly controlled and if it is protected by a structure which prevents the displacement of particles at its surface. The protective structure termed the pavement will then need to be only of sufficient thickness to afford such protection and

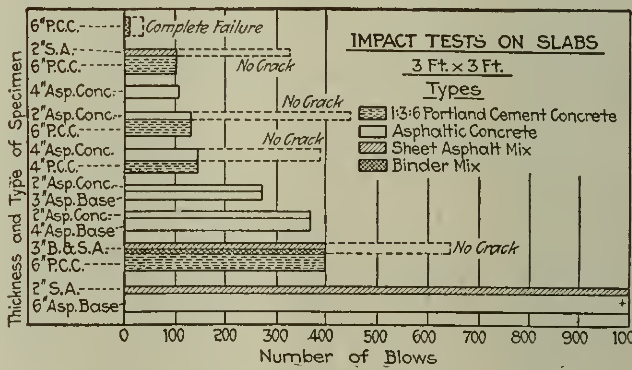


FIG. 1. IMPACT TEST RESULTS FOR SLABS

at the same time itself withstand the various destructive agencies of traffic. For a given traffic this thickness will depend largely upon the type of pavement used.

The bearing capacity of most soils, particularly the clayey types, decreases as their moisture content increases above a certain point. Although there is much yet to be learned regarding the comparative bearing value of soils this fact is generally recognized and various drainage methods are employed to control the moisture content of the subgrade. Proper drainage is the first essential for maintaining a dry subgrade and measures taken to prevent access of water to the subgrade directly below the pavement are often more important than measures designed to remove accumulations of water in the subgrade. Some soils are so persistently retentive of moisture once absorbed that it is impossible to remove it with sufficient rapidity by any ordinary system of drains. Certain clayey soils belong to this class and when all practical preventive measures in the way of drainage are apt to prove inadequate it may well be advisable to modify the character of the subgrade material. Thus at relatively low cost a clay subgrade may often be greatly improved by mixing it with sand in exactly the same manner as in the construction of a sandy-clay road. Such a mixture will not only retain less moisture than the clay but will possess a much higher supporting value than moist clay.

It is now generally admitted that in the past too little attention has been paid to drainage in the construction of pavements outside of municipalities. At the same time there exists a marked tendency to increase the massiveness of design to a point far beyond that which is at present proving entirely satisfactory for heavy traffic in municipalities and in other places where subgrade conditions are favorable. This matter should receive the most careful

consideration of engineers as it points not only to the most logical but also to the most economical solution of the design of pavements. It is evident that in many cases it will cost far more to increase the thickness of a pavement to such an extent that it will distribute the load sufficiently to enable a poor subgrade to support it than it would be to change natural subgrade conditions so as to create a high supporting value for the relatively thin pavement.

The widespread use of rigid pavements or pavements with rigid foundations has been largely responsible for this trend in paving design through too great dependence upon the bridging value of such rigid types, and right here there exists a rather anomalous situation, for while many claims are made of the bridging value of rigid pavements it is generally admitted that careful preparation of the subgrade is necessary to uniformly support these rigid types. As a matter of fact it is impracticable to design a highway which will permanently bridge appreciable areas of a weak subgrade when subjected to modern heavy traffic.

In pursuing a policy upon which general attention has once been centered many who are interested in highway construction are apt to overlook the experience of others following different lines of development and fail to profit by their experience. One of the most striking examples of this has to do with the flexible type of construction as represented by the asphalt base pavement, and this in spite of a number of valuable papers and discussions upon the subject by leading engineers. Citations of past and present experience in localities other than that of interest to the individual engineer apparently carry little weight once the majority concentrate on a given line of development, and it is difficult to focus attention on any other line for the time being.

To state that considerably over 12,000,000 sq.yd. of asphalt base pavement are now giving satisfactory service in California and Oregon, many of them 5 in. or less in total thickness and subjected to heavy motor truck traffic, and that some of these pavements have been in service for over 20 years with little or no cost for maintenance, should at least arouse some degree of interest on the part of Eastern engineers. To further state that in such cities as Washington, D. C., Chicago, Omaha, Pittsburg, Buffalo and Denver there are in existence sections of bituminous base which have given satisfactory service for over 20 years should also serve to dispel any illusion that the serviceability of this type is restricted to any given locality.

Service results should in themselves be conclusive, but explanations of such results are sometimes required before their full significance is grasped. It is true that theories have been advanced, but these have not been backed up by test data in such a way as to make them convincing. Some degree of cushioning effect under traffic has been claimed and admitted for the asphalt base as well as the wearing course, but few engineers have believed that a mineral aggregate cemented together with asphalt could possibly possess any degree of slab strength or beam strength, at least to an extent comparable with the rigid type of construction.

Impact Studies Begun

With this in mind an investigation was begun under the direction of the writer assisted by W. E. Rosengarten, traffic engineer of the Asphalt Association, to determine certain relations that exist between the rigid and flexible types of construction. Fortunately through the very valuable work of the U. S. Bureau of Public Roads it has already been proved that impact, and not dead load, is the most destructive traffic factor to be taken into account in the design of modern highways. It was therefore decided to limit these investigations to a study of the effect of impact upon test specimens having thicknesses equivalent to those commonly used in the construction of highways. It was clearly realized in advance that it would be impossible to duplicate all of the variable conditions under which impact is delivered to a pavement by traffic, and it was therefore decided to confine this study to the effect of pure impact as delivered by an iron ball falling from a relatively small height.

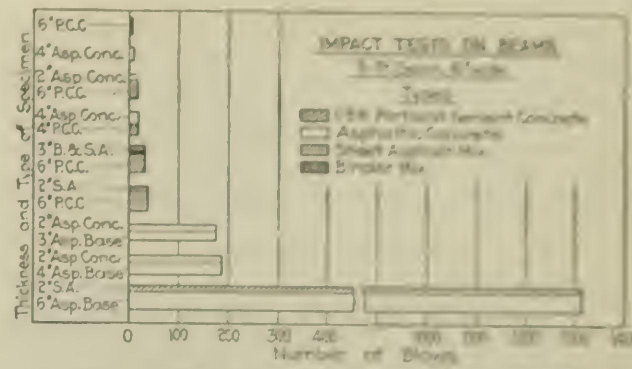


FIG. 2. IMPACT TEST RESULTS FOR BEAMS

The following description of tests will be brief, both because of the limited time available for the presentation of this paper and because the results here reported are only a portion of those included in a more comprehensive investigation involving other comparisons which will shortly be presented in a detailed article.

In order to obtain comparisons at two extremes of conditions it was decided to construct and test slabs of various design upon a solid uniform subgrade and to test beams of the same design supported only by knife edges. A plot of ground was secured and upon this was laid a 6-in. course of cinders thoroughly compacted by rolling. Slabs 3 ft. square were constructed directly upon this subgrade except that after the forms had been placed the subgrade within the forms was leveled up with a very thin layer of sand so that each specimen would have a uniform thickness throughout. Portland cement concrete slabs of a 1:3:6 mix were cast 4 and 6 in. thick. These were cured under a cover of moist sand after they had set. Some of the concrete slabs were then covered with from 2 to 4 in. of coarse, graded aggregate, asphaltic concrete and some with sheet asphalt with and without a binder course. In addition, slabs were constructed of asphaltic concrete base mixture and covered with either asphaltic concrete surface mixture or with sheet asphalt so as to produce total thicknesses directly comparable with the Portland cement concrete base specimens. At the same time corresponding sets of beams 4 ft. long and 10 in. wide were constructed of the same type and thickness. In general, the specimens were tested when the concrete was 28 days old, although in a few cases they were slightly older when, for one reason or another, it was found impossible to keep up with the testing schedule which had been planned.

How Tests Were Made

All slabs were tested where they had been cast by means of a machine which was designed and operated so as to drop a 125-lb. iron ball upon the center of the upper surface from a height of 6 in. at the rate of about 30 blows per minute. In all cases a specimen was considered to have failed when the first crack appeared. Cracks in the Portland cement concrete were invariably first noted developing on one or more sides of the specimen from the plane of contact with the subgrade. Under continued impact these cracks traveled to the upper surface of the monolith and then across the upper surface toward the center. The all-Portland cement concrete specimens broke into two to four large fragments shortly after the first cracks appeared, while similar slabs with an asphalt top showed no cracking of the top after the base had failed. The results obtained on check specimens were in some cases erratic and in others quite close together. By averaging results, however, the general trend is apparent and is closely borne out by results obtained on the beam specimens.

The accompanying diagram, Fig. 1, shows the resistance to impact of the various types of slabs as measured by the number of blows required to produce failure. The dotted extensions of the asphalt tops on slabs with a Portland cement concrete base show the number of blows at which the test was stopped, no failure of the top then being apparent.

The beams were tested upon steel knife edges 3 ft. apart with the same machine used for testing the slabs, but with a 50-lb. iron ball dropped from a height of 1½ in. at the center of the span at the rate of about 50 blows per minute. The number of blows required to produce the first crack was recorded as point of failure. In all beam tests complete failure occurred within a very few blows after a crack appeared. The results of these tests are shown in Fig. 2 in the same manner as the slab tests.

What Diagrams Show

In considering these diagrams no attempt will be made to draw conclusions based upon a comparison of absolute values as here shown. In fact, it is frankly admitted that such a course would be unwise until much more test data is available. It is believed, however, that the general similarity in trend of the results obtained in both the slab and beam tests is highly significant and points to interesting facts. What is clearly apparent for conditions under which these specimens were tested may be summed up as follows:

Asphaltic mixtures develop very decided slab and beam strength, as measured by their resistance to impact. The all-asphalt type of a slab and beam appears to offer considerably more resistance to impact than an equivalent thickness of 1:3:6 Portland cement concrete, considered either as an integral structure or as a base for an asphaltic top.

It is recognized that, unsupported by practical service results, deductions drawn from these tests might not be conclusive as applied to the design of highways for heavy traffic. They do, however, help to explain the remarkably satisfactory service record of the millions of square yards of 4 and 5-in. asphaltic concrete pavements in California and Oregon and point the way to a more rational development in the design of highways in other localities. In summing up the substance of this paper there are a few points which the writer wishes to emphasize:

Conclusions

1. Any rational design of highway should take into account the fact that the subgrade must ultimately take the weight and shock of traffic as transmitted through the pavement and practically any reasonably dry subgrade will do this if it is compacted and its surface is protected from displacement. Careful attention to subgrade preparation and drainage is, therefore, the first essential to be considered.

2. The asphaltic concrete pavement is highly resistant to impact which is recognized as the most destructive traffic factor and under impact develops as a single unit relatively high slab and beam strength.

3. It is manifestly uneconomical, if not impracticable, to adopt a design of highway which will permanently bridge appreciable areas of weak subgrade. While the asphalt type develops bridging action to an appreciable extent it will of itself constantly seek to maintain contact with the subgrade at all points and thus reinforce itself with the maximum supporting value of the subgrade. The rigid type of pavement or base cannot do this because of its inherent characteristics. It is, therefore, almost sure to crack eventually where appreciable areas of subgrade fail to support it uniformly.

4. Both the service history of asphalt base pavements and the test data here presented indicate that under given conditions it is not necessary to adopt as massive a design for the flexible type of base as for the rigid type. It is difficult for engineers who have had no opportunity to observe the asphalt base pavement under heavy traffic to think of it in terms of less thickness than the rigid base but in the light of present experience such consideration appears to be entirely warranted.

[Photographs furnished by Mr. Hubbard, but which would not reproduce well, indicate little if any deflection or deformation of the slabs that would have rendered them unsuitable for pavement base before cracking occurred.—Editor.]

Fees and Services of Practicing and Consulting Engineers

Extracts From Report by W. L. Benham, Chairman of A. A. E. Committee, Giving Minimum Schedules and Defining Services

FROM the report of the committee on fees and services of practicing engineers of the American Association of Engineers (W. L. Benham, chairman) made public last week, the following extracts are taken:

Is it not high time for practicing engineers to establish a definite basis of fees and charges for engineering services? Adequate engineering fees is a subject much talked about but very little practiced. Many elaborate schedules have been prepared by the various engineering societies and organizations of this country but it may be stated without fear of successful contradiction that very little has been accomplished to bring about practical results for the engineer. The public has not been educated to a point where it knows what reasonable charges are or really understands the scope of services which engineers are expected to render. The engineers themselves have stood in their own light and this may be the reason why the public holds its present attitude towards them. In order to obtain successful results engineers must make up their minds to pull together with a clearer understanding of their rights as well as their responsibilities and duties. A more strict adherence to the numerous codes of ethics of our engineering societies will go a long way toward bringing about a spirit of co-operation among engineers and helping us to accomplish our ends. We cannot force the public to recognize us; we do not advocate the accomplishment of our ends through the medium of strikes. Recognition must be achieved by education of the public, co-operation among ourselves and service to our clients.

Realizing the need of efforts in behalf of the practicing engineer, and by this is meant the engineer who sells or contracts his services and that of his organization, the national executive committee of the American Association of Engineers appointed a committee of practicing and consulting engineers to consider the scope and practice of engineering activities, the desirability of having uniform practice with reference to fees and scope of services, and the feasibility of establishing such practice.

The consensus of opinion of members of the committee seems to be that it is not possible to establish any hard and fast uniform or standard schedule of fees for practicing and consulting engineers for all classes of work and for all contingencies, but it is believed that some definite schedule can be adopted as a basis for *minimum* charges.

It seems to be the desire of the majority of the committee to draw a line of demarcation between the practicing and consulting engineers and to allow the latter sufficient latitude so as to enable them to obtain higher fees.

A *practicing engineer* may be termed one who is actively engaged in the practice of engineering, such as the making of surveys, designs, plans, specifications, valuations, appraisals and reports and supervising work of construction, and who contracts with his clients for engineering services, as differentiated from the engineer who is employed on a salary basis.

A *consulting engineer* may be termed one who has had highly specialized training and experience in certain lines of engineering and who has mature judgment and experience in general engineering—experience which qualifies him to act in the capacity of adviser to other engineers or directly to their clients, to design and supervise the construction of the more important engineering problems—as apart from the practicing engineer who is engaged in the design and supervision of the more simple projects.

As a general guide for the establishment of fees for professional services of engineers, for work in the United States within the field of the engineer, the following is suggested. These services can be divided into two classes, as follows:

TABLE OF PERCENTAGE FEES FOR ENGINEERING SERVICES

	Estimated Cost of Project										
Service Classification	$10,000 to $25,000	$25,000 to $50,000	$50,000 to $100,000	$100,000 to $200,000	$200,000 to $300,000	$300,000 to $500,000	$5[illegible],000 to $750,000	$7[illegible] to $1[illegible]000	$1,[illegible] to $1,[illegible]	$[illegible] to $2,[illegible]	$[illegible] and [illegible]
B-1 Surveys					Actual Cost Plus 25% and Upward						
B-2 Preliminary reports	2.25	1 75	1 20	80	70	60	55	50	45	40	40
B-3 Plans and specifications	5 00	4 50	3 75	3.25	3.00	2 75	2 65	2 60	2 55	2 [illegible]	2 50
B-4 General Supervision	2 00	1.90	1.70	1 50	1 40	1 35	1 35	1 25	1 20	1 15	1 10
B-5 Resident Supervision					Actual Cost Plus 25% and Upward						
B-6 Purchasing	2.00	1 80	1.35	1 00	90	85	80	75	70	70	65
B-7 Management	5.50	5 00	4.30	3 50	3.00	2 75	2 55	2 45	2 35	2 25	2 15

A. Special Engineering Service

1. Consultation. 2. Arbitration. 3. Professional advice. 4. Expert testimony and court work. 5. Valuations and appraisals. 6. Service and efficiency tests. 7. Reports.

B. Regular Engineering Service (See table)

1. Reconnaissances, surveys of all kinds, borings, soundings, tests, experimental work and compilation of all data necessary for preparation of preliminary report, estimates of cost and for plans and specifications.

2. Necessary conferences, preparation of preliminary plans, estimates and report covering all features of the work with various alternate plans setting forth advantages and disadvantages, cost of operation and maintenance and recommendations for solution of the particular problem.

3. Preparation and presentation of working plans, profiles, specifications and estimates for letting of contracts or purchase of material and machinery and for complete information of client or owner, describing in detail manner under which contract or contracts will be let, general stipulations, complete detailed description of all parts of the work, general manner in which work shall be done, forms of proposal blanks, contracts and bonds, and detailed estimates of cost.

4. Attendance and advice at meetings for award of contracts of construction or for purchase of materials and machinery, supervision of construction work during progress, progress reports and rendering of estimates. By "general supervision" is meant occasional visits of a principal to the work, and such office work at headquarters which is necessary to prepare progress estimates and reports, correspondence between field and office and final records. It does not include surveys and inspection work in the field or testing.

5. Resident supervision of construction continuously "on the ground" during the progress to see that the plans and specifications and contract are being complied with.

6. Purchase of all materials, equipment and machinery.

7. Complete management of project from conception to completion, but not financing.

Charges for all classes of work under "A" may be placed on the per diem basis. The amount of the charge should vary according to the character, magnitude or importance of the work or subject involved or according to the experience and reputation of the engineers. This charge should vary from $50 a day upward and it may be considered legitimate to charge a retainer fee of $250 or more. An additional charge should be made for all actual expenses, such as traveling and general office expense, field assistants and materials used, with a suitable allowance for indeterminate items, plus a profit on this portion of the work of at least 25 per cent over and above all expenses as above enumerated. In such cases when doing office work 8 hours shall be considered to be a day, but when absent from the city each day of 24 hours while away from the office shall be considered a day, regardless of the actual time spent on the work. This includes all days in travel going to and from location of engagement. Payment for services shall be made monthly as the work progresses or upon submission of report or upon completion of work as outlined in contract.

In lieu of the per diem charge a fixed total sum for services may be agreed upon. In determining this fee, however, the per diem charges plus expenses should be figured as closely as possible, with a reasonable allowance for contingencies. It may be considered legitimate to charge a retainer fee. Payment for services shall be made monthly as the work progresses or upon submission of report or upon the completion of the work as outlined in the contract.

Charges for work as set out under "B" may be made on a percentage basis according to the table.

The percentages in the above table are to be computed upon the entire cost of the completed work exclusive of legal and engineering, or upon estimated cost pending execution or completion.

The term "cost of work," as used, refers only to such part or parts of the whole work or project as the engineers may be engaged to deal with in any of its stages.

Payment for services shall be monthly.

General Provisions

1. Upon undertaking engagement a written contract should be entered into stating as fully and clearly as practicable the conditions of the engagement, services to be rendered and amount or rate of compensation.

2. When alterations or additions are made to contracts, drawings or specifications, or when services are required in connection with negotiations, legal proceedings, failure of contractors, franchises or rights-of-way, a charge based upon time in office and field and all overhead expense should be made in addition to the percentage fee agreed upon as in case of B-1 and B-5 of the table.

3. In case of abandonment or suspension of the work at any time an adjustment of the fee shall be made on the same basis as that of the partial payments or by application of the per diem rates for all work done previous to notification of abandonment. Engineers should keep their records so that such cost may be accurately determined.

4. When services are required other than those reasonably to be expected for proper fulfillment of the contract per diem charges may be made, if the work involved be of sufficient magnitude, in addition to percentage fees provided for.

5. Engineers may with propriety undertake all the work in connection with the project, including business, legal and other matters, in which case the fee shall be the subject of special agreement.

6. It should be recognized that in any project undertaken by an engineer there may be many problems requiring the services of a specialist. Testing and inspection of materials at factory or plant shall be construed as coming within this class. The cost of such specialist shall be paid by the client or owner.

7. Drawings and specifications by any method of payment for services are to be considered the property of the engineer but the client is entitled to receive a reasonable number of complete records of the same. All other copies shall be paid for by the client on basis of actual cost.

8. It is for the best interests of the client or owner that the engineer be given full direction of the work during the construction period, or, if this is impracticable, that the client employ experienced inspectors approved by the engineer and working under his general supervision.

New York City's Immense Budget

The budget of New York City for 1921, adopted on Dec. 6 by the Board of Aldermen just as framed by the Board of Estimate and Apportionment, totals about $346,000,000, besides which there is an estimated deficit in the education appropriation of some $25,000,000 for which provision must yet be made. The 1920 budget, not including the deficit, is about $72,000,000 above that for 1919 and is expected to call for a tax rate of from 2.75 to 2.85.

Earth in Foundations Considered as an Elastic Solid

Deductions from Angle of Repose Theory Disputed—Earth Not To Be Regarded as Non-Cohesive and Granular—Tests Cited To Support New Theory

By Lazarus White

President, Spencer, White & Prentis, Inc., Engineers and Contractors, New York City

RECENT investigations show clearly that earth in foundations behaves as an elestic solid of low strength and low shearing value, and much progress in the proper understanding of foundations has been made when the subject has been approached with this thought in mind. The principle involved is simply the treating of earth as any other structural material, ascertaining its relation of stress to strain or, in common parlance, of loads to settlements.

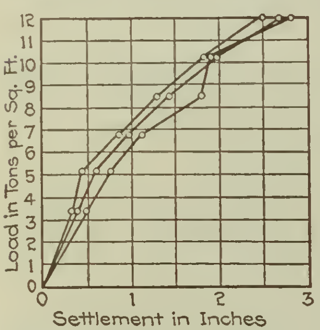


FIG. 1. BEARING TEST ON EARTH UNDER FARMERS LOAN AND TRUST BUILDING

Progress has been made in the art of securing earth samples by borings and test pits, as well as in placing footings at any desired depths by sheeted pits and pneumatic caissons. But these methods have been classed as branches of an art, and it has been claimed that not even a beginning has been made in a real science of foundations. Various attempts have been made to classify soils minutely as different varieties of sands, clays, etc., and to ascribe a definite bearing value to each class, but this has led to confusion. In extensive mathematical investigations earth has been considered as a granular material without cohesion and with different angles of repose. The result has been to increase the confusion and to discourage investigation into problems which are of fundamental importance in the design of many engineering structures.

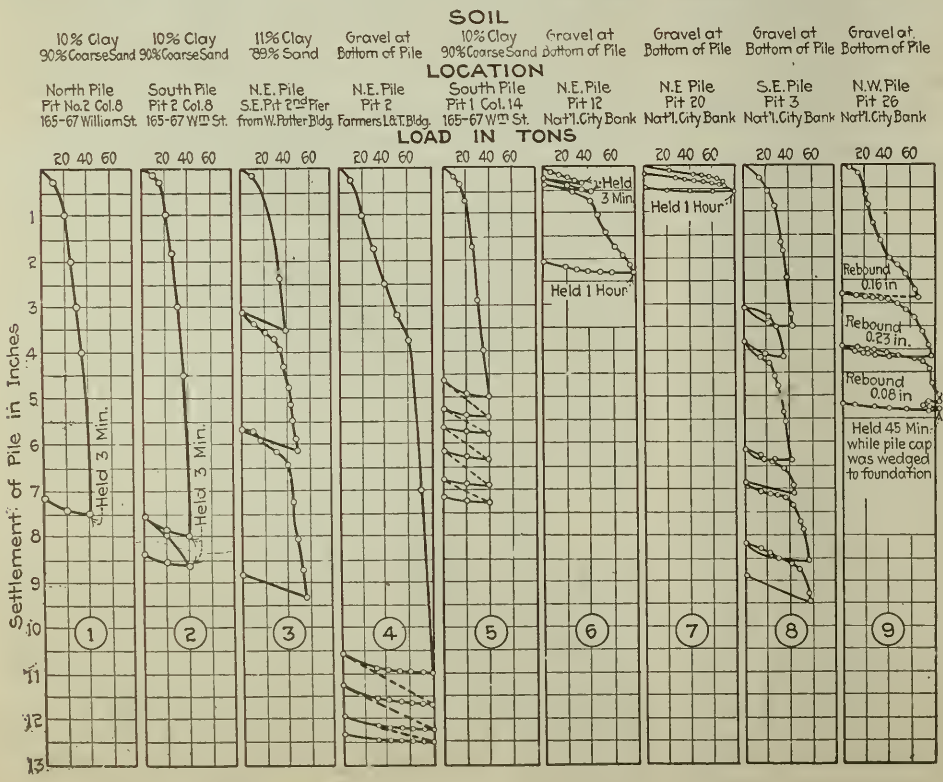


FIG. 2A. SETTLEMENT AND REBOUND CURVES FOR 14-INCH PILES

It is believed that establishment of the principle that earth under load behaves as an elastic solid is a real

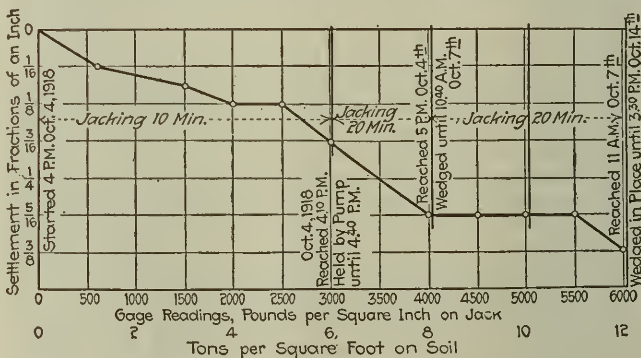


FIG. 2. BEARING TEST ON EARTH IN OPEN GROUND

beginning in the science of foundations. This article presents a discussion of tests supporting the above principle, together with a description of its application in developing a system of foundation construction.

The bearing value of soils should be stated in terms of settlement—5 tons for a settlement of 1 in. for instance. Such tests can be readily conducted and plotted as in Fig. 1, which represents a test carried out at the Farmers Loan & Trust Co. Building, New York City. The soil, which was well compressed and undisturbed, consisted of 88 per cent sand and 12 per cent clay. The load was applied continuously and increased uniformly over the entire duration of the test (20 min.) by a 6-in. hydraulic jack. The bearing area was 4.1 sq.ft. Each curve represents the settlement at one corner of the bearing block.

A similar test was conducted in an open lot (see Fig. 2) for Armour & Co., McLean Long, engineer, at 14th St. and 10th Ave., New York City, from Oct. 4 to 14, 1918. The soil was coarse, sharp sand to a depth of 15 ft. below the filled ground. A 50-ton jack was used imposing a load of 8 tons per square foot for 65 hr. 40 min. and 12 tons for 7 days, $4\frac{1}{2}$ hours. In this case a time element was also introduced to satisfy the Building Department requirement. By means of the gage a wide range of tests can be made quickly and much light thrown on the behavior of soils. A glance at the curves

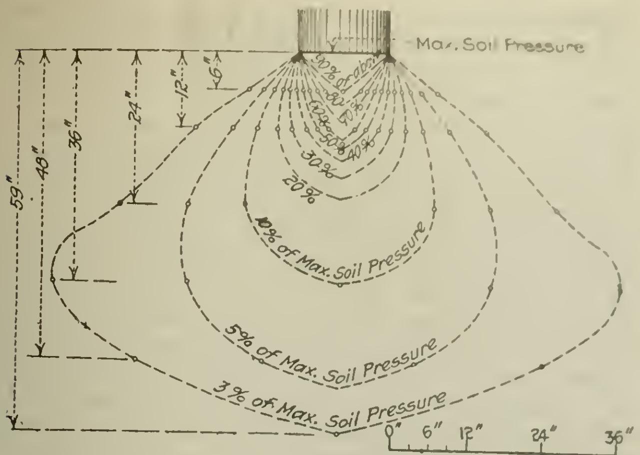


FIG. 3. LOAD DISTRIBUTION BY BULB OF PRESSURE

of Figs. 1 and 2 will show plainly that the earth has the properties of an elastic solid. This is shown still more clearly by tests, Fig. 2A, where much higher pressures were used. These tests were made under the direction of J. F. Greathead for the Public Service Commission. The curve plainly shows distinct elastic properties, including recovery or "rebound." But the settlement, on reapplication of the load, to a greater amount than the rebound was a rather unpleasant discovery for the underpinning specialists and led to further investigations.

About the time the above tests were made, some interesting tests were published in the *Engineering Record,* March 13, 1915, p. 330. These tests were made at the Pennsylvania State College on a large scale and several interesting curves were published. Graphically, the distributions of pressures were measured at various distances and depths from the load applied by a hydraulic jack, the resisting pressure being measured on a similar area of the bottom of a large box by a scale beam. Tests on different soils and with different pressures gave very similar curves, particularly for the greater depths and eccentricities. Using the Pennsylvania State College data as a basis, Mr. Greathead plotted the bulb of pressure under a 14-in. pile as shown in Fig. 3.

It is believed that thus for the first time the distribution of soil pressure below a footing was given qualitatively and quantitatively. A little study of the "bulb of

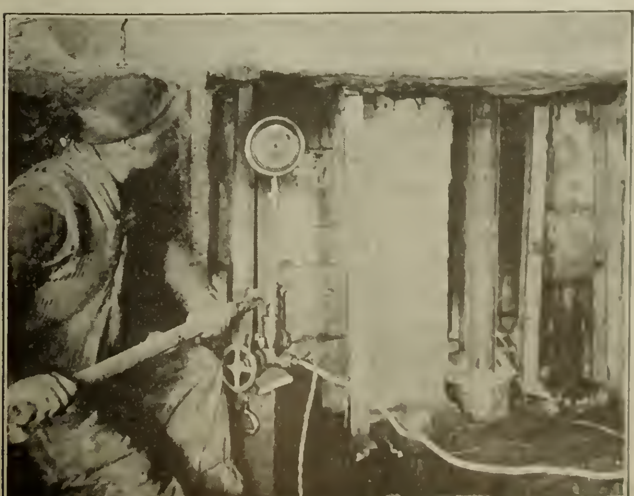


FIG. 4. JACKS MAINTAIN LOAD ON FOUNDATION PILES

pressure" will enable one to understand how a soil can take great pressures, the bulb merely spreading the load over such a great area that the unit pressure is reduced to a value that the soil can sustain without settlement. The bulb also explains rebound and resettlements. When the load is released, an elastic expansion of the bulb takes place, but in so doing it partly breaks down. It is formed again at a lower level by a reapplication of the load. An examination of the bulb of pressure discloses further interesting things, particularly the closeness of the different intensities of pressure near its top, and that in no sense has earth in this condition liquid properties and that it is a true solid. It shows also that a footing can be approached closely without encountering lateral pressure.

The formation of the bulb of pressure has been photographed by a camera placed before the glass front

FIG. 5. PRETEST CYLINDERS IN UNDERPINNING FOR KUHN-LOEB BUILDING

of a box within which sand was compacted by a superimposed block. An inspection of fine wet sand subjected to a pressure of 40 tons per square foot revealed that it became quite dry, had a vertical cleavage and in fact had been turned into an incipient sandstone.

The data shown in Figs. 1 to 3 were accumulated previous to 1916. Recent investigations of the joint committee on stresses in railway track of the American Society of Civil Engineers and the American Railway Engineering Association have disclosed much confirming evidence. They indicate that the ballast below the railway ties, whether of broken stone, gravel or sand, showed truly elastic qualities. The committee also found the pressures on the ballast at various depths below the ties and published a diagram of these pressures similar to, but not as complete as, that of Fig. 3.

A correct understanding of the action of a spread footing leads directly to an understanding of all other types of footing, such as piles and caissons. Each pile, cylindrical or tapering, forms a bulb of pressure. If the pile is cylindrical, the bulb is at the base. For a tapering pile the bulb extends along the pile but is on the same projected area as that formed by a cylindrical

pile of the same cross section. A group of piles forms a large spread footing through overlapping bulbs of pressure, which simply transfer the load to a layer of soil at the base of the piles. If the bearing value of the entire area is sufficient little settlement takes place; but if insufficient there will be a general settlement over the whole area. Placing more piles within the original area will do little good.

A splendid opportunity in 1915-17 was given for application of this recent knowledge. Only about 20 per cent of an unprecedented underpinning job on William St., New York City, had been completed, and the worst buildings had still to be underpinned by the use of 14-in. sectional steel piles. The assessed valuation of these buildings was about $40,000,000 and the frontage 3,000 ft. It was seen that if the "rebound" were eliminated,

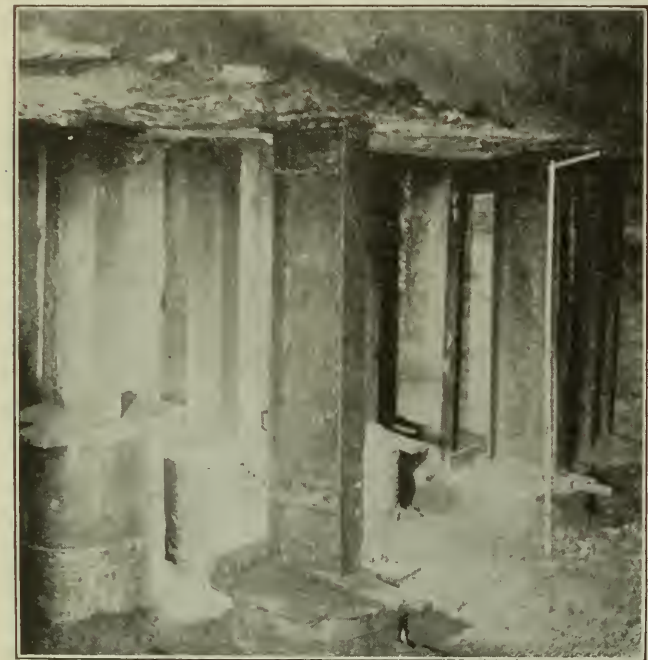


FIG. 6. FOUNDATION CYLINDERS WITH WEDGING POSTS IN PLACE

the problem would be solved, and the bulb of pressure retained permanently below each sectional pile. To accomplish this result (see Fig. 4) the load of the jacks was maintained on the pile until the wedging beams were securely placed, the rebound being held down to about 1/16-in. whereas the full rebound is about 3/8-in. Reapplication of the loads showed no settlement of the pile up to the original test load, but only a negligible elastic compression of the bulb. Observations were kept over long periods by means of the Berry sctrain gage with the same result.

The first application of this method gave wonderfully good results, the Bank of America settling only 1/4-in. during the whole process of going under the footings, underpinning piers up to 600 tons in weight, cutting off half of the footings and excavating 20 ft. below them. The Kuhn-Loeb Building, a 20-story structure, was underpinned in a similar way, the front row of piles being almost entirely exposed, as shown in Fig. 5. In this method of underpinning the loads were carefully computed and each 14-in. cylindrical pile was assigned a load of about 40 tons, but to give a definite factor of safety each pile was tested to about 60 tons.

The application to a new building came next at William and John Sts., where a stratum of fine sand extends to a depth of about 140 ft. A new 20-story building was projected, but would have to be at least two stories high within a few months after the property was acquired so as to anticipate the zoning law, which on that street would permit of an 11-story building only. All the material below the footings was quicksand. The architect observing the success of the underpinning methods along William St. appealed to the contractor's engineers to help him out, which they did by devising what is now known as the "Pretest" system of foundation. This system applies the knowledge acquired, as described in this article, and also the technique of underpinning. But knowledge is science and technique is art, and science and art should go hand in hand.

This work presented three unusual features: (1) The erection of a building simultaneously with the construction of the foundation; (2) the securing of a foundation with a definite factor of safety; (3) the reduction of settlement to low limits. It is believed that all these were accomplished with resulting economy for the owners of the building. The methods employed were described in the *Engineering News-Record* of Dec. 6, 1917, p. 1060. Briefly, backfilling was placed over the cylinders, with wood posts resting on the cylinders and embedded in the fill, a concrete girder being then cast on this backfilling and posts. The steel grillages were then placed and erection was started. As the work progressed, the backfill was removed and the cylinders were loaded successively by hydraulic jacks. When the desired load was reached, I-beam posts were placed between the pile head and the base of the girder. After thse had been wedged tight the jack was removed and the I-beams were concreted.

The erection progress was slower than had been expected, so that by the time the building was eighteen stories high all the cylinders had been tested, wedged and corrected. A group of cylinders with wedging posts ready for correction is shown in Fig. 6. A 50-ton load was assigned to each 19-in. cylinder, but each was tested to 70 tons to give a factor of safety. Similar foundations have been used in three additional cases.

It is believed that the "pretest" system of foundations owes its success to the proper application of the principles set forth in this article.

Building Activities in 1919

In view of the present unusual conditions in the housing situation, a report just issued by the U. S. Geological Survey, Department of the Interior, on building operations in the larger cities of the country in 1919, by Jefferson Middleton, is of interest. This report shows the number and cost of buildings erected in 128 cities, classified by the character of the principal material entering into their construction.

In these cities there were 186,933 new operations, costing $951,047,495; 131,729 additions, alterations, or repairs, costing $171,024,832; and 20,846 miscellaneous operations, costing $15,246,422.

In 141 cities 365,972 permits were issued or buildings erected in 1919, representing a cost of $1,302,998,607. Approximately the same cities reported 210,538 building operations in 1918, costing $430,041,365, and the record for 1919 thus shows an increase of 155,434, or 74 per cent, in operations, and of $872,984,242, or 203 per cent, in cost. The average cost per operation in 1919 was $3,560.

Trend of Highway Development —A Survey

Indiana's Practice

THIS is the eighth of a series of articles on the highway situation. It discusses chiefly the task of bringing, by maintenance, the old gravel and dirt road system into a serviceable state prior to final improvement.

The ninth article of the series will appear in next week's issue.—EDITOR.

INDIANA this year has regenerated a large mileage of its state highway system by maintenance. Important roads have been paved and pavement construction will be extended, but maintenance is the more notable accomplishment; (1) Because it has involved

ONE TYPE OF INDIANA HIGHWAY TAKEN OVER FOR MAINTENANCE

reconstruction to an extent which ordinarily is not comprehended in maintenance; and (2) because it had to be inaugurated by an organization in process of creation under limitations of directing personnel which have thrown an ungenerous burden on the department's heads. As a working organization the state highway commission is virtually only eighteen months old and all of the routes of the state highway system have not been definitely located. These facts also have affected maintenance practice.

In 1920 Indiana took over approximately 3,600 miles of highway, to be improved and maintained by the state. Except for a small scattered mileage of pavement, these state highways were gravel or earth roads. Ordinarily the gravel roads, except on certain main routes, were not of modern high-class gravel construction; many of them were little more than gravel surfaced trails. Formerly these roads had been maintained by the counties. With state control in prospect, the counties had for a season or two done little maintenance work. When, therefore, the state highway department assumed the task of maintenance, the roads as a whole were in bad repair. Maintenance in many cases involved virtual reconstruction, including widening, ditching and resurfacing.

Obviously, highway maintenance, as practiced in 1920 in Indiana and as it must continue, under present plans, to be practiced until the roads are substantially reconstructed is a quite different task than it is in states having gravel and earth roads completed to permanent grade prior to maintenance. Emphasis of this fact is important, if a clear conception is to be had of the trend of highway development in Indiana, and this emphasis is given best by views of actual maintenance operations. The distressing state of repair shown by Fig. 1 was not common but it was encountered and many miles of road had to be provided with shoulders and ditches, as shown in Fig. 2, before maintenance in the true sense was possible.

Organization for maintenance is based on the patrol system. Under the chief engineer of maintenance are five division engineers each in charge of a territorial division of the state roads. Each division engineer has under him five or more superintendents each in charge of half a dozen or more patrolmen, a mechanic and two or more special gang foremen. The equipment of a patrol is a motor truck, a light blade grader, two drags, a plow and small tools. In the extensive reconstruction work of this year gangs have often been grouped and labor and equipment exchanged, but the plan permits of true patrol organization involving personal responsibility for distinct sections of highway as the roads are put in shape for maintenance.

The funds available for maintenance are the automobile license fees and the inheritance tax. Construction is financed by a one-mill tax on real property. At present the future amount of this fund is in doubt, it being held by the tax commissioner that the tax applies only on the original assessed valuation which is about half the present assessed valuation. Legislation will be required to clarify this situation. With taxation on the full valuation, construction funds in 1922 should approximate $12,000,000. The total Federal aid available is $4,726,239 and of this $2,724,271 is now covered by project agreements. In county work this year, there have been unusual financial difficulties. Counties in many instances have been unable to market their low

MAINTENANCE GENERALLY INVOLVED PRELIMINARY DITCHING

interest bonds and projects have been held up after after contracts had been let and construction had begun. It is, for these various reasons, the general opinion that clarifying legislation is needed to place highway development on a definite basis financially.

With about 210 miles of pavement under contract a little over 75 miles were completed in 1920. Transportation shortage of materials explains the small percentage of construction. The progress on bridge work has been even less favorable. Transportation difficulties in obtaining commercial materials is leading to serious study of local pit development and, particularly, of methods of using pit-run gravel. The specifications now hold rigidly to definite ratios of sand and gravel, so

their modification in respect to aggregate mixtures is among the possible developments. Paving methods, as in most other states, continue along old lines.

Indiana is in the process of finding herself in state highway improvement. Her greatest obstacle appears to be difficulty in appraising the magnitude of the task before the highway department. A sort of penury has been practiced, therefore, in building up the technical directing organization which has put too heavy a burden of detail on the directing heads. Breadth of organization needs to be secured. With legislation which will clarify uncertainties in financing road work, this policy will set highway development in the ways of modern practice.

Cross-Sectioning With Stadia Arc

By F. W. Medaugh
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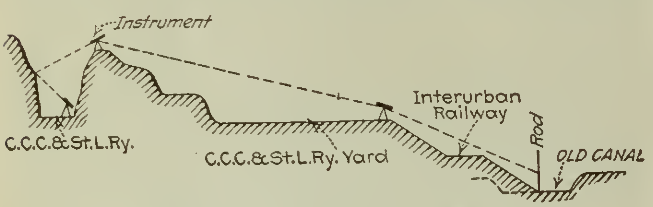
In measuring cross-sections for the railway valuation work of the Interstate Commerce Commission the value of the Beaman stadia arc has been demonstrated. A light instrument was used, consisting of a telescope mounted upon a small revolving plate supplied with a central circular bubble and fitted to a head similar to that used for leveling plane tables. Attachments for the telescope were the bubble, clamp, slow motion screw and stadia arc attachment. Readings were taken in the customary manner by setting the zero



DIFFICULT CROSS-SECTION WORK

point of the telescope upon an even graduation of the stadia arc and then recording the stadia reading above the arc reading and the rod reading to the left. To increase the accuracy the stadia constant was added mentally each time, and when the vertical angle was large the rodman held a small level against the rod in order to have it plumb.

The chief difficulty was indefiniteness of the original ground line. At the top of cuts the original examination showed generally a dark line due to decaying vegetable matter of the original top soil. In other places the upper toes of fills were covered by soil washed from the surrounding hillside, rendering it practically impossible to tell where the original surface had been. The rodman then held his rod at the present toe and the recorder added to the rod reading an amount based upon the topography of the surrounding slopes.

A recorder, an instrumentman and a rodman composed the cross-section party. In rough country the recorder carried a light 6-ft. rod and gave readings on one side of the roadbed, thus increasing the speed of the party. The readings were recorded on sheets kept in a large loose-leaf binder, a carbon copy being made for the railroad. On small cuts and fills many of the readings were taken with the telescope horizontal. The instrumentman then mentally subtracted the height of the instrument (usually 5 ft.) from the road reading and called out the result to the recorder. Thus the notes showed the cut or fill with respect to the base of rail.

All readings taken with the telescope inclined were reduced in the office with the aid of a table, but as most of the shots were comparatively short it was not necessary to have a very extensive reduction table. The stadia distances from zero to 50 ft. were placed in the column to the left, while the Beaman arc readings were placed at the top of double columns, from which the horizontal distance and difference in elevation could be read directly. When calculating the difference in elevation, the computer had to take into account the rod reading and the height of instrument, and had also to remember that Beaman arc readings between zero and 50 gave negative values, while readings between 50 and 100 gave positive values. To facilitate the use of the table it was mounted on a large wooden roller in such a way that the distances and elevations moved past the stationary Beaman arc readings as the operator revolved the roller.

In level country it was questionable which was the better method of taking measurements, by stadia and Beaman arc or by hand level and cloth tape. The former method was a little more accurate in reading elevations, but was not quite as rapid, even though many of the instrumentmen were extremely expert. In many light fills made from side borrow by scrapers there was no sharp line of demarcation between side of fill and side of borrow pit. Measurements could be made then much more rapidly with the hand level and tape, for the distance could be taken to the approximate toe of fill and the rodman could then hold his rod on the original ground on the far side of the borrow pit while the elevation was being read.

If the country was at all rough, however, the use of the stadia and the Beaman arc was found in most cases to effect a decided saving of time, in special cases at least 50 per cent. When double lines of box cars obstructed the sights it was a simple matter to set the instrument on the roof of a car to take the section, being careful to locate the position of the instrument with respect to the center lines both as regards distance and elevation. This procedure was specially valuable in yards where there was constant shifting of cars so that measurements with a tape would be attended with danger and loss of time.

A specially difficult problem solved successfully in this way was the measurement of the grading quantities of the Big Four yards at Wabash, Ind., as shown in the accompanying view. The main line here was in 40 to 50 ft. of cut and was separated from the yard by a mass of rock. The yard tracks were partly in cut and partly on fill, the fill sloping down to an interurban line and then into the bed of an abandoned and partly filled canal. The computers were furnished by the railroad with notes giving the original ground line and the closeness with which this line fitted the section taken spoke well for the accuracy of the work.

South American Ties for Pennsylvania R.R.

Investigation of the hardwoods of Central and South America as material for ties is to be made by the Pennsylvania System in view of present high prices of ties in this country, the cost and life of the tropical woods being the main points. Under normal conditions this railway requires from 5,000,000 to 6,000,000 ties annually and the average net cost has risen 100 per cent since the beginning of the war, according to an official statement.

An Analysis of the Proposal to Establish a National Department of Public Works

By Lieut.-Col. C. O. Sherrill
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THE proposal to create a Department of Public Works has been urged for many years by members of the engineering and contracting professions, with the avowed purpose of bringing under one head all engineering and construction activities carried on by the U. S. Government. Although advocated for many years by individuals, it is only since April, 1919, that this question has been actively taken up and advocated by engineering societies and contractors' associations with a carefully organized propaganda directed by the National Public Works Department Association. The activities of this association have led to the introduction in the U. S. Senate and House of Representatives of a bill to create a Department of Public Works, known as the Jones-Reavis Bill (S-2232, H.R.-6649).

The most important provision of the bill consists in the conversion of the Department of the Interior into a Department of Public Works, and the placing in that department of all engineering, construction and related activities now distributed throughout the various departments and independent bureaus of the Government. It also provides that the secretary of this department must be appointed from the engineering profession; that each assistant secretary must also be specially qualified by training and experience for his particular service; that the tenure of the assistant secretaries in office is for life or good behavior, subject to removal only for inefficiency or malfeasance in office, or physical disability. These assistant secretaries are to be charged respectively—one with all governmental matters of engineering design and construction; one with all governmental architectural design and construction; one with all governmental scientific work and surveys; and one with all governmental land and legal matters. In other words, one assistant secretary must be an engineer; one an architect; one a mapping expert; and one a lawyer.

Objects of Bill

The ends to be accomplished by this bill as set forth in the propaganda of the Public Works Department Association are briefly as follows:

To create an industrial organization along the lines followed so successfully by American industries; to secure centralization with resultant large economies of overhead; to eliminate rivalry and competition for appropriations; to provide a special technical organization to do engineering work for other departments; to secure standardization and simplification of Government contracts and specifications; to provide a complete business organization available in case of war for its construction activities; to render aid to the budget system; to serve as a regulator of our national industries; to provide a means of broader training for the Corps of Engineers, U. S. Army; to bring the United States into line with other important countries in having a Public Works Department; to provide for co-ordinated technical research.

The advocates of the Department of public works cite, as the principal reasons for the creation of such a department, the following: That there would be improvement in the administrative organization of the national government; that efficiency would be promoted in overhead administration, that duplication of effort would be avoided, with better utilization of plant and personnel, and with the standardization of specifications and procedure; that economy and efficiency of the other departments relieved of public works would be promoted; that a permanent corps of civilian engineers would be created that would be of great public advantage both in peace and in war.

It is argued that the administrative branch of the federal government has grown up piecemeal, on no well-thought-out plan, with the result that as the government activities have extended their scope, many inconsistencies of assignment of functions have resulted, with much overlapping and lack of co-ordination. One of the strongest points made by the advocates of this measure is that there will be a single head to all the related activities of the Government along engineering and construction lines, apparently allowing the elimination of duplication not only of work done, but of organization personnel and plant.

Arguments Against the Creation of the Department

The principal arguments against the creation of this Department of Public Works have been well summarized by the Chamber of Commerce of the United States in its referendum submitted to the component chambers of commerce throughout the United States, March 30, 1920, which resulted in the rejection of the proposal. These are briefly as follows:

(a) The proposal is too vague and indefinite for adoption, especially as definiteness and exactness are supposed to be fundamental qualities of proposals made by engineers.

(b) While reorganization of all the activities of the federal government might well be undertaken by Congress in the interest of logical arrangement, such reorganization should be based upon a careful examination of the governmental functions for which these departments were brought into being, and not by a piecemeal consideration, as proposed by this bill, such an effort having an inevitable tendency to create many new non-essential departments of government at a time when the number of Cabinet officers is so great as to form an unwieldy body. Instances of these new departments having an equal or greater merit than the Public Works Department are: Department of Education, Department of Public Health, Department of Public Welfare, Department of Air Navigation, Department of Transportation. The evil results of the proposal are already evident in the effort to prevent the placing of all construction activities of the War Department in the hands of the Corps of Engineers by the perpetuation of an additional and unnecessary Construction Division within this department.

(c) The inefficiency of the present arrangement of engineering and constructing services has not been demonstrated.

(d) Economy would not be promoted, but expenditures would, on the contrary, be increased. Each of the bureaus of this new department will inevitably build up a large organization of clerks and other employees for itself. Instead of allowing each department to do the minor engineering work incident to its principal function, the Public Works Department will have to be called in to build each item, no matter how trifling, as for instance, a few miles of telephone line for the Forest Service, which could under this bill no longer be constructed by its own employees when not otherwise engaged.

(e) The Public Works Department at best would be a misnomer, as the United States does not have public works of the kind described by the proponents of the measure of

sufficient importance and suitable for transfer to warrant the setting up of a new Department of Public Works, nor to justify its head having a place in the Cabinet. This department suggests strongly public ownership and operation of utilities not now apparent.

(f) The governmental departments can in other and more appropriate ways secure competent engineering services. This appears to be an effort to increase the permanence, compensation and emolument of one class of government employees, viz., engineers, at the expense of all other classes.

(g) Governmental organization must for success be functional, and engineering is not a function, but rather one of the branches of technique of governmental functions. Engineering is a profession which exists solely for the assistance it can render in the accomplishment of purposes wholly apart from engineering. The head of a government department utilizes professional services of lawyers, engineers, accountants and of various other professional and technical men to assist him in carrying out the functions of his department, but there is no reason why these functions should be subordinated to any of these branches of service technique.

(h) There are many other special objections that will arise from such a concentration of engineering work to be done for other departments, an example being the Office of Indian Affairs, whose function is the guardianship and trusteeship of Indians while they are being brought to the status of citizens. This trusteeship controls more than a quarter of a billion dollars' worth of property. The absurdity of having the trustee withdraw altogether in favor of a lawyer or engineer because legal or engineering questions from time to time have to be settled by the trustee, is self evident. Responsibility for the performance of governmental functions should be made more definite, not dispersed. If the execution of engineering or construction work is placed in one department, and a purpose to which the work contributes in another department, there will inevitably be a diminution of official responsibility upon the official charged with the accomplishment of the purpose. Giving the department head his own professional assistance may mean some duplication, but the advantage to the public in having a public duty expeditiously and properly fulfilled and in having some one person whom it can hold exactly responsible for any failure far outweigh any such duplication.

At first glance and on theoretical grounds solely, the proposal to establish a Department of Public Works to handle all the construction and engineering activities of the government is one that naturally makes a strong appeal to the public at large. To say that one, rather than a number of different heads, shall direct all work of similar nature under the government is a principle to which no one can consistently object, unless there are other and more potent reasons why such concentration should not take place. Since all engineering and construction activities have a certain similarity, it might require but little argument to convince the uninformed on matters of govermental policy that a separate department to handle all these matters should be established. I am prepared to go even further and say that if the disadvantages that will result from such consolidation are not greater than the advantages to be secured, then such consolidation might well be made.

Two Classes of Engineering Work

In drafting the bill for the Department of Public Works, its advocates appear to have lost sight of the two fundamentally distinct classes of engineering and construction works carried on by the government, and in failing to make this distinction they have committed themselves to an illogical grouping of bureaus in the proposed department. These two distinct classes of activities are:

(a) Engineering and construction activities carried on for the public at large and as the primary function of the bureau of service concerned, *i.e.*, the principal business of the bureau and the reason for its existence.

(b) Those engineering and construction activities carried on as mere incidents to the primary functions of the departments or bureaus which execute these functions. These incidental activities vary in magnitude from the most minute detail to projects involving hundreds of millions of dollars, and yet, notwithstanding their magnitude, are after all only incidental to some other primary function.

In the effort of the advocates of the Public Works Department to make out a good case for a separate department, they have thrown together a heterogeneous lot of slightly related independent and incidental activities under one head, with little regard at all to the real governmental functions to which these activities are only incidental. Take the case of the Bureau of Indian Affairs and the Board of Indian Commissioners; this bill proposes to place these bureaus under the Department of Labor, while taking from them their engineering, construction and survey work carried on as an incident of caring for the Indians. In other words, the Bureau of Indian Affairs is the trustee for the Indians and is responsible to Congress for their welfare, and yet it is at the outset to be deprived of some of the most essential means for the accomplishment of that end, and with no other argument than that all engineering and construction activities should be grouped together under one independent head. The undesirability of such a proposal would be apparent if it were applied to a trustee in private life, for instance, to the trustee of a minor child. Who could imagine a case where a trustee of a child should not direct all legal, moral or educational activities necessary to care for the child's interest to the time of its maturity.

Bill Held to Be Inconsistent

The proposed bill is equally inconsistent as to what is omitted therefrom, as for example, one of the most costly activities of the Interstate Commerce Commission is the valuation of railroad properties, largely an engineer function. Evidently the advocates of this measure could hardly justify even to themselves the taking away of this important adjunct to the primary functions of the Interstate Commerce Commission, and yet they have done other things even more radical and more detrimental to other departments. For instance, they propose to place the construction work of the Army in this Department of Public Works on the ground that its work is largely of a civil engineering nature, apparently ignoring the fact that the Army does not construct quarters and storehouses solely to get something built, but only that troops and supplies may be protected from the weather and be in constant readiness for war; or in other words, the army's construction work is only incidental to its business of defending the nation.

The General Land Office, however, is left in the Department of Public Works, although its engineering and surveying functions are solely an incident, though an important incident, to its primary function of administering the public lands of the United States for the benefits of settlers. The Reclamation Service is also left in the proposed Department of Public Works, although the building of dams and drainage ditches is an incident only to the administration of reclamation projects and laws for the benefit of settlers on otherwise arid government land. The National Park Service is left in the Department of Public Works, as if its prime object were the construction of engineering monuments rather than the administration of the national parks of the United States as playgrounds for the pleasure and benefit of the people at large.

These inconsistencies in assigning activities are no-

where more obvious than in the assignment of river and harbor improvement to the Department of Public Works, while leaving the Bureau of Lighthouses under the Department of Commerce. No two activities of the Government are more closely related than are these or could be combined under on head with greater advantage. In fact many of the lighthouse districts have their construction and repair work done at this time under officers of the Corps of Engineers in charge of river and harbor work.

The example most frequently given by the Department of Public Works advocates of the inconsistency of the present arrangement of governmental construction activities is that of the Supervising Architect's Office in the Treasury Department. The real reason why this is under the Treasury rather than any other department is that this department is the largest governmental user of public buildings in our cities for custom houses, sub-treasuries, Internal Revenue officies, Federal Reserve banks, etc. What is more appropriate than that the Secretary of the Treasury should direct the construction of the buildings he needs in his business?

Arguments for the Department

The cases above cited are but a few of the many inconsistencies that result from this effort to bring together many apparently similar but actually dissimilar activities to create a Department of Public Works; and the reason for these inconsistencies arises from the fact that the advocates of this measure have failed to realize that there is one and only one vitally important reason for the creation of governmental departments and bureaus, and that reason is that some essential governmental function may be carried out for the benefit of the people of the country. The construction of engineering works cannot by any means be classed as a function of government, but only as one of the many means used by the various governmental departments in carrying out their proper functions. This is clearly shown in one of the most prominent of the arguments for this department, viz., that there are nine federal departments, thirty-five bureaus, and four unattached commissions now engaged in engineering and construction work. This means that every one of the government departments and nearly all the bureaus and commissions find it necessary, in the execution of their primary governmental functions, to do a certain amount of engineering and construction work, just as most of them find it necessary to do a certain amount of legal, educational, commercial and research work, but if they are to be held responsible for accomplishing the purposes for which they are created, then they must be given all of the essential machinery, including construction, for the successful execution of these functions.

Having had some experience as an engineer in the Army, engaged on construction work, and having also been in command of troops for whom construction work is done in the Army, I realize how difficult it is to secure a proper consideration of the object for which construction work is done, even in a small organization and where the engineering and using services are in closest co-operation and associated under one army head. To secure the class of construction work necessary for the different government departments through an entirely independent and outside agency, such as this Department of Public Works, would be almost impossible of accomplishment. Such a roundabout and unworkable arrangement would cause only delays, annoyance and interference with governmental functions.

An Assumed Case of Red Tape

Let us assume a particular case: The Army has a battalion stationed at Fort Huachaca, Arizona. The battalion commander finds that in the administration of his battalion it will be necessary for him to have a company barrack. In order to get this through the Public Works Department he would report the necessity of it to his army department commander at San Antonio, who in turn would report the matter to the War Department. The Secretary of War would in turn report to the Secretary of the Department of Public Works that a barrack is required at Fort Huachaca. The Secretary of the Department of Public Works would transmit this information through his various intermediate divisions down to his office nearest to Fort Huachaca. This official would then made a survey and an estimate of the amount of money involved in this project, and if he were an official of the best type, would consult with the battalion commander to see if their views agreed. If, however, he did not care to co-operate in this way, he would make up his plans independently, send them back through all the various intermediaries to Washington, and so on to the head of the Public Works Department, who would submit them to the War Department, and thus they would go back once more to the battalion commander, to find out if the plans were adapted to his requirements. It can be readily seen from this simple illustration that it would be impossible to get the desired results by a segregation of construction activities in a separate department, independent of the agency for which the construction is being done.

But the segregation of activities in the proposed department goes much farther than this. In the department itself there are to be four main branches, each under an assistant secretary appointed for life. Before a cantonment for troops under the Secretary of War can be built by the Secretary of Public Works, his assistant secretary "A" must procure the land and do all necessary legal work, assistant secretary "B" must make the required surveys, and assistant secretary "C" must then make the necessary plans. If any architectural design is involved, assistant secretary "D" must be called upon to do this before assistant secretary "C" can begin the work of construction. Before the cantonment would be built under this arrangement the war would be over or the particular battalion out of the service due to exposure.

Engineer Corps Menaced

The Public Works Association has devoted most of its attention for the past year and a half to the Corps of Engineers, U. S. Army, in its propaganda for a Public Works Department, without a rejoinder in the public print from that conservative organization up to this time. In fact, a reading of the bill quoted above discloses that practically as much space is devoted in the bill itself to the destruction of the Corps of Engineers as is given to all the other construction agencies of the government combined. It will also be noted that whereas all other construction agencies of the government are taken into the Department of Public Works bodily, without change of their organization, in the case

of the Corps of Engineers the transfer is arranged so as to take away completely its administrative control over construction activities, allowing such officers of the Corps of Engineers as the Secretary of Public Works may deem necessary to be detailed by the Secretary of War for temporary duty for instruction purposes only in the new department. This proposal to take away from the Corps of Engineers its diversified construction activities is moreover emphasized in all the literature and propaganda that has been issued by the Public Works Association, making it appear that this proposal is aimed more at the destruction of the Corps of Engineers than for the general good of the government as a whole.

In a thirty-page pamphlet of propaganda issued by the Public Works Department Association, approximately five pages are devoted to explaining why the Corps of Engineers must be destroyed. This is advocated in spite of the long and honorable record of achievement of the Corps, free from political influence and graft, dating back to Revolutionary days and extending down to the building of the Panama Canal and to its construction exploits in France. The questionable ethics of these attacks on the Corps of Engineers by the Public Works Department Association seem entirely unworthy of the professional men by whom they are advanced.

Again, the advocates of this measure are absolutely inconsistent, for while urging in one breath the taking away from the Corps of Engineers of the construction activities with which it has been charged by Congress for over a hundred years and which it has carried out with the cleanest of records, this association, in the next breath, to secure efficiency proposes a system of tenure of office practically identical with that in the Corps of Engineers and differing solely in the fact that the officials in one case are commissioned officers, subject to all the dangers and disabilities of the military service, and in the other case are officials of this Public Works Department permanently in Washington. Section 7 of this bill undertakes to make the tenure of office of the assistant secretaries as permanent as is that of the officers of the Corps of Engineers, but with none of the advantages to the government of the latter, due to the possibility of relieving an unsatisfactory engineer officer from his construction duty without the necessity of the elaborate procedure prescribed for removing one of the assistant secretaries.

Another of the arguments used by the advocates of this measure is that it will provide an organization of trained engineers, available for use in war, which is what the government secures much more efficiently under its present system of using the Corps of Engineers to as great an extent as possible on the construction of essential public works in time of peace, in view of the military as well as civil engineering training of this body. When these peace-time construction activities are suspended at the outbreak of war, the Corps of Engineers is free to carry on all needed construction work of the Army in the theatre of military operations and in the United States.

Engineering Council's Committee on Military Affairs, realizing the importance of utilizing the army engineers on public works to the fullest extent possible in peace, as a preparation for war, recently enunciated the following principle:

But the bringing together of the two great divisions of engineering science, military and civil, is only partly done when there is extended to civilian engineers the opportunity for gaining experience as military engineers. The full result will be attained when the military engineers in a corresponding manner are given the opportunity to become experienced as civil engineers. To enable the members of the Corps of Engineers to gain experience in all branches of civil engineering they should have opportunities for service on as much as possible of the general construction work done by the Federal Government, and not be confined to river and harbor improvements, as has been the custom. In addition to this, members of the corps should be assigned for temporary employment with state highway commissions or private corporations such as railway companies, metallurgical establishments, large contracting firms or factories where machinery, electrical devices and other forms of manufactured articles, in which engineers are interested, are produced and where members of the corps can become acquainted with all phases of practical operation.

This would clearly indicate that not only should the Corps of Engineers continue to execute the public works functions which it has successfully executed throughout the past, but that, in the interest of economy and preparedness for war, it should be given added duties of this nature whenever not decidedly disadvantageous to the interests of the government to assign it such additional duties.

The Corps of Engineers is a body of technical men of high standing, poorly paid but honest, whose lives are devoted to the public service, free from political influence; and no possible rearrangement of government functions can ever do more than to secure a similar high quality of service from government officials, whether commissioned or civilian.

In conclusion, it is believed to be established that there should be no Department of Public Works created as a new department or out of the Department of the Interior; that there is a possible necessity of a general reorganization of the government departments as a whole, but that any such reorganization should be based on governmental functions rather than on engineering technique; that the Corps of Engineers should continue as in the past to be charged with the execution of public works of construction to the fullest possible extent, in the interest of honesty, economy and reparedness for war.

Investigation of Drill Steel Undertaken

The Bureau of Mines is taking up actively an investigation of drill steel. Many users of drill steel feel that the improvements in that product have not kept pace with the improvements in drilling machines. The matter has been the subject of recent conferences between Dr. F. G. Cottrell, the director of the Bureau of Mines, D. A. Lyon, supervisor of experiment stations, and bureau specialists with representatives of various types of mining enteprises. The testimony of users in the districts where the rock is hard is wholly to the effect that the failure of steel has become a very serious problem, due to the loss of time on the part of high-priced labor.

B. F. Tillson, of the New Jersey Zinc Co., has made a special study of the causes of breakage in drill steel and will co-ouerate with the Bureau of Mines in the study of the problem. Mr. Tillson's investigations lead him to believe that the blows of the drill hammer set up vibrations comparable to sound waves and that nodes are caused by the concentration of these waves at certain points in the drill. This leads to prompt fracture. When a flaw or sand hole comes within the area of concentrated wave effect, the failure of the drill takes place almost immediately.

The Bureau's specialists, who are to be assigned to this problem, will be sent to the manufacturing plants to discuss the matter with officials there. A collection is to be made of broken steel so that the breaks may be studied.—*Engineering and Mining Journal.*

Irrigation Water Divided Between United States and Canada

Under International Agreement Flow of St. Mary and Milk Rivers Systematically Shared by Montana and Provinces

By Benjamin E. Jones
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CONTROVERSIES over the division of irrigation waters in the western United States are frequent. Similar controversies arose on the St. Mary and Milk Rivers, in Montana and in Alberta and Saskatchewan, Canada, previous to 1909, and the fact that the contending parties lived in different countries did not make it easier to settle the dispute. This article will tell how an amicable adjustment was effected by an international treaty agreement for a division of the flow of the two streams between the two countries by a joint commission and how the division is being made year by year under the joint supervision of the directors of the U. S. Reclamation Service and the Reclamation Service of Canada.

St. Mary River, in the Hudson Bay drainage basin, rises in the mountains of Glacier National Park, in Montana, and flows northward into Canada where its water is used for irrigation. Milk River, a tributary of the Missouri, rises in the low hills adjacent to the St. Mary River drainage basin, flows northward into Canada, turns east, and finally, after flowing 216 miles in Canada, returns southward to the United States. The size of the drainage basins of these two streams, as indicated by the accompanying map, might suggest that Milk River would yield the larger flow, but a study of the character of the two drainage areas, as illustrated in the photographs here reproduced, shows why the glacier-fed St. Mary is a much better irrigation stream than the Milk, whose upper tributaries reach only as far as the foothills of the Rocky Mountains and whose lower valley is a dry prairie. As a result, during periods of long-continued drought, when irrigation is most necessary, Milk River goes dry, while the snows on the mountain peaks that drain into the St. Mary are melted by the hot summer sun, and the maximum flow occurs at that time.

In 1901 or earlier the U. S. Reclamation Service, then a part of the U. S. Geological Survey, proposed to remedy this condition on Milk River by diverting the water of St. Mary River into the basin of the Milk, where it could be used to irrigate land in the lower end of Milk River Valley in Montana. After years of discussion an agreement between the United States and Canada was reached in 1909, and a treaty was made, under which the water of the two streams was divided equally between the two countries with one exception. To protect the rights of irrigators who prior to the making of the treaty had begun to use the water of the two rivers, a prior right to 500 sec.-ft. of St. Mary River, or so much of that amount as constitutes three-fourths of the natural flow of the river, was given to Canada, and a like priority on Milk River was given to the United States. As during the irrigation season there is nearly always more than 500 sec.-ft. in St. Mary River, and very seldom that much in Milk River, this exception was somewhat in Canada's favor. But Canada had been using St. Mary River water, and the United States that of Milk River, so this adjustment was probably adopted because it seemed to be the best one that was practicable. The actual division of the water was to be carried out under the direction of an International Joint Commission established by the treaty.

In 1917, the U. S. Reclamation Service completed its canal from St. Mary River to the top of the Milk River divide, and in May, 1918, the International Joint Commission met and issued a provisional order for the division of water for that year. A provisional order was necessary because different interpretations of certain parts of the treaty had been made in the two countries. Hearings and arguments on the questions at issue, which have not yet been decided, fill three large published volumes, besides a mass of testimony, briefs, etc., filed but not printed. A decision by the commission on the disputed points is expected soon. To carry out the orders of the commission, the United States named A. P. Davis, director of the United States Reclamation Service, as its representative, and Canada named E. F. Drake, director of the Reclamation Service of Canada. These two men, through their engineers in the field, divide the waters of the two rivers in accordance with the order of the commission.

FIG. 1. ST. MARY AND MILK RIVER DRAINAGE AREAS OVERLAPPING INTERNATIONAL BOUNDARY

The smaller drainage area, because of its location in the mountains, has the larger yield. Under international agreement and jurisdiction the two streams are gaged and their flow divided (see text) between irrigation projects in the state of Montana and the provinces of Alberta and Saskatchewan.

The main engineering problem involved in the division is the accurate measurement of the quantity of water flowing in the streams and canals and the determination of the time required for water to travel given distances along the river beds and canals. For determining the flow of streams that cross the international boundary, the Reclamation Service of Canada and the U. S. Geological Survey have maintained joint stations since 1912, and there are at present nine such stations on these two rivers or their tributaries, and on the U. S. Reclamation Service canal diverting from St. Mary River. The cost of installation is borne equally by the two countries, and in the operation of the stations measurements are made at frequent intervals by engineers from both sides. At the end of the season the results are worked up jointly by the two organizations. In addition to these co-operative stations others are separately operated in the two river basins by the representatives of each of the two governments.

FIGS. 2 TO 5. VIEWS ON ST. MARY AND MILK RIVERS IN THE UNITED STATES AND CANADA

(2) Gage shelter and control on Swiftcurrent Creek at Many Glacier, Mont. (3) Gaging station on St. Mary River at international boundary. (4) Typical view of St. Mary River drainage area, early July. (5) Upper Milk River at Pendant de Orielle Police Post, Alberta. Note the contrasting character as regards water yield of the St. Mary River drainage area views (2), (3), (4) and the Milk River drainage area view (5).

After satisfactory measurements of the stream flow are obtained the problems involved in the actual division of the water under the commission's order are not difficult. First, it is necessary to determine the natural flow of St. Mary River, as Sherburne reservoir (see *Engineering News-Record,* Feb. 21, 1918, p. 366) constructed and operated by the United States, is on Swiftcurrent Creek, one of its principal tributaries. The water entering the reservoir comes mainly from two streams, so that by installing on these streams gaging stations equipped with water-stage recorders, it is possible to get a very close estimate of the daily inflow. Comparison of the inflow with the outflow gives the amount daily stored or released by the United States. The natural flow at the international boundary is then determined from the measured flow plus the amount diverted above, with proper allowance for storage.

Seepage losses in the St. Mary Canal are measured at three stations equipped with Stevens and Gurley gages. Measurements at these stations also show the amount of water diverted from St. Mary River to Milk River by the United States. As the seepage loss in the upper half of the canal returns directly to St. Mary River and can be rediverted by Canada, the records of the middle station on the canal, where it crosses St. Mary River, are used for purposes of division. The water received by Canada is measured at a gaging station at the international boundary. Canada also maintains stations showing the amount diverted from St. Mary River in that country and at a station near the mouth of the river showing the water not utilized for irrigation. The city of Lethbridge takes its municipal supply from the river near its mouth.

On Milk River the main determinations necessary are the natural flow of the river, the inflow from the tributaries, particularly the large tributaries from the north whose courses lie in both countries, and the seepage loss. An interesting problem, although it is not international in character, is the determination by the U. S. Reclamation Service of the natural flow of Milk River below Havre, Mont., allowance being made for losses by seepage and evaporation. The natural flow of Milk River during the irrigation season is nearly all subject to old claims of private companies and individuals, but the diverted St. Mary River water belongs to the Milk River project of the Reclamation Service. On Milk River stations are maintained on North Fork above and below the point where the St. Mary water enters, and the flow at the upper station combined with that at a station on South Fork of Milk River gives the natural flow at the upper end of Milk River. Farther down stream are stations at the town of Milk River, in Canada; at the eastern crossing of the international boundary, where the stream returns to the United States, and at Havre, Mont., above all diversions in the United States. During dry seasons those stations show the seepage losses in over 300 miles of river channel, for at such times there is practically no inflow between the upper and lower stations. During wet years a large number of tributary streams must be measured. The losses by seepage and evaporation in 1919 amounted to about 100 sec.-ft., out of 400 sec.-ft., flowing at the upper end of the river. During very hot spells this loss increases somewhat, and in fact the influence of temperature on losses is marked.

Other gaging stations are maintained along the international boundary on the principal tributaries of Milk River from the north, Lodge and Battle creeks and Frenchman River. To acquire general information for the Milk River project, the southern tributaries of Milk River are measured, as well as the main canals. A station at Vandalia dam, below the last diversion, shows the amount of water not utilized for irrigation from the Milk River drainage basin.

In dividing the water, estimates of daily discharge are ordinarily made at intervals of about one week, but during periods of rapid fluctuation daily computations are necessary. Any discrepancies in the division of the water are thus discovered and corrected in the course of a few days. Tables are prepared showing the inflow and outflow from Sherburne Lake, the natural flow of the rivers, the amount to which each country is entitled, and the water received by each. If either is receiving less than its share under the treaty the headgates of the canals or the gates at the reservoir are adjusted.

The accompanying table is a sample of the statements supplied to the irrigation officials of Canada. Those for the United States are similar except that the last two columns relate to the United States.

DIVISION OF ST. MARY RIVER WATER BETWEEN CANADA AND THE UNITED STATES, AUGUST 3-7, 1919
(Quantities in Second-Feet)

Date	Diverted by U. S. R. S. Canal	St. Mary River at Boundary	Total	Stored Water Released	Naurtal Flow St. Mary River at Kimball	Canada's Share	Canada's Excess (+) or Deficiency (—)
3	389	470	859	203	656	492	—22
4	389	480	869	198	671	500	—20
5	386	475	861	233	628	471	+ 4
6	385	470	855	259	596	447	+23
7	385	457	842	257	585	439	+18

The first column shows the water diverted by the United States, the second that received by Canada; the sum is the amount of water in the river. From this is subtracted the stored water released, to give the natural flow of the river, from which is determined the share of each country.

As a rule the quantity of water flowing at any station is determined from the gage-height records of water-stage recorders by means of a station rating table, which is kept up to date by frequent current meter measurements. The field work of dividing the water has been carried on now for practically three years without misunderstanding or disagreement, with no complaint from either side, and although the division must continue as long as the water of the two rivers is used for irrigation the lapse of time should make the possibility of disagreement more and more unlikely.

In the United States, the stream gaging is done by the U. S. Geological Survey in co-operation with the U. S. Reclamation Service. In Canada, it is carried on by the Reclamation Service of Canada. The actual division of water is made by representatives of the Reclamation Service of each country, and the writer acted in that capacity for the U. S. Reclamation Service in 1918 and 1919. The photographs accompanying this article were taken by R. J. Burley, assistant director of the Reclamation Service of Canada.

Insects Destroy More Timber than Do Fires

The average annual loss of yellow pine in Klamath and Lake Counties, Ore., from insects is 150,000,000 board feet, worth $250,000, or 300 times the average annual fire loss. Fully 8 per cent of the yellow pine timber in private ownership has been killed in the past six years, according to the forest entomologist of the Oregon Experiment Station. The principal enemy is the western pine dark brown beetle, which bores through the bark and excavates long, winding galleries in the soft formative tissue next to the bark; the tree is girdled and its sap flow thus cut off. Epidemic infestations occur in cycles of four to five years, when 6 to 8 per cent of the trees may be killed. For eradication both state and federal funds are said to be insufficient.

Bituminous Surfacing for Plank Highway Bridge Floors

Postpones Renewal of Old Bridges by Producing Light, Easily Maintained Floor—Stiff Construction Essential

By M. W. Torkelson
Bridge Engineer, Wisconsin Highway Commission, Madison

IN THE years 1914 and 1915 the prevailing price for steel bridges erected in Wisconsin was less than 3c. per pound and reinforced-concrete floors cost no more than $10 per cubic yard. Due to the cheapness of new construction many old steel bridges in good condition but provided with wooden floors were scrapped and replaced with new structures, it being felt that it would be cheaper in the long run and more satisfactory to tear out an old bridge and build a new one with concrete floor than to maintain the old floor and bridge. The rise in the price of materials which has taken place since then, beginning slowly in 1916 and continuing rapidly through 1917 and 1918, changed all this. High costs of construction have made it necessary to keep old bridges in service as long as possible.

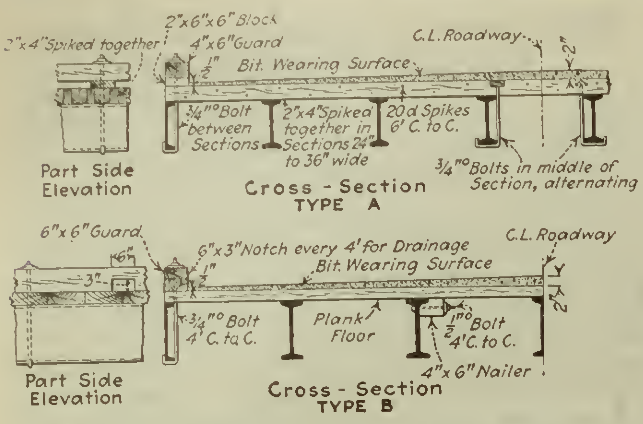
The weak point of the old bridges is the floor, yet they cannot carry the weight of a reinforced-concrete floor and have any live-load capacity left. A light, strong floor which could be maintained otherwise than by replacement was necessary. The Wisconsin Highway Commission first gave this subject consideration in 1917.

At that time Mr. Rollman, then county highway commissioner of Shawano County, at present division engineer for the Wisconsin Highway Commission at Green Bay, began the construction of bituminous-surfaced floors, using laminated units built up from 2 x 4's set on edge, bolted in place and afterward covered with a bituminous surfacing. Several of these were constructed prior to 1917 and are giving satisfactory service. The Illinois highway department had also made experiments along this line, and after correspondence with this department the writer visited several jobs in northern Illinois. Other investigations were made through correspondence. As a result of the information gained from these various sources a memorandum of instructions concerning bituminous floor surfacing was compiled in the spring of 1918 and has since that time served as a basis for installing a number of bituminous wearing surfaces. A standard plan was also prepared for the laminated floor, which is now in frequent use in Wisconsin.

Slightly condensed, this memorandum is reproduced below. It is not contended that the instructions cover the only method of making successful applications. There probably are many others. In fact, experience to date makes it appear that no great skill is required in the construction of bituminous wearing surfaces; that good results are practically certain if a few fundamental requirements are observed:

1. The floor must be tight and the planks must be stiff, so that there is not sufficient deflection to break the wearing coat between adjacent planks.

2. The bitumen should, preferably, be good, heavy material. In one instance where a light tar was used as a seal coat over a heavy tar it appears that the light tar acted as a flux and was responsible for considerable bleeding later on.



BITUMINOUS SURFACING ON LAMINATED AND PLANK FLOORS, WISCONSIN STANDARD

3. The bitumen should be applied in light coats and plenty of absorbent used. Experience will soon indicate just how each should be applied, but the beginner will do well to use about twice as much absorbent as he thinks the bitumen can possibly fill. It will be well to have a supply on hand for future applications in case there should be bleeding.

Bituminous Protection for Plank Bridge Floors (Abstract)

4. The application must be made on a clean, dry surface.

It is possible to protect plank bridge floors very effectively by means of bituminous carpets, using either tars or asphalts as the bituminous ingredient.

In using such treatment it is important that the bridge shall be as free from vibration as possible. To this end all bridges should be carefully examined to make sure that the bridge is resting firmly on its bearings. If necessary, the bearings should be shimmed up to make each take its proper load.

No one factor is of as great importance in securing success as having the plank floor tight. The failures that were observed resulted in part from an improper mixture of the ingredients of the coating, but if the floor is not tight it makes no difference how good the ingredients may be, traffic will force the bitumen through the cracks, holes will develop and the protective coating will be lost.

If new planking is to be supplied the planks should by all means be creosoted, as in this way they will be protected against rot as well as wear. The Illinois State Highway Department, which has had considerable experience, recommends that the plank be matched (shiplapped). Good results can be secured, however, with ordinary planks. The planks should in any case be drawn as tight together as possible and well spiked in place. Cracks between planks which cannot be filled in any other way should be calked with jute or oakum. It would also be well in case new planks are to be supplied to buy these of commercial 4-in. thickness; commercial 3-in. planks are usually about 2⅝ in. actual thickness, which is too thin for present-day loads.

Where the bituminous covering is to be applied to plank floors already on the bridge it is necessary to go to much more trouble to stop the cracks. In case the planks are rather far apart, as much as ¼ in., it will probably be best to pull the spikes and re-lay the planks. Possibly a little dressing of the edges of the planks might be helpful. If the number of wide cracks is not too great it probably will be economical to fill these with wooden wedges, using lath or thin lumber from packing cases which will fit snugly and can be driven between the planks, cut off flush with their tops, and toe-nailed in place so that by no possibility can they be forced through. Small cracks should be caulked with jute or oakum.

Previous to the application of the bitumen care should be taken to make sure that the planks are clean and dry. This result can be secured either by sweeping with a good stiff broom or by scrubbing with water. If it is possible to use water under pressure this is the best method. Probably a combination of the washing and the sweeping will be most effective. In any case the essential thing is to have all dust, dirt or vegetable matter absent, as these will prevent the proper adhesion of the bitumen to the planks. A sufficient time should elapse after washing to insure that all moisture remaining is thoroughly dried out.

Either tars or asphalts can be used as the bituminous ingredient of the coating. The bitumen should be a good heavy product, Tarvia A or Tarvia X, Trinidad A or even heavier asphalts. Where the treatment is to be given to an uncreosoted plank floor the first application of the bitumen should preferably be a very thin coat of light tar which can be applied without heating, such as Tarvia B, which should be allowed to dry before the succeeding applications are made. The heavier bitumens should then be applied, using ⅓ to ½ gal. per square yard.

The temperature necessary to produce proper results will vary with the bitumen. Tarvia A should be applied at a temperature of about 225 deg. F. Trinidad A can often be applied in warm weather without additional heating. Some of the heavier asphalts, on the other hand, will require to be heated to a temperature as high as 350 deg. The proper temperature is that at which the bitumen will flow with reasonable freedom and remain fluid for a sufficient length of time to permit the proper incorporation of the absorbent.

The application of the absorbent should follow the application of the bitumen very closely. The best absorbent consists of screened gravel or stone chips not smaller than ¼ in. nor larger than ⅝ in. The absorbent should be spread carefully over the bitumen with a square-pointed shovel to such a thickness as will just absorb the bitumen applied. As soon as sufficient of the absorbent has been applied to make it practicable the absorbent should be worked into the bitumen by means of a power roller if this is available, or if not by means of tampers. When thoroughly cooled make the next application in the same way.

The finished covering should vary in thickness from 1½ in. to 2 in. at the center of the bridge to ½ in. at the edges. This is sufficient for drainage. The Illinois Highway Commission recommends crowning the planks, but the utility of this appears doubtful when it is considered that no water can come in contact with the planks. A sufficient number of coats should be applied to bring the coating to required thickness, narrowing the applications to produce the crown effect referred to. Each application should be thoroughly cool before the next is made. Travel between applications is not harmful provided the bitumen has cooled off and the surface is thoroughly cleaned before the next application is made.

It is equally practicable to use bituminous coatings on concrete floors. Where the bridge is located on a highway which is treated with a bituminous covering it is practicable to continue the bituminous treatment across the bridge.

Panama Tolls Reach Million a Month

September tolls earned by the Panama Canal were $1,010,166.33, an increase of nearly $74,000 over the August record, although the number of vessels and craft decreased from 301 to 274. The net tonnage of the 256 commercial vessels, according to the *Panama Canal Record*, was 1,008,785 tons, 57,440 tons greater than for August. During the fiscal year ending June 30 ordinary expenses, exclusive of depreciation or interest, for the operation and maintenance of the canal including those of civil government and sanitation were $6,548,272.43. Tolls and other receipts for the same period were $8,935,871.57. Since 1914 the total excess of expenses over revenue for operating the Panama Canal has been $2,231,091.61.

Borrowing Power and a Fair Return For Public Utilities

By William G. Raymond
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That the fair return on investment in utility properties properly regulated is from one and one-third times the going rate for money loaned such utilities with proper security to one and a half times that rate is the conclusion drawn from the following analysis of lenders' and borrowers' demand. When one loans money on about the best security that any one knows of, namely an Iowa farm mortgage, he intends to loan not more than half of the value of the property mortgaged. When one loans money to an industrial enterprise he proceeds on much the same basis. Looking first to the earnings he lends only so much as shall require an interest payment equivalent to half the reasonably certain net earnings of the enterprise. As in the case of the farm mortgage, the lender requires a value to be shown by earnings capitalized at his demanded interest rate equivalent to twice the sum that he is willing to lend.

Money lent to industrial enterprises is less well secured than is that lent on farm mortgages, and hence although a value of twice the mortgage loan may be ordinary and ample security for a farm loan, twice the value of a mortgage loan in the case of an industrial enterprise is about the irreducible minimum because of the greater risk of the money invested in an industrial enterprise. Usually somewhat more than a reasonably certain earning capacity of twice the interest charge must be shown to secure loans at the ordinary market rate for money.

The investor who loans to an industrial enterprise by the purchase of stock, runs greater risk of loss than he who loans on a mortgage, that is to say, than he who buys the bonds of the enterprise; and it would seem to be reasonable to conclude that he who invests his money in the stock of the enterprise should expect a reasonably certain net earning capacity to be shown, over and above the payment of operating expense and the fixed charges, of at least twice the lending rate on the money that he invests, and almost as reasonable to conclude that a prospect of three or more times the lending rate on the money which he invests is necessary to induce the investment. The net earnings need not be all distributed as dividends—the accumulation of a surplus is a business necessity even with a utility enterprise.

Utilities Not Free From Risk Element

Money invested in a public utility is supposed to be somewhat less hazardously invested than that invested in other entirely independent, free from control, enterprises. In theory this is probably true, albeit in practice it often proves to be untrue. The public, in spite of its oft time carelessly and sometimes wilfully unfair demands on its utilities, believes that because of their monopolistic or somewhat monopolistic character they are less risky enterprises than other independent, free from control, undertakings, and hence should demand a less rate of return on the investment. Probably it would be quite difficult to disabuse the public mind of this attitude, because theoretically the attitude is right and practically it would be right if the public was always fair.

Based on these suggestions that the lender to industrial enterprises expects a reasonably certain net earning capacity of not less than twice the interest charge on the total indebtedness, and usually expects more than this; that the other investor must expect not less than the lender and should probably expect more after paying the lender his interest, and that a public utility investment should be somewhat more secure, even though it is not always so, than an independent, uncontrolled enterprise, the following discussion of fair return on capital invested in a public utility is developed.

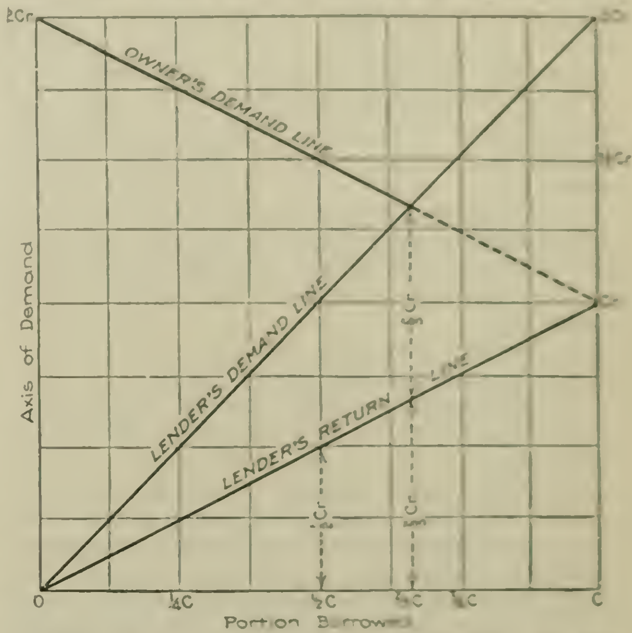


FIG. 1. EARNING CAPACITY TWICE FIXED INTEREST CHARGE REQUIRED BY LENDER

Problem 1. Let be assumed that the lender requires the minimum net earning capacity of twice the fixed charge, and that the owner investor requires this same minimum on the sum that he invests, and let "C" represent the total capital investment in an enterprise and "r" the lender's normal rate of interest. Then, referring to Fig. 1, if none of the money is borrowed the earnings to satisfy the lender investor should be nothing.

If all of the capital is borrowed the annual net earnings to satisfy the lender will be 2Cr. If axes of "portion borrowed" and "demand" are drawn, and a line is drawn from the intersection of the axes to a point 2Cr above C on the axis of "portion borrowed," an ordinate to this line from any point on the axis of "portion borrowed"—as ½C—will be to scale the net annual earning demanded by the lender. So far as the lender is concerned these ordinates measure the total required net annual earnings. The line drawn is called the lender's demand line. A line drawn from the intersection of the axes to a point Cr above C on the axis of portion borrowed may be called the lender's return line since ordinates to this line measure the annual interest payments to the lender—the fixed charges.

If the matter is considered from the standpoint of the owners demand for return and risk—an ordinate of 2Cr erected at the intersection of the axes will measure the demand when nothing is borrowed, and since the owner has nothing invested when all the capital is borrowed, his demand for this condition is only the fixed charge. Hence if a line be drawn from the point 2Cr above the intersection toward the point Cr above C, until it intersects the lenders demand line at Q, the ordinates

to this line will measure the owner's total demand on account of return and risk. The portion of these ordinates below the lenders return line measure the fixed charges, and the portion between the lender's return line and the line last drawn, called the owner's demand line, will measure the earnings on account of return and risk demanded by the owner on account of his own investment.

Up to the point of intersection Q, it is the owner's demand that determines total required earnings on account of return and risk. Beyond Q, it is the lender's demand that determines these earnings, since the owner's demand is less than the lender's demand when the portion of capital borrowed is more than that shown directly below Q on the axis of portion borrowed. Beyond this point the owner will receive more than his demand.

It can be shown by measurement on the diagram and by mathematical analysis that under the conditions of the problem the point Q is directly over the point $\frac{2}{3}$C on the axis of portion borrowed. The conditions of the problem are:

1. The lender demands total net earnings equivalent to at least twice his interest charge.
2. The owner demands total net earnings of twice the lender's rate on the money invested by himself.
3. Net earnings means, to the lender, earnings over and above operating expenses, and to the owner, earnings over and above operating expenses and fixed charges.

The diagram shows that under the conditions of the problem when less or more than two-thirds of the capital is borrowed the total earnings on account of return and risk must be greater than when just two-thirds of the capital is borrowed, the owners demand determining these earnings when less than two-thirds is borrowed and the lender's demand determining when more than two-thirds is borrowed.

Stated in another way, the total fair earnings on account of return and risk are a minimum when two-thirds of the invested capital is borrowed. At this minimum point the total fair earnings on account of return and risk are $\frac{4}{3}$Cr or once and one-third times the lender's interest rate on the whole investment. Of this sum $\frac{2}{3}$Cr goes to the lender and $\frac{2}{3}$Cr to the owner. The lender receives his regular rate of r per cent, on his loan and is secured by net earnings equivalent to twice this sum. The owner receives twice the lender's rate on his own contribution to the investment, and this covers fair return on a safe investment and payment for his risk.

From the standpoint of a public controlling utility enterprise and wishing to be fair it seems to be desirable that just two-thirds of the capital invested in these enterprises shall be borrowed, because with this proportion borrowed the net earnings required for interest and fair dividends is a minimum. Indeed it may be reasoned that in determining a fair return rate it should be assumed that the utility has adopted this borrowing limit; that if it has borrowed less it should be satisfied with a less return; and that if it has been able to borrow more it is entitled to the extra return resulting.

If this assumption is made, then under the conditions of this problem the fair rate of return on the total investment—not on cost of reproduction—should be one

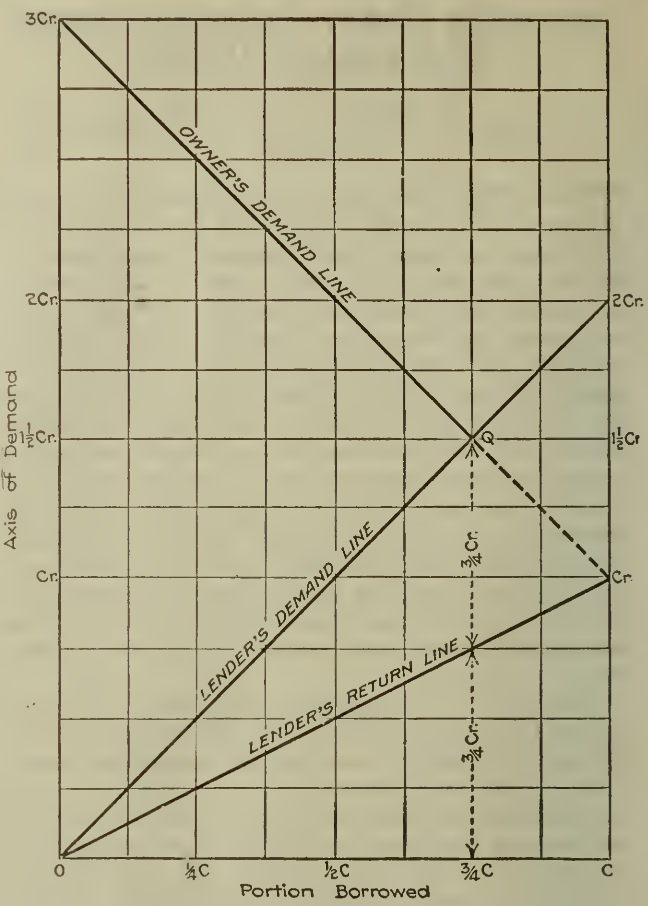


FIG. 2. EARNING CAPACITY THREE TIMES FIXED INTEREST CHARGE REQUIRED BY LENDER

and one-third times the going rate of interest, including the effect of discount, paid by utilities of the kind under consideration at a particular time. Thus, if 6 per cent is the going lender's rate, 8 per cent would be the fair rate of return on the investment. This would pay the lender 6 per cent on his contribution to the capital, and give him ample security, and would pay the owner 12 per cent for his fair return and risk. It is believed that such returns will attract capital to utility investment, and that less than such returns will be not attractive.

As possible allowable variations from the financing plan most favorable to the public, it may be assumed that as little as one-half of the investment is borrowed or as much as three-fourths of the investment is borrowed.

Referring to the figure or to a computation it will be found that if one-half the investment is borrowed, the total earnings on account of return and risk are $1\frac{1}{2}$Cr. The lender receives r per cent on his contribution and the owner 2r per cent on his contribution as before. If, however, one-half of the capital has been borrowed and the enterprise is allowed earnings on account of return and risk of only one and one-third times the lender's rate, then the owner will receive not 2r per cent on his contribution, but $1\frac{2}{3}$r per cent.

If three-fourths of the capital is borrowed it is found, by reference to the figure or to a computation, that once and one-half times Cr is required on account of return and risk, just as when one-half of the capital is borrowed As in that case too, the lender will receive r per cent on his contribution, but the owner will receive 3r per cent on his contribution. If, however, the

regulating body limits earnings to those suitable when two-thirds of the capital is borrowed, the owner will receive 2⅓r per cent.

Problem 2. Let it be assumed that the lender requires an earning capacity equivalent to twice the fixed charge and that the owner investor requires on his investment a net earning capacity, over and above fixed charges, of three times the lender's rate. Then referring to Fig. 2, it is seen that if none of the money is borrowed the total net earnings should be 3Cr. If all of the money is borrowed the total net earnings should be 2Cr. If ¾ of the money is borrowed the lender's requirement and the owner's requirement are the same, namely ¾Cr, and as before, if less than ¾ is borrowed, required earnings are determined by the owner investor's demand, and if more than ¾ is borrowed the earnings are determined by the lender's demand.

Under this problem the most economical arrangement for the public is that the company shall borrow ¾ of its necessary investment, and the fair rate of return on the total investment is $\frac{3}{2}$ of the lender's rate; that is, if the company can borrow money at 6 per cent the fair rate of return is 9 per cent.

Again if only half of the capital is borrowed, the lender will receive his rate of r on his contribution, and the owner will receive a rate of 3r on his investment. If, however, the earnings on account of return and risk are limited to ¾Cr—or those suitable when three-fourths of the capital is borrowed—the owner will receive only 2r instead of 3r.

It is suggested that Problems 1 and 2 include the limitations of proper public utility earnings under that conception of public control that demands that the earning rate shall be limited to a fair rate of return on the fair value of the property used in the service of the public. To be sure nothing has been said about value. Only investment has been considered. But it is thought that a method has been developed for finding the fair rate of return on investment—that rate which is the least that will attract capital to enterprise, and it is believed that this rate on investment will result in a fair rate of return on value. The rate which may be selected by the application of this method may be applied to original cost to date, or to reproduction cost—which ever may seem to a court to be the proper measure of investment—or as is commonly said, value.

Relation to Fair Value

In the opinion of the writer the method should be applied to original cost to date as nearly as that can be determined, and such application will result in a fair return on the fair value of any property that may be under consideration.

The discussion would seem to result in the conclusion that the fair rate of return on investment in utility properties properly regulated is from once and one-third the going rate for money loaned to such utilities with proper security, to once and one-half times that rate, the lower rate applying to large, old, seasoned, substantial enterprises, in the older communities, with accumulated and maintained emergency surpluses, and the higher rate applying to smaller, newer, less well seasoned enterprises, in new or old communities.

The discussion also suggests some interesting questions with respect to the proper or advisable relative proportions of bonds and stock to be issued when financing utility enterprises.

Factors Influencing Ultra Violet Light Water Treatment

By Russell D. Scott
Chief Chemist, Ohio Department of Health

Through the courtesy of the R. U. V. Co., New York City, the Ohio Department of Health was enabled to conduct some tests on water sterilization by ultra violet light. A single-bulb type of machine, this company's "P S," rated at 120 gal. per hour was used, the influent being supplied from a tank holding 90 gal.

TABLE I. EFFECT OF ULTRA VIOLET RAY TREATMENT OF SEWAGE-DOSED WATER

Rate of Flow Past Lamp, Gal per Hr	Per Cent Sewage in Influent	Turbidity of Influent, P.P.M.	Bacteria per Cu.Cm. 37 Deg. 24 Hr Influent	Effluent	B. Coli Presumptive Smallest Volume Positive, Cu.Cm. Influent	Effluent
175	0 1	0 1	170	12	0 01	[illegible]
1 5	0 1	0 1	170	1	[illegible]	[illegible]
95	0 1	0 1	170	0	[illegible]	10
75	0 1	0 1	170	0	0 01	[illegible]
64	0 1	0 1	170	0	0 01	Neg. [illegible]
104	1	1	750	5	0 001	[illegible]
79	1	1	750	0	[illegible]	[illegible]
61	1	1	750	1	[illegible]	[illegible]
46	1	1	750	0	[illegible]	Neg. 10
129	2	2	2,200	95	[illegible]	[illegible]
65	2	2	2,200	8	[illegible]	[illegible]
47	2	2	2,200	1	[illegible]	Neg. [illegible]
54	10	10	7,350	25	[illegible]	[illegible]
32	10	10	7,350	5	0 001	[illegible]
18	10	10	7,350	0	0 001	[illegible]
7	10	10	7,350	1	0 001	Neg. [illegible]

Preliminary tests having indicated that an initial period of at least 15 minutes was required for the lamp to reach an efficient working temperature, no samples were collected until it had been burning for at least [illegible] minutes.

The first runs were made using as influent Columbus tap water to which had been added fresh, cotton-filtered sewage in percentages as shown in Table I. The results indicate the sterilization of a heavily polluted water at the rate of about 50 gal. per hour with a turbidity of 2. With the influent containing sewage sufficient to produce a turbidity of 10 p.p.m. the effective rate was greatly lowered.

TABLE II. EFFECT OF TURBIDITY ON ULTRA VIOLET RAY TREATMENT

Rate of Flow Past Lamp, Gal. per Hr	Turbidity of Influent P.P.M.	Typhoid Bacilli per Cu.Cm. Influent	Effluent
175	0	31,000	[illegible]
93	0	31,000	[illegible]
64	0	31,000	4
180	12	27,000	300
90	12	27,000	50
65	12	27,000	[illegible]
175	66	22,000	[illegible]
93	66	22,000	[illegible]
66	66	22,000	[illegible]

To more definitely note the effect of turbidity some runs were made using as influent tap water to which was added 0.02 per cent of a broth culture of typhoid bacilli, followed by graded amounts of a sterile, finely divided clay soil in suspension. The results (Table II) show a progressive decrease in efficiency of sterilization with increasing turbidity.

The effect of color was next studied, the influent consisting of tap water plus 0.1 per cent of sewage and varying quantities of a filtered decoction of black tea leaves. The effect of color (Table III) is evidently pronounced. While by present methods of coagulation

and filtration it is possible to remove practically all turbidity from a water, the removal of color is not in all cases so successful. This fact should be taken account of in considering the U. V. treatment as an adjunct to filtration.

In conclusion it should be noted that the results obtained were from small-scale operation, the actual efficiency of the U. V. process in large-scale operation being much higher.

TABLE III EFFECT OF COLOR ON ULTRA VIOLET RAY TREATMENT

Rate of Flow Past Lamp, Gal. per Hr.	Color, Influent	Bacteria per Cu Cm. 37 Deg., 24 Hr. Influent	Bacteria per Cu Cm. 37 Deg., 24 Hr. Effluent	B. Coli-Presumptive Smallest Volume Positive, Influent	B. Coli-Presumptive Smallest Volume Cu.Cm. Effluent
72	1	92	0	0.01	10
49	1	92	0	0.01	Neg 10
70	18	92	2	0.01	1
48	18	92	1	0.01	1
30	18	92	1	0.01	10
68	25	93	5	0.01	1
49	25	93	2	0.01	1
30	25	93	0	0.01	10
75	50	98	38	0.1	1
52	50	98	27	0.1	1
34	50	98	26	0.1	1

Henderson, Ky., results (*Engineering News-Record*, Nov. 29, 1917, p. 1021, article by A. T. Smith) indicate that rates of 200,000 gal. daily per lamp are used, each effluent stream passing under five lamps in series. A progressive reduction in bacterial content is noted at each lamp, the final effluent being practically sterile. However, the results of the present paper emphasize the importance of thorough preliminary treatment to remove turbidity and color, before employing the ultra violet process.

Earthwork Methods on an English Railway

Exceptional care in the building of large railway embankments, in order to prevent slipping of the slopes, has been employed in the construction of a double-track relief line for the Great Northern Ry. of England. These fills, according to the *Railway Engineer*, London, were to be made with London clay, and after examination of a number of old banks made with this material a cross section was adopted with compound or graduated slopes conforming to the final sections to which the older banks have settled. Thus in a 10-ft. bank the slope from the roadbed is 1 on 2, with a base width for each slope of 20 ft.; for a 20-ft. bank this is followed by 1 on 3 for 30 ft. base; a 30-ft. bank has an additional slope of 1 on 3½ for 35 ft.; a 40-ft. bank has still a fourth slope of 1 on 4 for 40 ft., and a 50-ft. bank has this 1 on 4 bottom section continued over a base of 80 ft., making a total width of 165 ft. for each slope of a 50-ft. fill. These fills have a top width of 45 ft.

All material was side dumped and built up in 10-ft. lifts, wooden templates being used by the contractors in dressing the fill to the required section. The slopes were then covered with good soil and sown with grass. The work was done a few years ago and it is stated that there are no signs of slipping.

A cut in loose running sand caused some trouble and this material had to be wasted in spoil banks as it could not be used for fills. At times the steam shovels were overwhelmed by the sand. The very wide cut formed was not left in its rough condition, the excess excavation being filled with hard material and finished to the standard section with lump slag and old broken concrete.

Metal Flume Inspection on the Uncompahgre Project

Life of Metal Prolonged by Coal-Tar Paint—Rusting Mainly at Joints—Cement Patches Used—Ice Kinks Bottoms

RESULTS of the inspection in 1920 of 69 metal flumes on the Uncompahgre Project of the U. S. Reclamation Service indicate that careful attention should be paid to the following points if a life of ten years is to be obtained:

(1) Proper design as to sufficiency of foundation, sizes of bands, washers and cross ties, and a thickness of metal which will obviate excessive deformation; (2) thorough galvanizing; (3) joints which do not project into the current and which avoid cavitating; (4) trapping out of sand and gravel; (5) coating with a good quality of coal tar of joints and of inside of sheets as frequently as wear makes necessary, possibly joints every year and inside surface every two, three or four years; (6) provision for temperature changes either in the individual joints themselves or by expansion joints; (7) provision for self-drainage.

F. D. Pyle, formerly project manager of the Uncompahgre Project, now secretary and manager Columbia Irrigation District, gave these results in the November *Reclamation Record* from which the following notes are taken:

Substructures — All substructures were of wood. Some were untreated, some treated by dipping in creosote oil and some were painted. The substructures that were painted appear to be in the best condition. The untreated lumber was weathered and checked considerably, and the treated lumber showed some deterioration but not as much as the untreated. In a few instances dry rot was apparent in isolated pieces of timber.

In a considerable number of instances where dirt and alkali soil, especially sand or sandy loam, had been allowed to come in contact with the bottom of the substructure posts and braces, rot has made it necessary to cut off and block under the posts and to replace braces in from five to ten years.

A considerable number of crossties were cracked, and gave the general appearance of being too small for the load carried. On a number of the flumes the washers were pulled into the crossties, where the flumes had been tightened to prevent leaks several years afterward. This indicates that the crossties and washers were both too small and on account of the number of flumes affected it is believed that our designs have not provided adequate sizes to give the best results.

Paint—Of the 69 flumes, 59 have received a coat of tar or paint on the interior in order to protect them against rust and erosion. The first tar was used in 1913 but proved to be too brittle and lifeless. In the spring of 1916 various kinds of paint were tried without success. Later several paint companies furnished small lots of paint to make tests. In no case have these paints proved equal to the coal tar placed during the past three years.

In the fall of 1917 and spring of 1918 a number of flumes were treated by applying a coat of water gas tar followed by a coat of coal tar thinned with water gas tar. This made considerable extra work, and in a number of cases the coating was too thin, either running to the bottom of the flume or checking and cracking on the side of the flume exposed to the sun. Since the summer of 1918 coal tar has been used without thinning, with very good results. The best results have been obtained when tar was applied before the flume had been used more than one season and when the tar was applied in warm weather. When applied in cold weather it would not stick to the metal but blistered and peeled. In tarring flumes it was found essential to

clean the surfaces thoroughly, removing all rust from the sheets and from the joints, and to have them perfectly dry and free from dust. The tar was applied hot with heavy brushes or burlap swabs.

Conditions indicate that the joints should be retarred every fall, and the entire flume every other fall. On account of the long irrigation season, it has been difficult to tar as large a proportion of flumes each year as would be most advisable. The tar coat fails by drying, checking, peeling and blistering. In some cases there is a tendency to erode from the bottom, especially where gravel is carried by the water. A heavy coating of coal tar has proved to be the best method of protecting the flumes when properly applied. In tarring 502 lin.ft. of No. 204 flume, 550 gal. of tar were used, or 0.58 gal. per sq.yd. The labor and material cost was 21c. per square yard. An extra heavy coat was given this flume.

Flume metal fails principally at or near the joints, although occasionally pitting occurs along the lower joint arc of the flume. Of 930 ft. of flume used eight seasons, 33 per cent pitted through at the joints, and 9 per cent on the surface of the sheets. Pitting generally took place on the downstream side of the joint, with the exception of a few flumes on the West Canal, where the joint was arranged so that there was a flange giving a double thickness of metal below the joint. In this case the pitting was on the upper side of the joint. Where the workmen had inadvertently changed the sheets so that the flange was upstream, the pitting took place on the downstream side of the joint. Apparently all pitting and rusting takes place from the inside or water side of the sheets and works toward the outside. Where the pitting was in the joints it started at the bottom and progressed outward and uward through an arc of 12 to 18 in. Where pitting was along the sheet, it generally occurred at the bottom, although isolated pitting was observed for from 15 to 24 in. from the botttom.

There appears to be a greater tendency for the metal to pit near the black iron fittings of many flumes than where galvanized strips are used as the inside member of the joint. as in the corrugated type.

It is probable that the velocity of water, especially where heavy silt is carried, seriously affects the life of the metal. In one extreme case located below the big drop on the Montrose and Delta canal, where 200 sec.-ft. of water is turned over a sandstone bluff which gradually erodes, the original flume was found badly pitted along the entire length of the flume. However, in another instance a large amount of gravel and sand has been carried through a flume installed in 1914 without serious results, there being no pitting or rusting visible on the outside of the flume.

It is very probable that where alignment is poor, owing to settlement of foundations, additional strain is thrown on the metal, breaking the spelter and hastening rust and pitting.

Alkali water is apparently detrimental to the metal, but no direct cases can be cited.

The life of the metal may be affected by the type of joint. Some joints have sharp bends which cause additional strain on the metal and a tendency to separate the spelter or galvanizing from the metal. In some types of joints where the inside iron projects into the water section, the tendency is to erode the metal below the joint. In other types of flume, the metal is arranged so as to be double or even triple at the joint, giving increased strength and requiring longer for pitting to make the flume leak.

The metal on only a few flumes has been replaced on account of failure of sheets by rusting and pitting. However, in removing the metal on the CQ system in order to increase the capacity, it was found that only about 60 per cent of the sheets could be used for replacement purposes.

Joints—Very little could be learned as to the tightness of the various joints, as leakage depended so much upon whether the flume was being properly maintained and the condition of the tar coating. Apparently all types of joints can be made reasonably tight. In only one instance has a flume failed by pulling apart or giving way at a joint.

Miscellaneous Observations—Several flumes have been badly distorted by ice. Apparently when the ice in a flume commences to melt it starts on the sides and where the water can run off the weight of the ice rests on the bottom portion of the flume so that the metal and the joint rods are permanently distorted or kinked at the bottom.

In several extreme cases the pitting of metal had progressed to such an extent that it was necessary to line the bottom of the flume with cement sacks covered with about 1 in. of concrete. This had proved a good method of obtaining an extra year or two of service from small flumes. In a number of places on these flumes 4 to 10 sq.in. of cement sack is exposed in one patch where the metal is entirely gone.

In tarring the West Canal flumes, which are badly pitted at the joints, about 1 in. of fine gravel and coal tar was placed in the bottom to prolong their life.

Terms of New Cost-Plus Contract for Hetch Hetchy Tunnel Work

TERMS of the contract recently let by the city of San Francisco for 18 miles of tunnel on the Hetch Hetchy project have attracted the attention of other cities where similar conditions obtain, particularly since the legal decision upholds the validity of this form of contract. An announcement of the decision (Supreme Court of California, Crowe vs. Boyle, Oct. 16, 1920) appeared in *Engineering News-Record*, Nov. 11, p. 963.

In response to a request for a résumé of the features involved, the following was supplied by M. M. O'Shaughnessy, city engineer of San Francisco:

The contract embodies construction on the cost-plus plan, with the following modifications:

1. The contractor's fee is a flat sum fixed by competitive bidding and is payable in installments, including three annual advance payments which assist the contractor in financing his work.

2. While the contractor is required to secure and superintend the labor, and is given the right to "hire and fire" men, no change in wage scale can be made without concurrence of both the contractor and the board of public works. Materials and supplies furnished are purchased directly by the city after competitive bidding, in which the contractor himself may participate.

3. The contract contains a guarantee by the contractor as to maximum unit costs of work which were specified by him in his bid. If the actual costs exceed these bid costs, such excess is deducted from the unpaid balance of the contractor's fee. The method of determining the costs is set forth in detail in the specifications.

4. In order to insure the city's receiving the lowest possible bids both for contractor's fee and guaranteed unit costs, the board of public works was permitted to award the contract to the lowest bidder on either basis.

The contract has been in effect about six months, although payment of the contractor's fee had been withheld until the final determination of the suit. The system has worked very satisfactorily so far, and the City of San Francisco anticipated that the total cost will be less, by some $2,000 000, than the lowest flat price bid received under alternative specifications at the same time.

Swiss Railway Projects

At a recent meeting in Berne, Switzerland, of the board of administration of the Federal railways the agreements concerning the digging of the new Uetliberg tunnel on the line on the left bank of Lake Zurich and the construction of the foundation walls near Stalden, as well as the electrification of the Sion-Lausanne line, were approved and a credit of 40,000,000 Swiss francs granted for these purposes.—*Commerce Reports.*

Test of Trent Activated-Sludge Devices at Pasadena

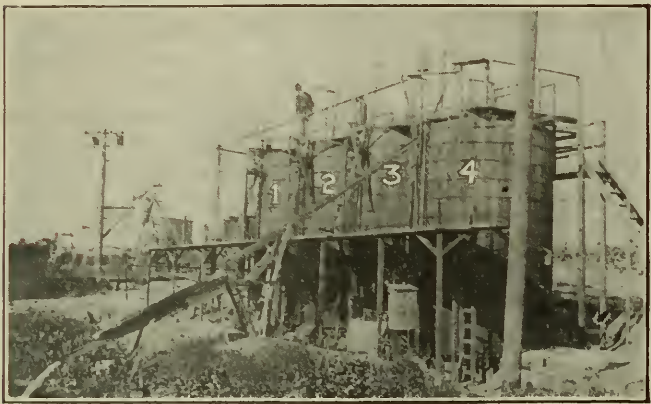
By R. V. Orbison
City Engineer, Pasadena, Cal.

During the latter part of the sewage-treatment experiments conducted under the direction of the writer for the City of Pasadena, Cal., tests were made of an activated-sludge plant in which aëration and agitation are effected by pumping sewage and air into the bottom of the activation tank, the distribution being through revolving perforated arms on the Barker mill or revolving lawn sprinkler principle. This is known as the "L. C. Trent aërator for activated-sludge treatment" and the test plant was built from designs made by the L. C. Trent Engineering Co., Los Angeles, Cal. The underlying idea is similar to the Brosius method of aëration and agitation experimented with at Hermosa Beach, Cal., and proposed as a permanent method of sewage treatment for that city, as described by A. M. Brosius in *Engineering News*, Nov. 9, 1916, p. 890. (The bond issue for the proposed plant at Hermosa Beach failed to carry.) The details are different in that Mr. Brosius placed a "diffusion wheel" or impeller type of pump at the foot of a downtake air and sewage pipe within the aërating tank, while Mr. Trent places a centrifugal pump at and outside of the tank base, with a suction extending upward to a horizontal connection with a suction chamber within the tank, and a dischange pipe leading into the distributor at the center of the bottom of the tank. Other differences in detail may be found by referring to the Brosius article. Experience seems to have proved that the aëration effected by both the Brosius and Trent devices was insufficient, so that supplementary air blowers were necessary.

In the Trent experimental plant as originally designed the process was all comprised in three sewage aërating tanks and a final sludge aërating and settling tank. As explained below, the writer found it necessary to force the settled sludge to a re-aëration tank.

The Trent plant was operated from Jan. 1 to July 15, 1919, when the experiments with activated-sludge, which had begun in 1917 at an earlier plant, were discontinued. Had more money been available the Trent ideas would have been continued, with some changes in detail to increase the mechanical agitation and an attempt to find a pump that would handle more air without beccming air locked. As matters stood when the test stopped, the general conclusion as to the Trent variation of the activated-sludge process was that it required the use of an air blower and a sludge re-aërating tank with filtros plates, and that the results obtained were not nearly as satisfactory as with the old plant. The process was too erratic; was not dependable, as is indicated by the stability curve, and required too close attention, especially as compared with the old plant.

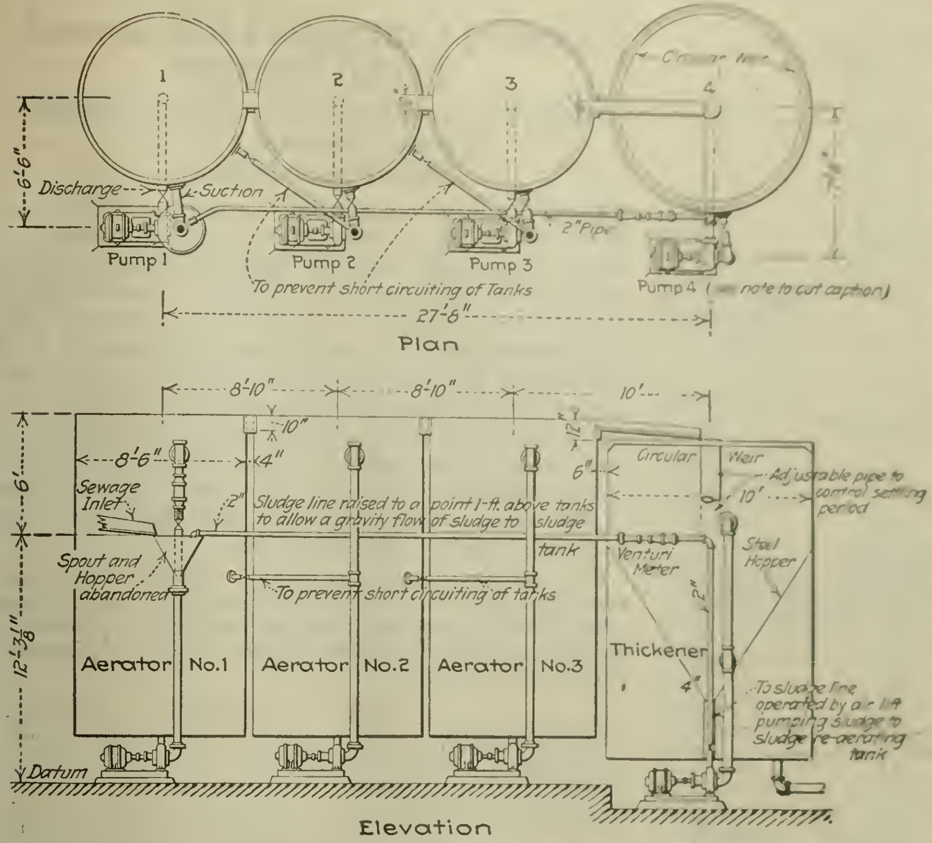
As first operated, the Trent plant consisted of three cylindrical aërating tanks 8 ft. in diameter, and a settling and thickening tank 10 ft. in diameter, all four tanks having an effective depth of 15¾ ft. Each tank was supplied with a centrifugal pump having a capacity of 220 gal. a minute, directly connected to a 3-hp motor, and with revolving air distributers, but as it was found impossible to aërate, thicken and settle sludge in one and the same tank, the machinery was removed from the fourth tank and it was used for settling only, by installing a steel cone, 10 ft. in diameter at the top, 4 ft. in diameter at the bottom, and 10 ft. deep, an air lift being used to force the sludge from the settling tank to the sludge re-aërating tank of the old experimental activated-sludge plant.



VIEWS OF TRENT ACTIVATED-SLUDGE INSTALLATION, PASADENA, CAL.
Tanks 1, 2 and 3 are for aërating the sewage, and Tank 4 for settling the sludge. It was found necessary to pump the sludge from Tank 4 to a sludge re-aërating tank.

The aëration and agitation pump of each of the three activation tanks drew sewage through an outside suction pipe from a point in the side of the tank about 2½ ft. from the top. The pumps discharged through nozzle arms near the bottom of the tanks, there being three arms in each tank and each arm having attached to it two 1⅛-in. nozzles, spaced so as to cut different paths on the bottom of the tanks, thus preventing deposition of sediment.

At the start it was assumed that sufficient air for oxidation would be drawn down the sewage suction pipe through a number of ⅛-in. pipes extending above the top of the suction pipe. The plan worked in principle but the air thus supplied was insufficient. Consequently we tapped into each pump discharge pipe a ½-in. air pipe connected with a blower, but with the conditions under which the blower was operating it was impossible to force the air into the tanks, and in order to accomplish this, one filtros plate was installed in each of the three aërating tanks. This produced better results within 48 hours.



OUTLINE PLAN AND SECTION OF ACTIVATION AND SETTLING TANKS AS ORIGINALLY BUILT

After trial the following changes were made: (1) The hopper shown in Tank 1 was abandoned and the sewage piped to a Y, connecting with a second pump at the base of Tank 1, pump 4 being moved to this point and delivering the raw sewage to the top of Tank 1. The top of Tank 1 is 5 ft. above the outlet sewer and pump 1 was air-locked too often for satisfactory results. (2) A Nash hydro-turbine air blower was set in the place occupied by pump 4, for reasons stated in the text. (3) The horizontal run of sludge pipe was raised to a level 1 ft. above top of tanks to allow a gravity flow to the sludge settling tank.

The raw sewage enters the first tank at the top. In starting the process, the first tank was filled to the level of the suction pipe, after which the corresponding pump was started, forcing the sewage through the nozzles and making the arm revolve. When the tank was full its contents would overflow into the second tank, where the process was repeated, and thence to and through the third tank in the same manner and on into the settling tank where sedimentation for some 45 minutes took place. To prevent short circuiting, baffles were provided at the connections between the various tanks.

The aërated sewage entered the settling tank through a central pipe 24 in. in diameter and 3½ ft. long, telescoping over which was another 3½-ft. length of pipe which could be so raised or lowered as to give settling periods of various lengths. The discharge (the effluent) was over a circular weir 9½ ft. in diameter, concentric with the tank, which was 10 ft. in diameter.

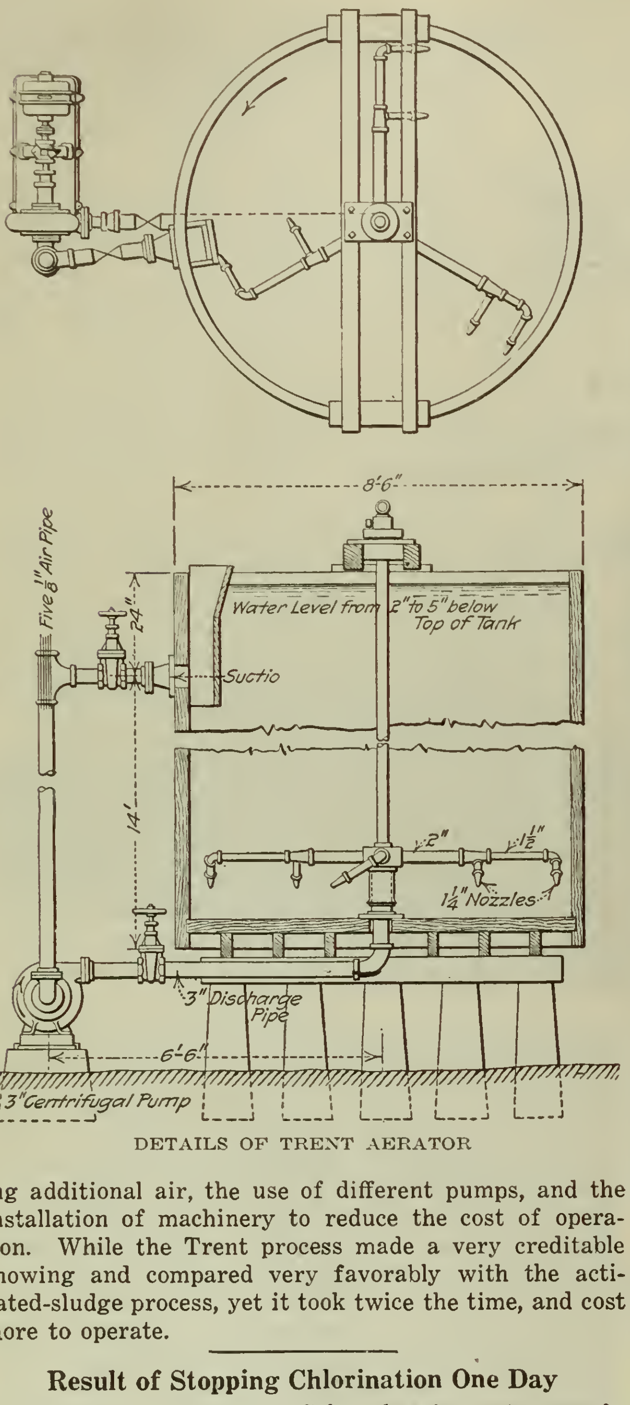
Until ready to use the sludge re-aërating tank the sludge was pumped from the settling tank back into the first activation tank, from which it passed on through the other two and back into the settling tank. When sufficient sludge had accumulated in the three aëration or activation tanks then we began forcing the sludge to the re-aëration tank, as already mentioned. This tank was 5 ft. 9½ in. x 12 ft. 4 in. in plan, had an effective depth of 9 ft. 6 in., and was provided with four filtros plates for air diffusion. After from 2 to 4 hours of aëration the sludge was run into the raw sewage pipe and sent back to the first activation tank. When sufficient activated sludge had been accumulated in the sewage aëration tanks, the excess sludge, beyond what was needed for renewal purposes, was wasted over a control weir which could be set to return any desired percentage of the sludge.

It was thought by the Trent people that the settling tank could be used for settling, thickening and re-aërating the sludge by drawing in air through a 3-in. centrifugal pump and aërating and agitating the sludge by revolving nozzle-arms. This was found impracticable — at least the pump could not provide sufficient air for the volume of sludge that it handled — and so the nozzle-arms were removed.

Before adding the blower to increase the air supply above that afforded by the centrifugal pump and free-air-supply pipes the effluent had a turbidity of 30 to 50 p.p.m. and an average of 50 p.p.m., and an albuminoid ammonia reduction equal to that given by the old activated-sludge test plant (70 to 80 per cent) but with a dissolved oxygen ranging from 0.5 to 4 p.p.m., as compared with nothing to a trace by the old plant. Also our sludge volume after a five-day run was equal to 12 per cent on settling 30 minutes, compared with 6 per cent from the old plant, but with a stability generally ranging from 3½ to 23 hours and once in a while extending to 3, 5 and even 10 days, whereas after the old plant had been running a week it gave a stability of 10 days plus throughout the whole 18 months' test. The bacterial count in the old plant was from 18,000 to 450,000, averaging 143,500, as compared with 200,000 to 2,000,000 for the Trent plant. We also found, before adding the blower, that by filtering through filter paper a sample of the effluent from the third activation tank we got a stability of 10 days, against an average of about 8 to 10 hours without filtration. The raw sewage, filtered, has a stability of about 10 hours and unfiltered of about a half hour. The added air from the blower soon increased the stability to 18 hours and also yielded nitrifying bacteria, which we lacked before.

The Trent tanks were built of the sizes already stated with the desire of giving a capacity of 50,000 gal. with 4 hours of aëration, the same as in our earlier experimental plant. We found that with only 4 hours' aëration the sewage became septic and had to increase the period to 8 hours.

In order to determine what would be needed to meet our requirements, further experiments would have to be made with Trent process, along the lines of supply-



DETAILS OF TRENT AERATOR

ing additional air, the use of different pumps, and the installation of machinery to reduce the cost of operation. While the Trent process made a very creditable showing and compared very favorably with the activated-sludge process, yet it took twice the time, and cost more to operate.

Result of Stopping Chlorination One Day

The town of Pittsburg, Cal., takes its water supply from the Sacramento River and treats it with chlorine. As the population served is only about 5,000, a single small-capacity chlorination plant was considered sufficient. Recently, according to a paper presented by Ralph Hilscher, director of the Engineering Division of the California State Board of Health, before the California Section, American Water Works Association, the chlorine apparatus had to be taken out of service for repairs. For the short time during which chlorination was to be discontinued it was not considered necessary to start up the chloride of lime plant, provided for emergency use, and hence raw water was supplied for one day. As a result, 100 cases of typhoid developed besides a considerable number of cases of other water borne diseases. In view of this experience Mr. Hilscher recommended the installation of duplicate chlorination plants so that one might always be held in reserve.

General Contractors Recommend Rental Schedule

Guide to Estimating Construction Equipment Expense Prepared by A.G. C. Committee on Methods

WITH a view to furnishing contractors with a practical means of estimating equipment expense and determining adequate rental charges the committee on methods of the Associated General Contractors of America has worked out a standard rental schedule for the association. The schedule has been evolved from the records and experiences of contractors, manufacturers and rebuilders of equipment and has been prepared by the research division under the direction of the committee on methods. The schedule, explained in the following paragraphs taken from a recent issue of the association's *Bulletin*, has been approved by the executive board of the association.

Seven items of equiment expense constitute the total rental charge and require consideration in estimating a lump sum contract or in determining fixed rate rentals. The items referred to and their annual proportions of the equipment's initial cost are as follows:

Item	Per Cent
1. Average depreciation	12½
2. Equivalent annual interest at 6½ per cent	4
3. Shop repairs	6
4. Field repairs	4
5. Storage and incidentals	3½
6. Insurance	1
7. Taxes	1
Total annual expense	32
Equivalent expense on basis of eight months' working time per year	48
Rental rate per month	4

How Percentages Were Obtained

These percentages and those given in the detailed schedule were determined according to the following principles:

The economical life of a machine is considered to end when its value has depreciated to 25 per cent of the original cost. The average annual depreciation then amounts to 75 per cent of the initial cost divided by the number of years it may be expected to give service. The initial cost of a machine is represented by the cost of that machine delivered at the contractor's yard.

Interest should naturally be charged at the prevailing rate. This may be computed in three ways:

(1) By charging the prevailing rate each year on the depreciated value of the machine.

(2) By charging the prevailing rate each year on the average value of the machine during economical life. For example, when the salvage rate value is 25 per cent the average value equals (100 per cent + 25 per cent) divided by two, equals 62½ per cent.

(3) By finding the proportion which the average value is of the initial cost and charging this proportion of the prevailing rate each year. This proportion is called the equivalent annual interest and shows what interest rate on original cost will yield the same interest as the prevailing rate when applied to the depreciating value of the machine. This is the method used in the above schedule. The average value is 62½ per cent of the original; therefore the equivalent annual rate is 62½ per cent of the prevailing rate, or 62½ per cent of 6½ per cent equals 4 per cent.

Shop and field repairs are separated by reason of a previous recommendation of the committee on meth-

ods that field repairs be considered a part of the cost under cost plus contracts and shop repairs be borne by the contractor and covered by the fixed rate rental charge. This recommendation was made on the ground that an owner should not be made to pay the total cost, for example, of refluing a boiler which may have been burned out principally on another owner's work. The other items of cost require no special explanation.

Owners of equipment find occasion to establish rental rates as follows: (1) For a lump sum or unit price estimate; (2) To owners on cost plus work; (3) To others than client owners. In these instances charges should be made as follows:

(1) The rental charge or equipment expense for lump sum work includes all the items mentioned above.

(2) The fixed rate to owners on cost plus work will include all but field repairs, if this item is paid as a cost of the work. To the amount thus determined may be added a service charge depending upon the policy of the contractor, i. e., whether the service of equipment is included in the profit fee or carried in the rental charge.

(3) The charge to persons other than client owners includes all of the items of expense and an additional amount for profit or payment for the machine's earning power.

A further consideration in each of these cases is the rate for double shift work, where the percentages for depreciation and repairs should be doubled, or nearly so.

The committee desires to emphasize the fact that the values presented in the following table should not be considered absolute in determining a rental charge. A real danger presents itself in using any tabular percentage without investigating the conditions under which the equipment is to work. To illustrate, if the values here given for a standard gage shovel outfit were applied to such an outfit engaged constantly in excavating hard rock the probability is that the charges allowed would not cover more than half the expense. The frequent dobey shots and the dropping of heavy boulders into cars entails a higher rate of depreciation and repairs than is given in the schedule. On the other hand, if this shovel outfit were steadily engaged in digging sandy loam the values given in the table would probably cause the equipment charge to contain a fair per cent of profit.

This schedule is offered to contractors with the understanding that individual judgment and experience should be applied to the tabular values to meet unusual conditions.

The component expenses incurred by the ownership and maintenance of construction plant are expressed in this table as percentages of the initial cost for individual items of equipment. They indicate the probable annual expense without profit under ordinary job conditions and should be included in any lump sum estimate or in determining time rate rental charges. The salvage value is considered to be 25 per cent of initial cost.

Total percentage amounts in the extreme right hand column should be applied to the total cost of a machine including charges for transportation from the factory. This gives the total annual charge, which for a lump sum contract covering a full season is the total equipment expense. For determining a monthly, weekly or daily rental rate the annual amount is divided by the number of such periods in the year during which construction work may be carried on.

TABLE FOR COMPUTING RENTAL CHARGES FOR CONSTRUCTION EQUIPMENT

[illegible]

Items of Equipment	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Yrs.	[illegible]	[illegible]	[illegible]	[illegible]
Auto crane	5	[illegible]	[illegible]	[illegible]	[illegible]
Auto truck	[illegible]	25	[illegible]	[illegible]	[illegible]
Auto trailer	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Backfiller, power	4	[illegible]	[illegible]	[illegible]	[illegible]
Ballast spreader	[illegible]	[illegible]	[illegible]	4	[illegible]
Boiler, upright	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Boiler, locomotive	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bucket, clam shell	4	[illegible]	[illegible]	[illegible]	[illegible]
Bucket, orange peel	4	[illegible]	[illegible]	[illegible]	[illegible]
Bucket, drag-line	4	[illegible]	[illegible]	[illegible]	[illegible]
Cars, steel dump	[illegible]	[illegible]	[illegible]	4	[illegible]
Cars, wood dump	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cars, flat	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cars, hopper	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Compressor, steam	7	[illegible]	[illegible]	[illegible]	[illegible]
Compressor, gasoline	4	[illegible]	[illegible]	7	[illegible]
Compressor, electric	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Concrete chutes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Conveyor, belt	2	[illegible]	7	[illegible]	[illegible]
Conveyor, bucket	2	[illegible]	[illegible]	[illegible]	[illegible]
Crusher, rock	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Derrick, wood	[illegible]	[illegible]	4	4	[illegible]
Derrick, steel	10	7	4	[illegible]	[illegible]
Dragline, steam	[illegible]	12	[illegible]	[illegible]	[illegible]
Dragline, gasoline	4	[illegible]	[illegible]	[illegible]	[illegible]
Dragline, electric	8	[illegible]	7	7	[illegible]
Drill, tunnel carriage	5	[illegible]	[illegible]	[illegible]	[illegible]
Drill, traction well	6	[illegible]	7	[illegible]	[illegible]
Drill, tripod	4	[illegible]	7	[illegible]	[illegible]
Drill, jack hammer	4	[illegible]	7	[illegible]	[illegible]
Engine, gas	6	12	8	[illegible]	[illegible]
Engine, steam	10	7	5	[illegible]	[illegible]
Excavator, cableway	6	12	4	[illegible]	34
Excavator, Keystone	5	15	8	4	[illegible]
Excavator, trench	5	15	[illegible]	[illegible]	[illegible]
Forms, steel concrete	2	37	20	[illegible]	[illegible]
Graders, common road	4	18	12	[illegible]	[illegible]
Graders, elevating	4	[illegible]	15	7	[illegible]
Hoist, steam	10	7	[illegible]	4	[illegible]
Hoist, gasoline	6	12	7	[illegible]	[illegible]
Hoist, electric	8	9	5	[illegible]	[illegible]
Loco., Indus. steam	9	[illegible]	6	4	[illegible]
Loco., Indus. gas	4	[illegible]	13	[illegible]	[illegible]
Loco., Indus. battery	4	[illegible]	15	4	[illegible]
Loco., Stand. gage	10	7	6	4	[illegible]
Loco. crane, steam	8	9	7	[illegible]	[illegible]
Loco. crane, elect.	8	9	6	4	[illegible]
Mixer, steam	5	15	[illegible]	4	[illegible]
Mixer, gasoline	4	[illegible]	13	[illegible]	[illegible]
Mixer, electric	6	[illegible]	[illegible]	4	[illegible]
Mixer, paving steam	5	15	[illegible]	4	[illegible]
Mixer, paving gas	3	25	16	[illegible]	[illegible]
Motors	6	[illegible]	6	4	[illegible]
Pile driver, steam	8	9	7	5	[illegible]
Pile driver, track	10	7	5	[illegible]	[illegible]
Pile hammer, steam	7	[illegible]	7	[illegible]	[illegible]
Pipe, galvanized	3	25	5	[illegible]	[illegible]
Plows	3	25	15	[illegible]	[illegible]
Pneu. concr. mach.	4	[illegible]	[illegible]	[illegible]	[illegible]
Pump, centrifugal	8	[illegible]	[illegible]	4	[illegible]
Pump, piston	6	[illegible]	7	[illegible]	[illegible]
Pump, pulsometer	8	[illegible]	2	4	[illegible]
Pump, Emerson	8	[illegible]	2	4	[illegible]
Rails	8	[illegible]	5	[illegible]	[illegible]
Riveter, air	5	15	4	4	[illegible]
Rock channeler	6	[illegible]	7	8	[illegible]
Roller, steam road	10	[illegible]	5	[illegible]	[illegible]
Saw rigs	4	[illegible]	[illegible]	[illegible]	[illegible]
Scraper, wheel	3	[illegible]	[illegible]	4	[illegible]
Scraper, slip	1	[illegible]	[illegible]	[illegible]	[illegible]
Scraper, fresno	2	[illegible]	[illegible]	[illegible]	[illegible]
Shovel, steam	6	12	7	[illegible]	[illegible]
Shovel, gasoline	4	[illegible]	9	7	[illegible]
Shovel, electric	7	[illegible]	6	[illegible]	[illegible]
Switches, fabricated	3	[illegible]	[illegible]	[illegible]	[illegible]
Tower, steel hoist	7	[illegible]	[illegible]	4	[illegible]
Tractor, wheel gas	6	[illegible]	9	[illegible]	[illegible]
Tractor, caterpillar	5	[illegible]	11	[illegible]	[illegible]
Wagons, dump	4	[illegible]	17	[illegible]	[illegible]
Wagons, hauling	4	[illegible]	12	[illegible]	[illegible]
Wagon loaders, power	5	15	[illegible]	6	[illegible]

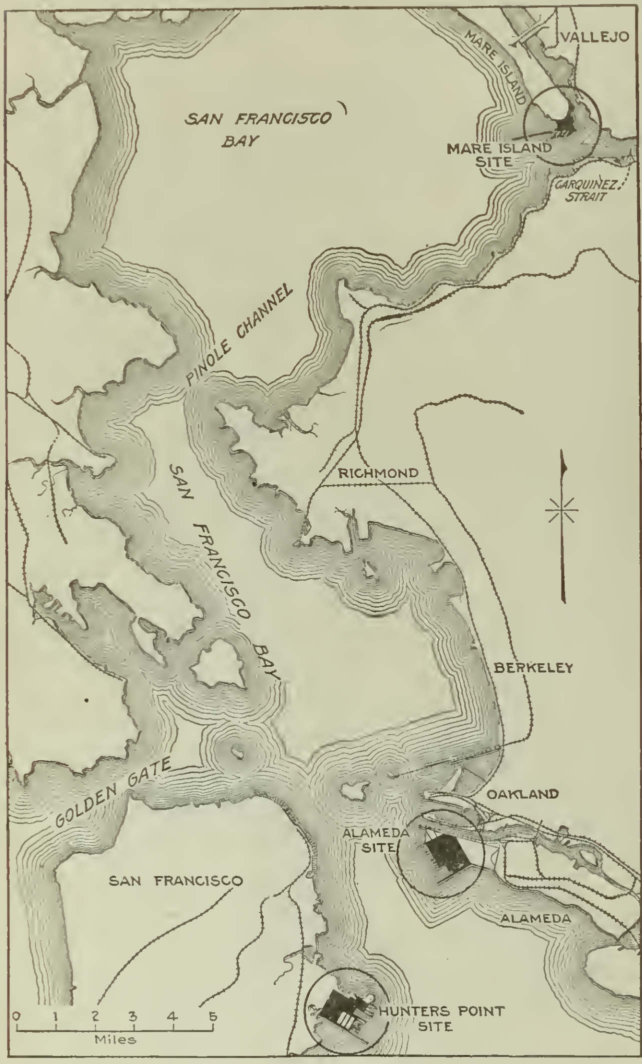
Lumber Cut for 1919

Little variation in the lumber cut of 1919 over that for the previous year is indicated by preliminary statistics of the Bureau of the Census so far available. In 788 identical mills, each of which cut 3,000,000 ft. or more in each year, there was an increase of only 0.3 per cent in 1919 over 1918. On the basis of the production for 1918 this increase will bring the total production for 1919 to 32,000,000,000 ft. The largest increase was in Washington and the largest decrease was in Minnesota.

Three Sites Considered For San Francisco Naval Base

Engineering Considerations Govern in Selection of Location for Large Plant to Cost From $25,000,000 to $50,000,000

NAVAL policy apparently is committed to the immediate construction in San Francisco Bay of a huge naval repair and supply base to cost up to $50,000,000. Reports have been made at different times for some years and a congressional committee has just completed a survey of the situation. It will soon report recommending one of the three sites favored in the earlier reports, namely, Mare Island, the site of the present Navy Yard; Alameda, on the east side of the bay and Hunter's Point in San Francisco proper.



SAN FRANCISCO BAY, NAVAL BASE SITES

Military considerations govern in the selection of a site but it is understood that the balance in this respect is about even and that the selection will hinge on such engineering questions as suitable foundation for the large graving docks, accessibility and service by utilities of all sorts, the providing and maintaining of suitable channels and anchorages and the conservation, so far as feasible, of existing government investment in the Mare Island Navy Yard.

On account of the emphasis laid on the engineering features of the three sites, the matter is a big one in engineering circles on the coast. For that reason there are presented below abstracts of the arguments in favor of each site by engineers who are well acquainted with the situation.

MARE ISLAND SITE, (*By Howard C. Holmes, Consulting Engineer*).—It was universally admitted by naval authorities as late as 1916 that the development of Mare Island as a base for modern fleet units was impracticable for two reasons, (a) the impracticability of maintaining a channel of requisite depth over Pinole shoal in San Pablo Bay, which is the approach-channel to Mare Island, and (b) the constricted width and shallow depth of Mare Island strait, which now constitutes the Navy Yard's waterfront. The Pinole shoal problem has now been solved. In 1916 the army dredged a channel 500 ft. in width and 30 ft. deep at low water and because the silting was less than anticipated the depth was carried to an average of 35 ft. without additional cost. The maintenance expenditure has been relatively negligible. It is now certain that this channel can be maintained to a depth of 40 ft. for any desired width, at a cost and annual maintenance insignificant as compared to the saving over the cost and maintenance of the other proposed naval base site. A plan for improvements at the south end of Mare Island, proposed by Commander Leonard M. Cox, C. E. C., U. S. N., completely solves the Mare Island strait problem because it would place the new major docks and 1,200-ft. piers not on Mare Island strait but on Carquinez straits. This body of water has a depth of 40 ft. and over, a width in front of the proposed base of 4,000 ft. and an anchorage area of 3.55 square miles, greater than any anchorage ground immediately adjacent to 90 per cent of the naval stations of the world. The location of the naval base at Mare Island Navy Yard would mean the retention of a very efficient organization with the wonderful community spirit that exists there. In addition to this, every facility contemplated for the suggested sites in the lower bay could be provided at a cost of more than twenty million dollars less than the cost of providing the same facilities at the other sites. However, this would not represent the total saving because the capitalized value of the cost of a new station, amounting to $50,000,000 should be added to the saving, making a total saving of something like $70,000,000.

ALAMEDA SITE (*By C. E. Hewes, City Manager, Alameda, Cal.*).—The Helm commission report, transmitted to Congress in December, 1917, after eliminating Mare Island as being out of the question for many reasons, stated in substance that the Hunter's Point and Alameda sites offered advantages superior to every other site for the following reasons: (1) lower cost of development for equal areas; (2) proximity to better and deeper anchorage grounds; (3) proximity to labor supply; (4) lower cost of maintaining channels of approach; (5) sufficient area for indefinite expansion. The report further stated that either of these two sites could be developed into a satisfactory base, and although the Hunter's Point site has the advantage that dry docks could be built in rock, rather than upon pile foundation, the Alameda site has many more important advantages, to wit: (1) better foundation for all other structures; (2) site gratis (the land has been deeded by the people of Alameda to the Government for naval base purposes); (3) direct railroad connections (the east shore being the

termini of three transcontinental railroads); (4) better passenger transportation, housing and living facilities; (5) direct pipe-line oil supply; (6) better facilities for handling navy stores; (7) from a standpoint of range for indirect gun fire, Alameda has the advantage of being three to four miles further from the open sea; (8) lower cost of development. A series of sub-surface explorations in the form of fifty-seven test piles was made on the Alameda site. These showed that the material forming this submerged flat consisted very largely of sand, gravel and clay with a comparatively small percentage of soft pockets. The comparative uniform supporting power of this material is advantageous in permitting the site to be developed along the most economical lines as regards relative position of shops, piers, drydocks, etc.

HUNTER'S POINT SITE (*By M. M. O'Shaughnessy, City Engineer of San Francisco*).—A naval base located at Hunter's Point would have favorable foundation conditions for large graving docks. Transportation facilities and utilities of all sorts are already available, there is ample land area, adequate channel depths, and all San Francisco Bay as adjacent anchorage. Next to military advantage, the most important requirement of a good naval base is a solid foundation. On this score Hunter's Point has excellent qualifications in the works already constructed there. At Hunter's Point is a green serpentine rock formation which forms an ideal foundation, is easy to work, impervious to water, and requires only 15 to 18 in. of concrete for a lining instead of the dense mass of concrete necessary for structures on pile foundations. Including the submerged areas that can be readily reclaimed there is, a total of 3,035 acres available for naval base purposes. Just off-shore there is a natural depth of 50 ft. of water with current velocities of about 1½ knots. This makes it easy to land and handle ships, at the same time that the current is strong enough to prevent the deposit of silt. Very little silt comes from the relatively limited watersheds draining into the bay here. Soundings over a 40-year period show very little change in sediment deposits. A particularly advantageous water-supply system, for domestic, industrial and fire-fighing purposes is available.

Airplane Effective in Forest Fire Control

Of the 196 forest fires sighted and reported this year by the airplanes operated out of the Sacramento, Cal., base maintained by the U. S. Forest Service, 33 per cent were located within ¼ mile of the exact location as later determined by actual surveys on the ground. Ten per cent of the total number of fires were discovered by the air patrol before the rangers knew of their existence; 42 per cent of the fires were reported by radio, while the airplanes were in flight. Besides acting as lookout to detect and report fires, airplanes were used this year to direct fire fighting operations and to patrol fire lines which had been built but which needed watching. If reports from the air showed the line to be clear the fire fighters were kept at work elsewhere, but if the observer reported that the fire had broken away a force of men could be rushed to the spot. In addition to the two planes which have been operating daily on fire patrol service from Sacramento, two planes have also been operated from three other stations, namely, Fresno, Riverside, and Red Bluff.

The "Glunch"—Creator of Ideas

IN THE Dec. 16 issue of *Engineering News-Record* there appeared in the article "Useful Dodges in Surveying," p. 1164, a method of determining the day of the month by making an altitude observation on the sun. A member of the advertising staff of the McGraw-Hill Co., who claims that his wonderful mathematical ability was developed by learning how to figure out his income tax, seeing a wide application of the idea, wrote the following classic for the "Accelerator," an intradepartmental bulletin of the advertising service department of the McGraw-Hill Co.:

Well, you can throw your calendar pad away. There is no further use for it now that a writer in *Engineering News-Record* has pointed out how remarkably simple it is to learn the day of the month without the aid of a printed reminder. His method is this:

> If the day of the month has been forgotten make an equal altitude observation of the sun and establish a true meridian. Measure the angle from the meridian to the sun, also the sun's altitude. Compute the declination of the sun by the formula
>
> $$\text{Cos. } Q = \frac{\text{sin. dec.}}{\text{cos. lat.} \times \text{cos. alt.}} - \text{tan. lat.} \times \text{tan. alt.}$$
>
> The sign of the first term of the right-hand side of the equation is minus when the declination is south; the second term is plus where the latitude is south. If the algebraic sign of the result is plus, Q is the angle between the sun and the north point, but if it is minus it is the angle between the sun and the south point. Correct the resulting declination by the hourly distance to obtain the declination at Greenwich. If the observation has been made correctly an inspection of the ephemeris will disclose a declination similar to the computed one, and the date corresponding to this declination is the date of the observation.

As a possible suggestion showing how this idea may be applied to our own work, Ye Editor has worked out a formula for finding a good headline when thoughts on same are completely lacking. It is hoped that copy writers who at times may be suffering from a slump will find this helpful:

If all thoughts are lacking, open up your desk shears and set the points exactly four and sixteen thousandths of an inch apart. Hold the shears three verts from the eye, and measure off the bi-sectional angle which appears on the west wall chart, twenty and one-half bluts from the dixtus. With this as a basis, compute the hypote of the *d q* juncture thus formed, using the figure 86 as a binominal focus. This will give you the following formula:

$$\text{Polq } Y = \frac{\text{mt. M. D.}}{\text{DDS.} \times \text{Ugh}} - \text{zing. fft.} \times \text{osh.}$$

The sign on the upper terminus of the glunch will give you the Grecian declination, Helios. Box this by north meridian by morain surplus by the ancient symbol of Yat. If the glunch fits the deformation caused by the injecture of the post-alteriorie dixtus of Yat, then the sub-normadial fluxtures will equal its distance from the basic formation of the parent sidius. If the lines converge, the calculus thus arrived at will set up a corresponding vertu-ssuge where the west-wall chart overlaps the dixtus. This will give you the letter of the alphabet.

Follow this formula for each letter and your headline will appear automatically.

Truck Makes 24-Hr., Non-Stop Run

In a recent test made upon the Indianapolis speedway a stock model of the Duplex truck, loaded with gasoline, oil and ballast and weighing 6,300 lb., exclusive of drivers, made a 24-hr., non-stop run at an average speed of more than 38 mi. per hour, running the total distance of 930 mi. between 1:57 p.m., Sept. 30, and the same hour the following day.

Better Port Terminals to Develop Nation's Commerce

Abstract of paper by Col. W. J. Wilgus, consulting engineer, New York City, Am. Soc. C. E. Proceedings, November, 1920, as a discussion of a paper, "Larger Ships, Deeper Harbors, and Better Dredges," presented Oct. 6, 1920, by A. W. Robinson, consulting engineer, Montreal.

THE maritime nation offering the lowest freight rates and best shipping service through superior development of ships and ports will have a pronounced lead over its competitors as instanced in Mr. Robinson's paper and his former paper (*Journal*, Engineering Institute of Canada, February, 1919), summarizing the opinion of British authorities that the development of future world trade will depend on increase in size and drafts of ships and consequently on the improvement of ports properly to serve them. Americans should undertake development of their principal ports to provide ample accommodations, as for instance vessels of the type mentioned by Mr. Robinson having a length of 660 ft., a loaded draft of 36 to 38 ft., and a dead-weight capacity of 25,000 tons.

For proper accommodation of such ships, as the author so well states, channel and slip depths should be not less than 40 ft., with provision for future deepening to 50 ft. There should also be provided trackage for direct interchange between ship and car; electric gantry cranes and other mechanical devices for quick handling of widely varying weight and bulk; slips of generous proportions for movement of ships and all auxiliary water craft; piers of sufficient width for receiving, forwarding, sorting and temporary storage of cargo and for the location of cranes, tracks and vehicular driveways. The aim of such an arrangement is to hasten to the utmost the release of ships, cars and motor trucks, to minimize manual labor and to dispense with the need for ship tackle.

Pier Width a Fundamental Consideration

In the fundamentals of port design pier width is of special importance. The 25,000-ton ship will occupy say 700 lin.ft. of stringpiece, approximately equal to 36 long tons of dead weight capacity per lineal foot. While some consider that shedded "transit" space should be made sufficient for the entire cargo, others believe that one-quarter the cargo may be immediately evacuated from the pier. For the entire cargo, figured at 60 cu.ft. per ton or say 50 cu.ft. per ton of ship's dead weight capacity, equal to 1,800 cu.ft. of goods, with mechanical equipment for tiering 12 ft. high to an average height of 10 ft. for the entire area of shedded space and with suitable provision for aisles and passages, the width of shed required would be 180 ft. For three-quarters of the cargo or 27 tons per lineal foot of stringpiece requiring shedding, in conjunction with the usual ship-ton figure of 40 cu.ft. per ton and an average height for tiering by hand of 4 ft. (5 ft. on the actual space occupied), the width of shed required would be 270 ft. It may be said that a fair compromise between these extremes is 200 ft., to which, of course, there should be added a suitable width for outer tracks and working space between edge of pier and shedded area, and likewise ample interior widths for inner tracks and motor truck driveways.

For double-sided piers this would mean an aggregate width of not less than 550 ft., the lower floor of which would be used for inbound and the upper floor for outbound cargo. Even with a ship of half the capacity under discussion, the pier width should be not less than 340 ft., with all equipment, track and driveway layout having proper relation to the length of the pier. With overhead warehouses there would be need for even greater widths, for additional serving tracks and driveways. These figures are used in a general sense and should be considered merely as indicating the need for adopting liberal widths.

The only 40-ft. channel on the Atlantic coast is at New York, and unfortunately, is now available for little more than one-half of one per cent of that port's 771 miles of water front. Of this meager percentage only one-half is in direct contact with the principal rail carriers, and a considerable portion of deep-water frontage is devoted to uses other than those of legitimate water-borne commerce. And there is as yet nothing planned, apart from the projected Claremont Terminal of the Lehigh Valley R.R., in the way of spacious and well equipped modern piers and accessories, properly adapted to the prompt handling and release of large ships, cars and motor trucks. According to press accounts, several great transatlantic companies intend building new piers on the west side of the Hudson River; but it is reported, as in the case of the New York City Staten Island development, that advantage is not to be taken of the proximity of trunk line railroads to provide tracks on the piers and adequate shedded "transit" areas, so that the railroads and therefore indirectly the public will continue to be burdened with the wasteful practice of rehandling freight by lighter and truck between the termini of rail and ship, and with highly objectionable delays to cars from their use for storage.

Effect of Rate Structure

One of the causes is unquestionably the provision in the seaboard rate requiring railroads to deliver and receive cargo freight at the ship sling, with no voice in the planning of pier facilities. Another cause is the practice of permitting the lessee, the ship owner, to dictate the character of the port terminal improvement. The result is the creation of piers at the least possible cost to ship interests regardless of the injury done to land carriers, both rail and truck.

The various transportation interests of New York should get together to bring about (a) the revision of the rate structure and more equitable methods of paying for the use of shore facilities properly to distribute cost between rail and water carriers; (b) plans conducive to economies in operation and quick release of ships, cars and motor trucks; (c) whole-hearted co-operation by the Federal government will mean a great deal for the country as a whole.

It should be borne in mind that the investment in port terminals is a comparatively small fraction of the aggregate investment devoted to the combined ocean and rail movement of freight. Therefore a liberal expenditure for the perfecting of the lesser part is fully justified if substantial benefits therefrom will accrue to the plant as a whole, in which are included ships, cars and motor trucks, as well as the shore facilities in general.

[As of interest in connection with Colonel Wilgus' discussion of the requirements fundamental to a satisfactory solution of harbor terminal development, there is published on the opposite page the "Policy" of the Port Development Commission of Baltimore.—Editor.]

Large Floating Crane Built in Holland

A self-propelled floating crane of the Atlas type capable of lifting 220 tons, has just been built by A. F. Smulders, of Schiedam, Holland, for the Mersey Docks and Harbor Board at Liverpool. The crane is one of the largest, if not the largest, of its type ever built. It is capable of lifting its maximum load at a reach of 110 ft. from center line to a height of 170 ft. above water, or of lifting 150 tons at a reach of 143 ft., according to *The Engineer* (London) of Oct. 15, 1920. The extreme height of the end of the jib when raised to its highest position is 240 ft. above water. There are two independent main hoists of 110 tons capacity each, attached at a point on the jib having a maximum distance out of 143 ft. They hoist at 3½ to 5 ft. per minute. For lighter service two 33-ton hoist trolleys running along the jib can be used independently or coupled to move together, so that they are capable of handling 66 tons combined; their lifting speed is 18 ft. per minute and traverse speed 29 ft. per minute. The crane was erected complete at Schiedam and was towed to Liverpool with the jib in place.

Baltimore's Port Development Policy

AS AN INITIAL declaration of policy, in undertaking harbor development work, for which $10,000,000 can now be made available, as required by new shipping business, the Port Development Commission of Baltimore, Nov. 8, 1920, adopted nine general requirements published in full below:

It shall be the policy of this commission

(1) To develop the port of Baltimore in accordance with a definite and comprehensive working plan, based on the best modern conception of port design. This plan shall serve as a guide for each step in the development in order that the completed whole may be harmonious in the correlation of its individual parts.

(2) To consider the elemental function of a pier the furnishing of a safe means for the expeditious and economical interchange of freight between land and water carriers and not merely the furnishing of a shelter for a ship so as to insure stability during the process of loading and unloading.

(3) To make improvements for the broad purpose of the widest possible use and benefit of the port as a whole and not solely for the narrow purpose and restricted use by meeting only present conditions or the special requirements of prospective lessees. All structures shall be readily adaptable to future changes in kinds of cargoes, methods of operation and special requirements of future lessees.

(4) To obtain expeditious movement of cargoes between land and water carriers and a maximum of economy by constructing piers large enough to hold the full contents of vessels which can tie up to them, and by making proper provision for the installation of mechanical appliances and facilities to move these contents to or from the piers with the least possible delay to vessels.

(5) To locate all improvements preferably in places where it is possible either now or at some future date to make railroad connections with all the trunk lines entering the city, and to locate warehouses, wherever practicable, so that there will be the shortest possible movement of cargoes from the carriers to the place of storage.

(6) To provide the space and the supports for ample railroad tracks on both the inside and outside of piers so that these tracks may be added at any time required.

(7) To construct transfer sheds with at least two stories wherever the business of the lessee warrants such construction, and when only one story is required at time of construction, to design the foundations and the framework in such a manner that an additional story can be added at any future date with the least possible interference with the operations on the first story.

(8) To build all structures with the primary conditions of stability, permanency and economy.

(9) To have in view

(a) The ultimate concentration of terminals and shipping facilities so that the combined railroad trackage may be made accessible to all piers, and

(b) The unification of the administration of the terminals and shipping facilities so as to assure co-ordination and co-operation of all interests.

J. E. Greiner, consulting engineer, Baltimore, is chairman of the Port Development Commission. $10,000,000 will become immediately available for the building of new piers as soon as lessees are found and $10,000,000 will become available later, in accordance with the recent Baltimore bond issue vote, aggregating $53,000,000. It is expected that work will start early in 1921.

Australian Engineering Jubilee

The 50th anniversary of the Engineering Association of New South Wales was celebrated at Sydney, Sept. 24. At a meeting held in that city Sept. 24, 1870, and called by John Laing an association of mechanical engineers was organized, its first president being John Fyfe, mechanical and marine engineer. Speakers included James Vicars, president; Prof. Warren, president, Institution of Engineers of Australia; James Fraser, chief railway commissioner of New South Wales.

Double-Deck Street and Sidewalks for Congested Chicago

SUGGESTIONS for the relief of congested streets in Chicago made by P. S. Combs, city engineer, include double-deck sidewalks in the downtown or loop district and elevated roadways in the center of certain streets leading from the loop. The upper sidewalks would take 50 to 60 per cent of the pedestrians off the present sidewalks. The roadways would expedite night and morning automobile traffic, taking 40 to 50 per cent of the fast-moving vehicles from the present street levels. They would be operated one way only, out at night and in in the morning. By depressing the street car tracks a few feet and erecting a through-girder roadway structure the usual objection to a double-deck street as to cutting off of light and unsightliness would be minimized.

Other suggestions to improve traffic conditions are: Several underground parking spaces to remove automobiles from the streets during the day; a restriction of heavy-truck traffic to streets provided with reinforced-concrete tracks, and a prohibition of deliveries of heavy supplies during the day time.

In making these suggestions Mr. Combs classifies the traffic as follows: Street cars; automobiles and light vehicles for general business; package and heavy freight haulage for commercial shipment; pedestrians; heavy supply trucks for coal, building materials and quantity supplies for the larger stores. It is his opinion that all of these factors must be considered together since piecemeal solution simply works for the betterment of one to the detriment of the other. The creation of a commission representing all of the interests concerned, to study traffic and to devise means to prevent undue destruction of pavements, is now under consideration by the judiciary committee of the City Council. An ordinance prohibiting any parking in the downtown district beyond that necessary to load and unload passengers or freight has recently been passed in an endeavor to speed up street car and vehicular traffic.

New Garbage Collection Equipment for Dallas

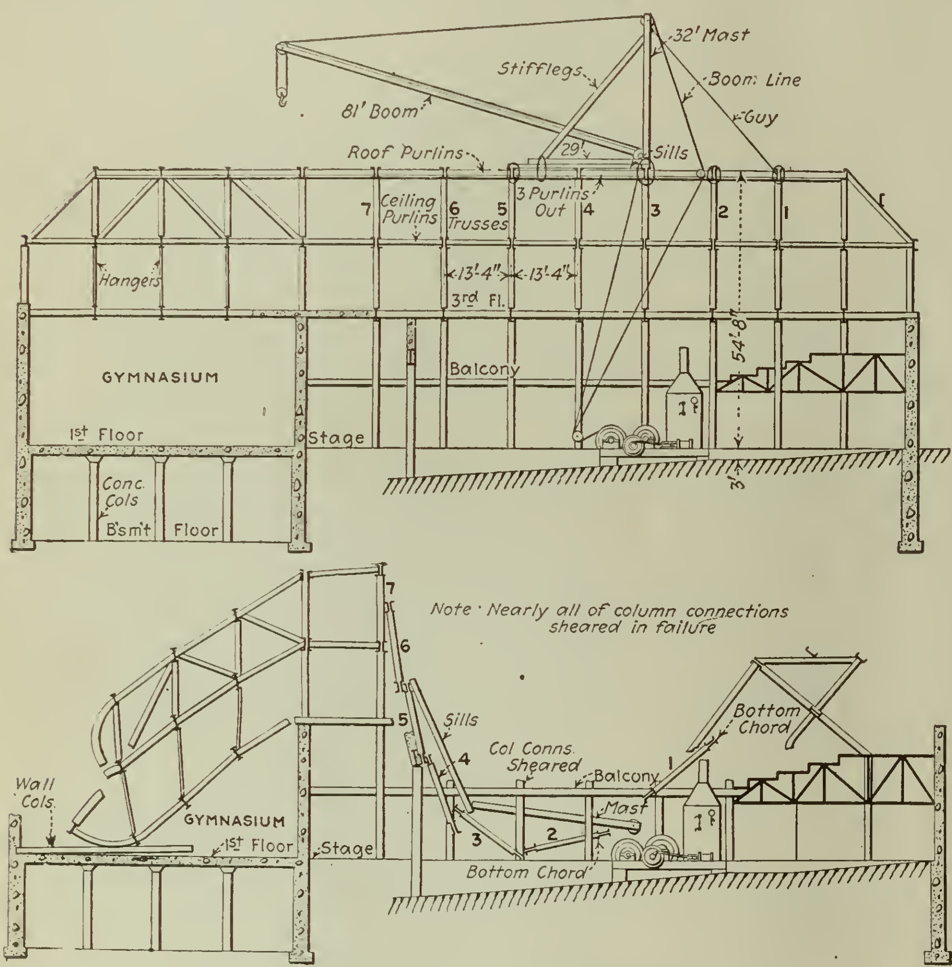
The city of Dallas, Tex., is putting in use a new system of garbage collection. For this purpose new equipment has been purchased, consisting of 40 two-ton, drop-frame, reversible chassis, with $4\frac{1}{2}$-yd. side dump steel bodies. Twenty teams will be used to draw these trailers for the collection of garbage and its haulage to a central point, from which six motor trucks will take the trailers to the garbage dump. The teams, trailers and tractors are divided equally between five districts.

The garbage at Dallas is collected four times each month. It is very light, weighing only 600 lb. per cubic yard. Under the old system of collection there were used 60 team-drawn, 7-yd. wagons and four 9-yd. motor trucks. Each team made two loads per day.

A thirty-day survey showed that each team spent 2 hr. 58 min. per day in loading garbage into the wagon and 5 hr. and 2 min. in going to and from the dump and unloading the garbage. Under the new system each team will spend 8 hr. in the collection of garbage only. It is expected that the same service will be given at a great decrease in cost. For the foregoing information we are indebted to George D. Fairtrace, city engineer of Dallas.

Erection Derrick Falls With Steel Framework of School

THE collapse of a school building in Indianapolis during construction, a few weeks ago, proves upon investigation by the building authorities and the coroner to be a case of highly unusual kind. The steel roof trusses and columns, insufficiently braced by the brickwork of the walls, were pushed over laterally, to all appearances by the side thrust of a derrick set on the top chord of one of the trusses. The entire upper portion of the building was involved in the resulting collapse, as the purlins connecting the several trusses pulled down not only the trusses nearest to the point of initial failure but also a set of trusses at right angles to these in an adjoining portion of the building.



INDIANAPOLIS HIGH SCHOOL BUILDING BEFORE AND AFTER COLLAPSE—LONGITUDINAL SECTION

Walter B. Stern, commissioner of buildings of the city, has supplied sketches reproduced herewith, and states the facts of the accident as determined by the investigation, as follows:

The building was designed to provide an auditorium 90 x 106 ft. and a gymnasium 54 x 90 ft. on the first floor, with balconies at the second-floor level. The balconies at the sides of the auditorium were of reinforced-concrete tile construction, and were in place and hardened at the time of the accident. The entire third floor, designed to be used for a students' lunchroom, was suspended from the roof trusses; of this floor only a small section over the gymnasium was poured, while over the auditorium forms had not even been placed. All the roof trusses and their supporting columns were up. The trusses over the auditorium ran crosswise of the building, being supported on trusses on steel columns about 9 ft. in from the outside walls. The trusses over the gymnasium ran lengthwise of the building (across the 54-ft. width of the gymnasium) and rested on steel columns. The trusses were completely riveted up, but the roof and ceiling purlins, the connections to the columns, and the column splices were only bolted temporarily. The side walls had been laid up only a few feet above balcony level.

Witnesses at the coroner's investigation, conducted with the assistance of representatives of the city's building, police and fire departments, testified that more than half of the holes in these various connections had bolts in them, but the steel structure was not properly guyed to provide the necessary bracing until the walls should be built high enough to brace the structure.

A wooden stiff-leg derrick with 32-ft. mast and with 12 x 12-in. wooden boom 81 ft. long, had been placed on the top chord of one of the roof trusses five or six days previous to the accident. The derrick was rigged and in service on the morning of the accident. The brake lining on the boom-hoist drum of the hoisting engine was practically worn out, and it is probable that the boom was handled in a jerky manner when being lowered.

It was determined at the investigation that the cause of the accident was the improper rigging and operation of the derrick before the steel structure was adequately braced and riveted. The roof trusses were designed to support a load in the finished building many times the weight of the derrick. Testimony given at the investigation supports the view that an unusual thrust caused by the operation of the derrick sheared a connection between a roof truss and its column, causing the truss to start down at one end. The pull on the purlins then brought about the collapse of the remainder.

Yellow Fever in Ecuador

The elimination of yellow fever from the coast towns of Ecuador, as the result of several years of a sanitary campaign, is reported in the *Bulletin* of the League of Red Cross Societies for October, 1920. The last case at the city of Guayaquil is said to have occurred on May 22, 1919. The stegomyia mosquito, carrier of the disease, has practically disappeared.

Letters to the Editor

Does Hydrated Lime Weaken Concrete? Abrams' Tests Discussed Pro and Con

Sir—Prof. Duff A. Abrams of Lewis Institute has rendered a real service to the concrete world through his long series of tests to determine the effect of hydrated lime and other powdered admixtures in concrete. He broke 20,000 specimens, which is far and away, the greatest undertaking ever attempted in this line. This makes it especially a pity that the conclusions which Prof. Abrams draws in his paper before the last meeting of the American Society for Testing Materials, abstracted in *Engineering News-Record*, July 8, 1920, p. 55, are at variance with his figures. In a very proper effort to be thorough in covering the field he has investigated ranges of all the variables, far outside of practical limits. No one can disagree with this, but when the attempt is made to establish straight-line relations by the use of these figures, or to average them in with practical ranges, or to say that because extreme amounts of lime are injurious small amounts will be also, it becomes necessary to refer the public to the figures themselves. Let us quote some of the conclusions drawn from the paper and indicate wherein they are not substantiated.

Conclusion 1—"In general the addition of powdered materials reduced the strength of concrete approximately in proportion to the quantity of admixture. Some exceptions are noted below."

Here all the specimens have been averaged together whether they contain small amounts of lime or 50 per cent, and the statement is made that the "relation is a straight line"; but many of the curves reveal the vital fact that small amounts increase the strength, even though larger ones reduce it. This is so evident in one figure after another that more study of the usual amounts of lime used seems to be necessary. Practically one-half of the curves and tables referring to compressive strength display points and figures higher than the corresponding plain specimens. These are mostly within the maximum percentages used in practice as follows:

Concrete	Hydrated Lime Per Sack Cement	Proportion By Volume
1: 3 : 6	12 lb.	30 per cent
1: 2½: 5	10 lb.	25 per cent
1: 2 : 4	8 lb.	20 per cent
1: 1½: 3	5 lb.	12½ per cent

(For waterproofing purposes, 15, 12, 10, and 7 pounds respectively.)

Conclusion 2—"In usual concrete mixtures, each 1 per cent of hydrated lime (in terms of the volume of cement) reduced the compressive strength 0.5 per cent."

Mixtures 1: 1½: 3 and 1: 2: 4 are the only ones considered here as usual mixtures, and 1: 2½: 5 is completely ignored although an enormous yardage of it is placed every year. Readers who examine the figures and tables will see for themselves that there is a region wherein lime increases the strength of concrete and a very much larger one where the laboratory losses in strength are more than overcome by the advantages. The qualities attributed to lime in concrete which account for its rapid progress of late years are not increased strength as hinted at by the author but prevention of segregation, easier flow in chutes and around reinforcement, reduction of honey-combing, smoother surfaces and watertightness. Throughout the paper it is assumed that immediately we begin adding lime we begin reducing the strength, in other words, "the relation is a straight line." The plotted points and figures, however, do not sustain this claim, as can be clearly seen when the curves are not drawn "by eye" as in the paper, but by some mathematical method. For instance, in Fig. 2 only two exceptions and eleven cases of increased strength within the limits; in Table VII, of 18 groups of tests only three failed to show increases of strength with lime; in Fig. 1 three-fourths of the curves show no considerable decrease within the limits; and particularly the summary in Fig. 1 in which all of the so-called straight-line curves are below the 5 and 10 per cent points and where within the usual limits no case of decreased strength is shown.

Conclusion 4—"The addition of 1 per cent of the following powdered admixtures in terms of the volume of cement reduced the strength of 1:4 concrete at 28 days by the following percentages: hydrated lime [illegible]

But 1 per cent of lime was not added at any point in the tests, and this is one of the many places where mistaken impressions are conveyed. Furthermore, all specimens have been averaged together by the straight-line method referred to above, which conceals the effect of small quantities of lime. It is a coincidence that 28 days is the age which makes the worst show for lime, and it is unfortunate also that 1:4 concrete is given so much prominence when only five pounds of hydrate per bag of cement is used in practice. Table XV shows very clearly that further study of small amounts of admixture is necessary. Here 1 and 2 per cent of mica, pitch, gypsum and [illegible] are added to the concrete and substantial increases in strength are shown, even though larger amounts do decrease the strength.

Conclusion 6—"Rich concrete mixes showed a greater loss in strength due to powdered admixtures than the leaner ones. In lean mixes (1:9 to 1:6) and those with aggregates graded too coarse for the quantity of cement used, the strength was little affected or was slightly increased by admixtures up to 50 per cent."

Under lean mixes, 1: 2½: 5 is included, and once more attention is called to the large yardage placed every year, in which even with large amounts of lime it is admitted that strength is increased.

Conclusion 7—"The wetter mixes showed a greater loss in strength than the dry, due to the addition of hydrated lime." Water is usually added in these wet batches for the sake of improved plasticity. Table XVI shows very decided improvement in the plasticity when lime is added, and indicates that it is unnecessary to use so much water in the lime batches in order to secure equal plasticity. This being the case, it is only fair to credit lime with a portion of the increased strength of the drier batches. Fig. 7, for instance, shows that 50 per cent of lime increases the strength up to 75 per cent, if no water is added, and this increase should be divided between the effect of the lime and the effect of the dryness.

Conclusion 10—"Hydrated lime and other powdered admixtures used in these tests slightly increased the workability of the leaner mixes (1:9 and 1:6) as measured by the slump test. Ordinary mixes (1:5 and 1:4) were little affected; richer mixes (1:3 and 1:2) were made less plastic."

It is easy to find fault with the slump test; for instance as the very first value under normal consistency where ½ to 1 in. slump is expected, we find 6.1 in.; but with all of its faults, the slump test is the best one we have for measuring plasticity, and some judgement can be formed from these results.

The effect of lime may best be realized by comparing the average slump in each column with the corresponding slump without lime. In 36 of these averages (including all mixtures and all percentages of lime), only 11 are less than the straight cement specimens. The increases with lime are 1:6, 31 per cent; 1:5, 112 per cent; 1:4, [illegible] per cent; 1:3, 19 per cent; 1:2, 12 per cent. This states that "for the richer mixes the slump was decreased," but it is seen in 1:2 concrete 5 per cent of lime increased the strength 26 per cent, and 10 per cent of lime, 34 per cent, averaging all consistencies. The four richer mixes average a steady gain up to 33 per cent.

Conclusion 11—"The wear of concrete was not materially increased by hydrated lime or other admixtures up to [illegible] per cent of the volume of cement."

Table XI cites ten cases of which seven average [illegible] per cent less wear when 10 per cent of lime is added, and the eighth case wears better with [illegible] per cent of lime than without. The average of all specimens containing 10 per cent (which is about the maximum amount used in practice)

reveals that there was 2.7 per cent less wear. In Tables XX and XXI, four-fifths of the cases where 5 per cent of lime was added show less wear than the average of all specimens up to the maximum of lime used in practice.

Conclusion 12—"The bond resistance was affected in the same manner as the strength by the presence of hydrated lime."

Four ages are studied here, but as only two of them show decreased strength, one can hardly draw any conclusions. In this study, lime was substituted for rather than added to the cement, which practically invalidates the figures.

Conclusion 13—"Hydrated lime had little effect on the absorption of dry concrete, increased the evaporation of water from wet concrete and produced no beneficial effect on the strength of concrete stored in air."

These curves are so close together that it is hard to see how one can conclude that evaporation was increased.

It is felt that these figures show that lime in concrete in the amounts usually added, does not reduce strength, but aids considerably in improving the plasticity, resistance to wear, volume, and freedom from voids. Lime is not hydraulic and damp sand storage is not a favorable condition for it, but 88 per cent of the specimens were so stored. Under conditions more like actual practice, the lime specimens would undoubtedly have made even a stronger showing. As a whole, however, the work was well planned. A wider scope than ever before was attempted with more refined methods and more thought to eliminate errors. There are many erratic figures, but the series as a whole compares well in this respect. Suitable emphasis in the results has not been given to the vitally significant matter of determining how much lime can be added before beginning to reduce strength.

Washington, D. C. L. H. Hart,
Nov. 23, 1920. National Lime Association.

[The above letter was submitted to Prof. Abrams, whose reply to Mr. Hart follows.— Editor.]

Sir—The writer is glad to take advantage of this opportunity to reply to the criticisms of our report on "Effect of Hydrated Lime and Other Powdered Admixtures in Concrete." It is unfortunate that the text of our report is not available; however, it will be published at an early date in the 1920 *Proceedings* of the American Society for Testing Materials.

It was a surprise to the writer that Mr. Hart comments somewhat adversely on the wide range of our tests. Many years' experience in testing concrete has shown that it is necessary to cover a wide range in order to determine the underlying principles. A large portion of the concrete tests reported in literature are almost worthless because they do not cover a sufficient range to give conclusive values. Instead of considering the wide range of the tests a weakness, we believe that it is just that feature to which the report owes its principal value. If the tests had been restricted to a narrow range of hydrated lime percentage, consistency, or cement content, we could not have discovered underlying relations. A great many engineers have been seriously misled by attempting to draw conclusions from narrow ranges of concrete tests.

There is no reason why undue weight should be given to the higher percentages of hydrated lime, if one is not interested in those values. The data are given, but attention can be concentrated on the smaller percentages if desirable. Whether or not the 50 per cent values are considered has little or no influence on the conclusions.

Re Conclusion 1—We were primarily interested in the *general* effect of inert powdered admixtures in concrete. Many powdered admixtures besides hydrated lime are of interest to concrete engineers; 17 other materials were used in our tests. The conclusions should be interpreted on this broad basis rather than with hydrated lime only in view. The tests show that certain types of admixture (pulverized granulated blast furnace slag, for example) *are beneficial to concrete strength*, possess all the advantages of hydrated lime and probably can be used at a lower cost.

Mr. Hart makes two errors in stating that "all the specimens have been averaged together whether they contain small amounts of lime or 50 per cent." (1) The values were *not averaged*, but the effect was determined from the slope of the curve plotted as described below, and fully explained in the original report. There is no reason for anyone falling into an error on this point. It conveys an entirely erroneous impression to say the values were averaged. (2) This conclusion was not based on *all specimens*, as the reader who had the original report before him would readily discover. Conclusion 5, which Mr. Hart omits, stated that "Pulverized slag up to 50 per cent of volume of cement gave a slight increase in strength of concrete . . ." This was one of a number of "exceptions noted below"; other exceptions were covered in Conclusion 6 which Mr. Hart quotes.

The expression "relation is a straight-line" which Mr. Hart places in quotation at two points, does not appear in our report. It is not good English and, as stated, does not indicate what we considered to be the facts. The statement (on page 17) was "It will be noted that in these figures the relation between the strength and the volume of hydrated lime used is *essentially* a linear one."

The effect of hydrated lime was studied by plotting the strengths against the percentages of hydrated lime and drawing a smooth curve through these points. In general, curves drawn in this way closely approximate straight lines. The average slope of these lines was taken as a measure of the effect of powdered admixtures on the strength of concrete. The fact that some of the curves and tables contained values with small percentages of hydrated lime which are higher than those without hydrated lime, has no significance, unless we inquire into the cause of the effect found in each instance.

It is clearly stated in our report that there are regions where hydrated lime increases or does not materially reduce the strength of concrete. These cases may in general be classified under: lean mixtures; fine aggregates; and accidental variations in the values which do not affect the general trend of the results. The effect of hydrated lime under the first two headings is fully covered by the tests and the discussion in our report. Accidental variations in tests are discussed below under Conclusion 4.

Mr. Hart objects to our using percentages of hydrated lime higher than those recommended for use in concrete. He does not state on what information those recommendations are based. He also criticises us for not investigating the effect of hydrated lime below 5 per cent; yet the smallest percentage recommended is 12½ per cent (by volume).

Re Conclusion 2—It should be stated that we are dealing with facts and not fancies. There has been ample opportunity for presenting evidence to show that hydrated lime prevents segregation, produces easier flow in chutes, etc., as claimed by Mr. Hart. The only tests with which we are familiar that were carried out specifically for the purpose of studying these points do not verify these claims.

The "by eye" method of drawing curves through plotted points is universally used by engineers; it is quite satisfactory and surprisingly accurate. The nature of the mathematical methods suggested is not divulged. It was not considered necessary to go into an elementary discussion of curve-tracing. The cause for minor discrepancies in concrete tests should be apparent to any engineer conversant with this subject.

It is not clear why Mr. Hart has placed particular emphasis on Fig. 2, in which a number of the curves were derived from tests made on lean mixtures which, as pointed out in our report, show an increase in strength with hydrated lime. We are at a loss to understand how anyone can interpret Fig. 1 as showing an increase in strength of concrete due to the presence of hydrated lime.

Re Conclusion 4—The absurdity of studying the effect of hydrated lime by adding 1 per cent of this material to concrete must be apparent to anyone experienced in concrete tests. The absurdity should be all the more apparent to one who has our report before him, since it is stated in a number of places that 1 per cent by volume of hydrated lime reduced the strength of ordinary concrete mixtures about 0.5 per cent. The most careful concrete tests will

show variations of several per cent, unless a large number of tests are made in establishing each value.

Mr. Hart has overlooked the fact that we are stating a *rate*. It is not necessary that our observations be restricted to 1 second in determining that a pulley is running 2.1 revolutions per second. It is not necessary for a machine to run for an hour to establish the fact that it can be run at 30 miles per hour.

Mr. Hart has pointed out that hydrated lime makes its poorest showing under the conditions in which concrete is usually used and tested, that is (a) aggregate graded 1½ in.; (b) consistency 1.10, which represents the best consistency for road construction and other high-grade work; (c) age 28 days. All designs are based on the 28-day strength of concrete. Most concrete engineers are coming to a saner use of mixing water. It does not seem practicable to modify the accepted sizes of the aggregate for the benefit of hydrated lime.

Re Conclusion 7—The comments are not borne out by the tests. In order that concrete containing hydrated lime may be plastic, sufficient water must be added to produce a plasticity in the lime which approximates that of the concrete. The statement "that it is unnecessary to use so much water in the lime batches in order to secure equal plasticity" does not change the observed facts.

Mr. Hart has misinterpreted Fig. 7, in spite of the explanatory notes which accompany that figure and in spite of the fact that this error has already been pointed out on a number of occasions. It is stated in our report that this table does not show directly the effect of hydrated lime on the strength of concrete. We went so far as to give an example illustrating this very point, so that the most careless reader has no excuse for misinterpreting the diagram. This diagram shows the fundamental relation between the strength of concrete and the water-ratio. While it is true that for the *same water-ratio* the strength of concrete with 50 per cent of hydrated lime is higher than that without hydrated lime, we must not lose sight of the fact that the water-ratio must be *increased* when hydrated lime is used. If the *same quantity* of water were used (the same water-ratio) the concrete containing hydrated lime will be less plastic; allowance must be made for this condition by adding water, which in turn reduces the concrete strength.

By identifying some of the points on the two curves in Fig. 7, the absurdity of his interpretation would have become apparent. Consider, for example, the 1:5 tests (identified by four solid circles), which in the diagram without hydrated lime gave a strength of about 2,600 lb. per sq.in. with a water-ratio of 0.87. In the diagram with hydrated lime these points will be found at a strength of about 2,100 lb. per sq.in., with a water-ratio of 1.10. In other words, the strength is reduced 500 lb. per sq.in. due to the presence of the additional water and hydrated lime. For richer mixes the difference in strength will be much greater for the same difference in water-ratio.

Re Conclusion 10—We have not claimed that our method of measuring the consistency or plasticity of concrete is perfect; in fact it is quite apparent that this is not the case. We are still searching for a better method. Our conclusions are based on a careful study of several thousand determinations by the slump test, only part of which are given in our report. It was pointed out that the slump of leaner mixtures was increased with the addition of hydrated lime (accompanied, of course, by the addition of water).

Mr. Hart's method of calculating the percentages in the discussion of the slump test is erroneous. By this method if a cylinder slumped 7 in. and we get "an increase of 112 per cent we would then calculate a slump of 14.8 in. which is absurd, in view of the fact that a 12-in. cylinder was used.

Re Conclusion 11—Our conclusion with reference to the effect of powdered admixtures on the wear of concrete was based on all wear tests made in this investigation, none of which have been omitted from the report. If we are permitted to select certain data and ignore others almost anything can be proven.

Re Conclusion 12—With reference to the substitution of hydrated lime for cement, it may be stated that some of these tests were made over three years ago, when it was common for the advocates of hydrated lime to recommend the substitution of lime for cement. We recognized that this was a poor practice and it was not followed in later tests.

DUFF A. ABRAMS,
Professor in Charge, Structural
Materials Research Laboratory,
Chicago, Dec. 11. Lewis Institute.

Engineers Urged to Join Scientific Bodies

Sir—As you doubtless know, the scientific societies are passing through difficult financial conditions due to the high cost of printing. Their only salvation, outside of increasing the dues unreasonably, is to increase their membership, and I am taking this opportunity to call the attention of the engineering profession to the desirability of becoming members of the American Mathematical Society, the Mathematical Association of America, and the Association for the Advancement of Science.

In joining these societies the engineers will not alone furnish the much needed financial aid in promoting and keeping alive the necessary and important work that these societies are performing, but will also derive much benefit to themselves from contact with the pure science societies.

It must be borne in mind that, after all, the proper carrying on of research is practically impossible without a thorough co-operation of pure scientific bodies, and as these societies eagerly look forward to analyzing and discussing the problems of the engineering profession, there is to my mind no doubt that much mutual benefit must result from an infiltration of the engineering profession in the mathematical and scientific societies.

A perusal of the publications of the three societies mentioned above will show that they contain much of interest to engineers. The editors will gladly open their columns to the presentation before scientists of important engineering problems.

I sincerely hope that this appeal will meet with immediate response, and with the aid of engineers the societies will be carried through the present financial storms.

G. PAASWELL,
New York City, Dec. 23. Consulting Engineer.

Automatic Recorder for Stream Discharge

Sir—In your issue of Dec. 9, 1920, p. 1124, appears a description of the Moore attachment as used in an "Automatic Recording Apparatus for Stream Discharge."

This invention consists of a cam to actuate the recording pencil, which draws a curve whose ordinate is directly proportional to the discharge of the stream and not to the altitude of the float. The idea of this invention occurred to the writer of this letter more than three years ago and he published an account of it, with applications to the stream discharge over both triangular and rectangular weirs (so far as the mathematical work was concerned) in an article which appeared in *The Cornell Civil Engineer* for November, 1917.

The writer has never patented his invention and the two-year limit having expired he supposes that it is now public property—though for aught he knows Mr. Moore may have brought out the idea prior to November, 1917, and may have patented it. IRVING P. CHURCH.

Cornell University, Ithaca, N. Y., Dec. 17.

Piles From Blight-Killed Chestnut Trees

Sir—The question has recently been brought to the writer's attention whether it is safe to use chestnut piles which have been cut from chestnut trees in Connecticut. Inasmuch as the chestnut trees in this locality have been killed off by a blight within the past few years, I question the advisability of using this wood for piles. If any of your readers have records of tests on the use of such piles, the writer would appreciate receiving information regarding it.

Bridgeport, Conn., Dec. 18. EDWARD A. LAMBERT,
Fletcher Thompson, Inc., Engineers.

In Behalf of the Butte Civil Engineers

Sir—I wish to take exception to the article on Butte appearing in *Engineering News-Record*, Nov. 25, p. 1032. It is certainly ill advised and incorrect.

The Anaconda Copper Mining Co. is much the largest operator in this district. This company maintains a large staff of able engineers in Butte composed of mining, civil, electrical and mechanical engineers and geologists. The slur on civil engineers in the article referred to will appear most absurd if you read the articles on mine surveying which appear from time to time in the paper published by the company. The cross-cuts and tunnels in the Butte mines, if placed end to end, would reach from New York to London, and the underground working in the Butte district are probably as intricate as those of any mining district in the world.

At Anaconda the engineering staff is very large and comprises metallurgical, mechanical, civil (including hydraulic and structural) and electrical engineers. This force ranges between 120 and 300 men.

I take especial exception to the paragraph next to the bottom of the first column of your article. It reads as follows: "There are no civil engineers to speak of at Butte. Outside of the water company and the Montana Power Co. there is no civil engineering to be done. What civil engineers there are are masquerading as mining or metallurgical men and from the looks of the main footbridge leading to the big smelter at Anaconda—a nice wood truss with no sign of post or diagonal, a perfect tribute to the efficiency of the arch, there are few of the metallurgical men with structural training." The bridge mentioned in this paragraph is a small wooden footbridge spanning a narrow waterway and was so insignificant that it did not receive the dignity of a design from the drafting room, but was built in a day or two by carpenters.

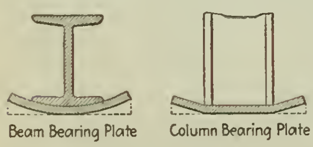
The article implies that the pipe line for the Butte Water Co. is the only large engineering undertaking in this vicinity. This is certainly a notable event in engineering. At the same time the Anaconda company has, each year for the past six years, spent as much money on new work as this pipe line cost and several of the enterprises have been new and unique in the engineering world. W. C. CAPRON,
Mechanical Superintendent Anaconda Copper Mining Co.
Anaconda, Mont., Dec. 17, 1920.

[There was no intention of slighting the work of the Anaconda Copper Mining Co. in the article referred to; in fact there is a tribute to the engineers of that and other of the mining companies in the Butte district. Their activities, however, are more in the field of the mining engineer. It is notoriously difficult to distinguish between the different kinds of engineering· Mr. Capron's letter only confirms this.—EDITOR.]

Different Formulas for Beam and Column Bearing Plates

Sir—Referring to R. W. Bowman's letter on bearing-plate formulas, p. 1105 of the Dec. 2 issue, and your editorial comment thereon, the following points relative to the application of the formulas occur to the writer:

For plates under I-beams the distribution of pressure over the bearing area of the beam flange is approximately uniform, due to more or less "flexibility" of the flange. In this case the Carnegie formula applies. This is especially true of girder beams having wide and thin flanges. Its use is on the side of safety.



FLEXURE OF BEARING PLATES

For base plates under columns, on account of the "inflexibility" of the column shaft, the load is not uniformly distributed and the Bethlehem formula properly applies. Use of a thicker plate to care for bending moment would seem to be unnecessary; however, where there is a possibility of corrosion, as is often the case, the thickness should be made greater than theory requires. WALTER J. FUSTON,
Dallas, Tex. Fuston & Van Valkenburgh,

Hooped Columns and Construction Joints in the Galveston Fire

Sir—In your issue of Dec. 2, p. 1101, Edward Godfrey has evidenced much interest in the results of the fires in the warehouse at Galveston, Tex. Mr. Godfrey states his opinion that "it is inconceivable that anything approaching this destruction could have occurred if the columns had been reinforced with close-spaced hooping." After closely examining the original photographs, three of which were not published by you, the surfaces of columns in the lower story which spalled off reveal a comparatively close-spaced hooping, approximately 3 in. on centers, and the hooping of columns supporting the roof about 6 in. on centers. The columns of the lower story show the same tendency, and actual failure in some cases, as did the columns with spirals about 6 in. on centers. If the upper story columns failed first it is natural to believe that the impact from the dead weight of the roof slab would cause an unfavorable condition of loading on the lower story columns; otherwise, if the design of all columns was uniformly proportioned with relation to unit stresses and the loads imposed, it appears from the results that in resistance to fire the spirals spaced 6 in. on centers compare favorably with those spaced 3 in. on centers.

In the absence of tangible evidence the writer would concur with Mr. Godfrey's theory, but the facts in this instance do not substantiate his conclusion. In all cases where columns remained, the spalling did not extend farther than the hooping which was left exposed. This condition of spalled-off column surfaces also prevailed in several cases in the compartment which did not fail.

Mr. Godfrey appears rather lenient in his conclusion regarding the effect of fire on construction joints. The photograph reproduced on page 983 of your issue of Nov. 18 unfortunately does not show the detail displayed by the original photograph. In the compartment that survived the fire the surface of floor slab revealed no indication of irregularity except at construction joints, although the distance between these joints and the exterior walls or expansion joint is considerable. The construction joints at the center panels offered the only opportunity for the excessive heat to attack the slab rods along the plane of maximum positive moment and hence produce elongation of these rods and subsequent distortion due to heat and stress from dead and live loads. This experience indicates the usual construction joint to be the most susceptible source of weakness in a reinforced-concrete building.

As Edgar A. Cross states in your issue of Dec. 2, p. 1102, the value of tension rods when subjected to heat even as low as 250 deg. C., or 482 deg. F., is greatly lessened. The expansive force due to heat is naturally cumulative, but the spandrel walls and expansion joints, being the points of least resistance, would hardly occasion the buckling of slabs if the present form of construction joints did not offer a direct medium for weakness and failure in the event of fire.
St. Louis, Dec. 17. W. J. KNIGHT.

City Must Pay Engineer's Fee for Services

The Superior Court of the Province of Quebec has ruled that the city of St. John, P. Q., must pay Royal LeSage, consulting engineer, Montreal, for plans, specifications and estimates prepared by Mr. LeSage for sewers for the city named. The city abandoned the project after having authorized the work and a bond to the amount of $50,000. Mr. LeSage presented a bill for $2,500 and the city denied liability, according to *The Canadian Engineer*, but offered $500 in settlement. It was shown by Mr. LeSage that his traveling expenses and other disbursements amounted to $725. The court decided that Mr. LeSage was entitled to 3 per cent for the preparation of plans and to 2 per cent for having been deprived of the supervision of the construction work. It was also decided by the court that the engineer was entitled to costs.

NEWS OF THE WEEK

New York, December 30, 1920

Erect Large Alaskan Bridge in Winter

Span of 504 Feet Under Way—To Erect Steel Arch Next Summer by Hell Gate Arch Method

The railroad being constructed by the Alaskan Engineering Commission has reached the Susitna River crossing, 260 miles from Seward, and on Dec. 1 more than 50 per cent of the steel in the bridge at that point had been put in place. This bridge is being built during the winter largely because piles could be driven only a few feet at the site and it was feared that high water in the summer would menace falsework built on piling of that sort. The structure as a whole consists of 392 ft. of trestle, two 70-ft. timber pony trusses, two 121-ft. Howe timber trusses and a 504-ft. steel span. The latter is a Baltimore truss, designed for a loading of two E50 locomotives followed by a uniform load of 4,000 lb. per foot. It has a center height of 76.75 ft. and a total weight of 1,650 tons.

Contract for the structure was awarded early in February, 1920. The designs were completed and spans assembled and shipped by July. Modjeski & Angier, as consulting engineers, approved detailed designs of the bridge prepared by the American Bridge Co., which, in turn, were based on the general plans of the Alaskan Engineering Commission. The bridge work and all other construction on the Alaskan railroad is under the supervision of Col. F. H. Mears, chairman Alaskan Engineering Commission.

The completion of the Susitna bridge this winter will make it possible to carry on work on a large two-hinged arch across Hurricane Gulch, 20 miles farther on, during the open season next year. The arch span in this structure will be 384 ft. long. At its center the rails will be 330 ft. above the bottom of the gorge. The plan of erection decided upon calls for the use of backstay anchorages, similar to those used in erecting the Hell Gate arch in New York. This bridge is being designed for E60 loading. With the steel approach spans, which total 530 ft. in length, t will require 1,300 tons of steel.

Saskatchewan Licensing Bill Fails of Passage

The bill for the incorporation of the Association of Professional Engineers of the Province of Saskatchewan, Canada, failed of passage by the Legislature when it came before that body this month.

Engineering Council Holds Final Meeting

The final meeting of engineering council held in Washington, D. C., Dec. 16, was almost entirely devoted to the closing of council's affairs. Unfinished business and uncompleted projects were transmitted to the United Engineering Society with the suggestion that they be referred to the new American Engineering Council with favorable recommendation. The principle action of a continuing nature taken by council was the adoption of the resolution to the effect that the present financial stringency and the prospect that federal revenues during the next year will not equal the government expenses, make it a matter of good citizenship for every considerate person to avoid advocating expansion of government activities; that in consequence of this belief, Engineering Council would endeavor to set the example by withdrawing its previously enlisted support of efforts to secure increased appropriations for certain government engineering projects.

To Give Up Boston Garbage and Refuse Disposal Contract

The Boston Development & Sanitary Co., which has a ten-year contract for the disposal of the garbage, ashes and rubbish of Boston, expiring July 1, 1922, has notified the city that it must discontinue its services on Dec. 31, 1920, on account of the losses that it is sustaining. These losses are attributed to the increase since 1912 in the cost of labor from 17½ to 60c. an hour and of coal from \$3.80 to \$14 a ton; the decrease in the price of grease from about 5c. to a quotation of 3c. a pound but with no market; and to the failure of the city to enforce the contract provisions for the separation of garbage and ashes. Had this separation been effected, the company states it could have continued to operate its contract without loss. A few months ago the company offered to pay the city the amount of its surety bond, \$100,000, if the city would cancel the contract. Since then it has offered to continue the disposal work if the city would pay operating costs, without profit to the company or executive salaries. These offers the company states the city has virtually rejected. It is supposed that the city will begin operating the plant on Jan. 1 and take action against the company for non-fulfillment of its contract. The contract price for 1920 is \$152,000; for 1921, \$156,000; and for the half year ending June 30, 1922, \$80,000.

Engineers on General Staff Eligible List

Twenty-one Regulars and Nineteen Ex-Service Men Included by Pershing Board in Roster of 607 Names

Engineers to the number of 40, of whom 21 are regulars and 19 reserve officers, members of the National Guard, or civilians formerly in the military service, are included in the General Staff eligible list of 607 names made public last week by the War Department as General Order 74. The list is published in compliance with Section 5 of the National Defense Act, approved by Congress June 4, 1920, which requires a board consisting of the general of the army, the commandant of the General Staff College, the commandant of the General Service Schools and two other general officers of the line, chosen by the Secretary of War, to select those officers of the Regular Army, National Guard, Officers' Reserve Corps and others who demonstrated their fitness for General Staff duty during the World War, who are considered qualified by "education, military experience, and character," for General Staff duty. The board was headed by General Pershing. From now on, no officer can be detailed for General Staff duty unless his name appears on the eligible list, which is popularly referred to as the "Blue Book" of the Army.

Among the Engineer regulars on the list which follows are Brig.-Gen. W. D. Connor, who served in France as commander of the Port of Bordeaux, chief of staff for Major General Harbord, commanding general, S. O. S., later succeeding him in that post, and then being placed in command of the American Forces in France after the return of General Pershing to the United States; Col. (formerly Brig.-Gen.) Edgar Jadwin, who served in the A. E. F. as director of construction and forestry, in charge of practically all the engineering work in France outside of the zone of the armies; Col. (formerly Brig.-Gen.) Sherwood Cheney, who was chief of the Army Transport Service abroad, and Major, (formerly Col.) W. T. Hannum, who was a General Staff Officer (G.-5) specializing in the training of troops. Col. Mason M. Patrick, who was chief of the Air Service in France, with rank of major general, Col. E. D. Peek, who commanded a light railway regiment abroad; Col. George R. Spalding, who was chief engineer of the First Army; Col. James A. Woodruff, who was assistant to Gen. Jadwin, director of construction and forestry, and Col. G. A. Youngberg.

who served on the G-4 Section of the General Staff at Chaumont.

Of the engineer officers assigned to duty in the United States were Brig.-Gen. Henry Jervey, assistant chief of staff and director of operations; Col. (formerly Brig.-Gen.) H. B. Ferguson, commanding port of embarkation; Col. Lytle Brown, General Staff, and others.

Of the civilians, Major Barber was among the first Engineer officers in France, having gone there as a member of the Railways Commission sent at the request of General Joffre. Brig.-Gen. R. C. Marshall, Jr., was chief of the construction Division of the Army, while Lieut.-Col. John P. Hogan served with G-2, Second Army, A. E. F. Col. John F. Sewell was Section Engineer and commanding officer of the 17th Engineers at St. Nazaire in France, while Col. Joseph Hyde Pratt commanded a divisional engineers regiment.

The following engineer officers' names are contained in the General Staff list:

Regular Officers—Brown, Lytle, Col.; Cheney, Sherwood, Col.; Connor, William D., Brig.-Gen.; Emerson, Thos. H., Major; Ferguson, Harley B., Col.; Hannum, Warren T., Major; Harts, William W., Col.; Jadwin, Edgar, Col.; Jervey, Henry, Brig.-Gen.; Kelly, William, Lieut.-Col.; Kingman, John J., Major; MacArthur, Douglas, Brig.-Gen.; Patrick, Mason M., Col.; Peek, Ernest D., Lieut.-Col.; Sherill, Clarence O., Lieut.-Col.; Spalding, George R., Lieut.-Col.; Steese, James G., Major; Ward, Ralph T., Major; Watkins, Lewis H., Major; Woodruff, James A., Lieut.-Col.; Youngberg, Gilbert A., Lieut.-Col.

Civilians—Barber, Alvin B., civilian, formerly Col.; Boesch, Clarence E., Major, R. C.; Bright, Graham B., Major, R. C.; Dasher, Charles L., civilian, formerly Major; French, Herbert W., civilian formerly Capt.; Hogan, John P., civilian, formerly Lieut.-Col.; Lightner, George C., Major, R. C.; Low, John C., civilian, formerly Lieut.-Col.; Marshall, Richard C., Jr., civilian, formerly Brig.-Gen.; Pill, Leon M., Major, R. C.; Poole, John H., Col., R. C.; Pratt, Joseph H., Col., R. C.; Roberts, Spencer, civilian, formerly Major; Sewell, John S., Col., R. C.; Shaughnessey, Edward H., Col., R. C.; Taylor, Roy, civilian, formerly Major; Whitehurst, Herbert C., Major, R. C.; Williams, Edward H., Col., R. C.; Wilson, William J., Major, R. C.; Woodruff, Edwin D., Major, R. C.

Tacoma Pier Nears Completion

The Port of Tacoma, Wash., will issue $60,000 of warrants bearing 6 per cent interest in order to complete its port project to the point where Pier 1, the open pier, can be placed in commission. The funds will be used in laying railroad tracks to the new pier, purchase of a big crane and other improvements.

Quartermaster Wants $20,700,000 for Construction

The sum of $20,700,000 is asked of Congress by the Quartermaster General, U. S. Army, to be used in the construction, during the next fiscal year, of barracks, quarters, stables, storehouses, magazines, administration buildings, sheds and shops. The appropriation for similar purposes during the current fiscal year was $8,500,000. In addition, $3,500,000 has been asked for the construction and repair of roads, walks, wharves and drainage channels and $1,509,000 for the construction and repair of hospitals.

Materials Handling Section of A. S. M. E.

With the purpose of formulating a definite program for the section, its executive committee is seeking the suggestions of the members of the section and of the society.

The scope of the work is covered by the two following questions:

(1) How the mechanical engineers can improve machinery and equipments for the handling of materials.

(2) How great the material handling costs can be reduced if the whole subject of transportation is analyzed and co-ordinated from the viewpoint of making economies over our present method.

The appointment of subcommittees is being considered along two distinct lines: (a) According to types of material handling equipment, such as conveyors, cableways, cranes, etc. (b) According to industries which have material handling problems, such as steel manufactures, storage warehouses, commodity distribution centers, construction work, automobile or tire industries, etc.

It is the intention of the section to so thoroughly discuss the controlling factors in each line by meetings held by these various subcommittees so as to develop better methods of handling materials and to standardize equipment and methods where that is desirable.

It is suggested that important research work might be undertaken to build up through the formation of specialized committees certain classes of data and of information of general interest to all members. Such classes of data pertain, for example, to the handling of materials at the terminals, the relation of costs of material handling to the general costs of factory operation, and the percentage of costs of commodities which merely represent transportation in its various phases.

A questionnaire is being sent out aimed to bring out the ways in which the material handling section can interest the members and can best serve the purpose for which the section has been organized. The office of the section is at the society headquarters, 29 West 39th St., New York City.

Hetch Hetchy Project Visited by U. S. Army Engineers

While on a western tour preparatory to making recommendations for the annual appropriations, the Board of Engineers for Rivers and Harbors, Corps of Engineers, U. S. A., made an inspection trip over the Hetch Hetchy project as guests of M. M. O'Shaughnessy, city engineer of San Francisco. Among the visiting engineers were Brig.-Gen. Harry Taylor, assistant Chief of Engineers, Cols. J. C. Sanford, Charles Keller, Wm. B. Ladue, J. C. Oakes, and Herbert Deakyne, Majors C. S. Ridley and U. S. Grant 3rd.

Railroad Regiment Authorized

Instructions have been issued by the Chief of Engineers, U. S. Army, for the organiation of the 16th Engineers, a railroad regiment. This is the first time that engineer officers and troops specializing in railroad construction will be concentrated in a single organization in peace time. Only a battalion is to be formed at present, but it will serve as a nucleus around which the organization can be expanded in case of necessity.

Urge Uniform Traffic Regulations

What started as a meeting of the executive committee of the International Traffic Officers' Association, at Cleveland, Dec. 7, developed into a National Conference on Highway Traffic Regulations which will meet in Washington Jan. 10 to reach final agreement on traffic regulations which can be presented with their endorsement to the country at large and particularly to the 42 state legislatures convening next month. A temporary organization of the National Conference on Highway Traffic Regulations was effected by the representatives of 15 national and 3 other associations who had been invited to give their ideas on the subject.

The conference of eighteen associations elected as their temporary chairman, Charles M. Talbert, director of streets and sewers of St. Louis; vice-chairman, Harry Meixell, Jr., secretary, Motor Vehicle Conference Committee; secretary-treasurer, David R. Faries representing the Automobile Club of Southern California; and assistant secretary and treasurer, Sidney J. Williams, secretary and chief engineer of the National Safety Council.

The National Conference on Highway Traffic Regulations is not a new body, but a consolidation of all existing organizations which are interested in standardizing traffic legislation and regulation. For years there has been a great duplication of efforts in the agitation for a national traffic code and there are now at least four proposed standards for such a code.

"Once a uniform traffic motor vehicle law is adopted," said Mr. Talbert "the next logical step will be standardization of traffic signs and signals and this will naturally lead to uniformity in administrative and judicial practice."

The feeling expressed at the Cleveland conference was that the standardization of vehicle laws is becoming more and more imperative. It is estimated that there are in the cities of the United States approximately one million arrests for traffic law violations each year and records at the headquarters of the National Safety Council indicate that a very large proportion of the 12,000 fatalities and hundreds of thousands of injuries caused by automobile accidents each year result from violation of traffic laws, in many instances from ignorance of such laws as are in force.

To Vote on Kittitas Irrigation Contract in Washington

Property owners under the proposed Kittitas high line irrigation project, designed to irrigate approximately 73,000 acres of land in the vicinity of Ellensburg, Wash., will shortly vote on the acceptance of a contract, approved by Secretary of the Interior Payne, providing that the Government furnish storage water necessary for the project.

Would Put Kansas Water Resources Under One Head

A State Water Congress was held Dec. 15 in Topeka, Kan., for the purpose of discussing a proposal to consolidate the administration, investigation and utilization of the water resources of the state under one head, the Division of Water Resources to be created within the Court of Industrial Relations. At present six state organizations having to do with water resources now work more or less independently. They are the Court of Industrial Relations; the Kansas Water Commission; Division of Irrigation with the Department of Agriculture; State Executive Council; State Geological Survey and State Board of Health.

The Industrial Relations Court issues permits through the Public Utilities Commission, values and controls rates and service of hydroelectric properties. The technical services would be handled by the proposed division of Water Resources. The duties of the Kansas Water Commission are to investigate and control the problems of flood prevention, drainage, domestic water supply, water power navigation and irrigation. It maintains river gaging stations and co-operates with the U. S. Geological Survey. The commission is to be abolished and its duties transferred to the proposed division. The State Irrigation Commissioner gathers irrigation statistics and operates by lease state-owned irrigation plants.

The Division of Irrigation within the State Board of Agriculture is to be abolished and its duties enlarged and transferred to the proposed division. The State Executive Council administers the "Sand Law" which relates to the sale and taking of sand, or any natural product from the river beds or state-owned property. The duties would be assumed by the proposed division. The State Geological Survey makes surveys of underground water surveys and would continue the work in co-operation with the proposed division. Likewise the State Board of Health would continue to function in handling sewage and water-works problems but would at all times co-operate with the new division.

In the discussions the few opponents to the plan argued for home rule and against corporation control which was considered easier of attainment under state commissions. More rapid and complete development of the state's water resources was considered possible under the proposed division.

A committee of five to represent all interests involved was authorized to co-operate with the governor and the Water Commission in drafting the proposed bill.

Report Withholds Recommendation on Imperial Valley Work

No specific recommendation as to the best method of proceeding with the irrigation of the Imperial Valley in California can be made until an examination of the Boulder Canyon dam site is completed. This statement is made by the Secretary of the Interior in submitting a report to Congress.

ARCHIBALD BYRON LUEDER

The report goes exhaustively into the details of the irrigable area and the location of the holdings which are to be benefited. The whole matter hinges on the possibility of constructing a large reservoir in Boulder Canyon, near the northern boundary of Arizona below the mouth of Virgin River. The report points out that a basin of large capacity could be obtained if a high dam were constructed. The investigation thus far, however, has not shown favorable foundation conditions for such a dam.

In case the Boulder Canyon reservoir does not prove to be feasible or is not constructed an alternative proposition provides for the construction of the Dewey reservoir on Grand River, together with the necessary canals and power houses. The total expense of the latter project is estimated at $67,-269,000.

The report calls attention to the fact that if all possible development on the upper rivers and tributaries is carried out and storage provided only in the Dewey reservoir there will be some shortage of water on certain lands in two years out of twenty-one, judging from past records.

Archibald Byron Lueder

The roving life a construction engineer must lead cannot be better told than by recounting the chronology of the career of Archibald B. Lueder, M. Am. Soc. C. E., who was one of the best exponents of that branch of the profession, and who died Aug. 21, 1920. His work took him to practically every corner of the globe.

Mr. Lueder was born at Nanticoke, Pa., Aug. 28, 1876. He graduated from the College of Civil Engineering of Cornell University in 1899, at which time he started as timekeeper upon construction work with the Berlin Iron Bridge Co. of East Berlin, Conn. After serving for a time as foreman of erection with this company, he was sent in the spring of 1901 by the American Bridge Co. as agent and assistant engineer on the construction of twenty-eight viaducts and bridges on the Uganda Railway in British East Africa, Port of Kilindini. Most of the work was done with native laborers who had had no experience in steel work.

Returns to America

Upon the completion of this work, he returned to America in the spring of 1903 and was employed by the American Bridge Co. as assistant engineer upon the construction of a number of bridges in various parts of the country.

In February, 1909, Mr. Lueder joined the Merrill Ruckgaber Co. and continued with this company until December, 1912. The work under his supervision included steel and concrete highway bridges and concrete sewer on Broad St., Stapleton, S. I.; some difficult sewer construction in Brooklyn and the construction of Evitts Creek reservoir and dam at Cumberland, Md., which included 9 mi. of wood stave pipe line.

In December, 1912, Mr. Lueder was superintendent for the Arthur McMullen, Snare & Triest Co. on the 1[illegible]th St. section of the Lexington Ave. (New York) subway, and after this work was well under way he was sent by Snare & Triest to Coquimbo, Chile, in charge of the construction of ore docks for the Bethlehem Steel Co.

Returning from Chile during the spring of 1915, he was first employed by the Jarrett-Chambers Co., and later by the Phoenix Construction Co. on a power plant at Omaha, Neb.

Mr. Lueder was connected with the Electric Bond & Share Co. as manager of construction in the summer of 1916 until early in 1919, the power plant jobs of which he had charge during this time being located at Omaha, Wichita and Fort Worth.

The year 1919 was devoted to the development of oil properties near Fort Worth, Texas. Mr. Lueder was president of the Phoenix Oil Co., which he organized and managed until it was necessary for him to give up his work because of ill health which developed early in 1920.

New Railroad for Quebec

A new line of railroad 120 miles long, from Chicoutimi to St. Felicien, via the north side of Lake St. John, is provided for in a contract that has been signed between the Government of the Province of Quebec and the Quebec & Chibougamou Railway Co. The new line will run through timbered country. A large amount of the material has been contracted for and the road is to be completed in two years.

Colorado May Not Build Tunnels

A constitutional amendment authorizing Colorado to construct three tunnels through the mountains, and also authorizing the issuance of bonds for the work, was defeated at the election of Nov. 2. In view of this result a movement is under way now to bring before the legislature in January another proposal to construct the tunnels. The method by which the work can be undertaken has not yet been decided upon. Favorable consideration is being given to the plan of authorizing (by legislative enactment) the formation of tunnel districts similar to irrigation districts, any district then to vote on the question of bonding itself for the tunnel construction. This plan would make it possible to finance a tunnel on the credit of those sections of the state that would be most directly benefited, without reference to other parts of the state.

High Dam Proposed for Merced Irrigation District

A report on the requirements of the Merced irrigation district in the San Joaquin valley of California, together with recommendations for the development of the necessary storage, canal systems, drainage, etc., has just been submitted to the district by John D. Galloway, civil engineer, of San Francisco. The district, formed about a year ago, contemplates the irrigation of 200,000 acres of fertile land, of which 52,000 acres is already irrigated. Plans are under way for a bond election to secure funds with which the proposed work may be carried out.

The work recommended by the report would include a storage reservoir on the Merced River formed by a dam at Exchequer, 7 mi. above Merced Falls. At this site, the report states, there is a favorable site for a simple arch dam of perhaps 330 ft. total height, which would raise the water 300 ft. and form a reservoir 12 mi. long. This would necessitate the relocation of 20 mi. of the Yosemite Valley railroad which now runs through the reservoir site. It is proposed to locate a 20,000-kw. power plant at the foot of the dam, part of the energy from which would be used for pumping within the district. The plans contemplate the purchase of the Crocker-Huffman canal system and the addition of mains and laterals to make a total length of about 850 miles of canal.

Small Mine Shares Proposed for German Workers

A feature of the plans now under consideration in Germany for the socialization of the coal mines is the proposal to give the employed miners as well as officials the option to take shares in the mine properties and to issue for this purpose shares of a small nominal value, that is 100 marks, whereas up to now shares of the German joint stock companies had a minimum face value of 1,000 marks. The mine owners, led by Stinnes, are fighting with all their power and vast influence for the maintenance of the present proprietorship conditions and to avert the danger of the expropriation they have been willing to make an important concession by providing a limitation of the share dividends. By this concession, and by the participation of the working classes in the proprietorship and other betterments promised them, it is hoped to defeat the expropriation advocates.

Would Withdraw Park Lands From Federal Power Act

A number of amendments to the Federal Water Power Act, signed by the President last June, have been introduced in the present session of Congress, but most of them are in regard to routine matters. One of them, however, is of radical nature. This is S. 4554, introduced by Senator Jones, of Washington, which provides that no water-power development may be made under the act within the limits of a national park or national monument. The amendment reads as follows:

> That hereafter no permit, license, lease or authorization for dams, conduits, reservoirs, power houses, transmission lines or other works for storage or carriage of water, or for the development, transmission or utilization of power within the limits of any national park or national monument, shall be granted or made without specific authority of Congress, and so much of the act of Congress approved June 10, 1920, entitled "An act to create a Federal Power Commission, to provide for the improvement of navigation, the development of water power, the use of the public lands in relation thereto, and to repeal Section 18 of the river and harbor appropriation act approved Aug. 8, 1917, and for other purposes," as authorizes licensing such uses of national parks and national monuments by the Federal Power Commission is hereby repealed.

Comprehensive Road System Proposed for Saskatchewan

A plan to provide the Province of Saskatchewan with 1,067 miles of paved roads suitable for automobile traffic, by connecting up the more thickly populated centers, has been evolved by Commissioner Forath. The total estimated cost of construction of the suggested roads is $24,000,000 provided the roads are constructed as near as possible to railways and the work is so organized that it can be carried on continuously and as rapidly as possible. In the main, the commissioner's scheme is to construct a 15-ft. paved strip on all the main roads in the Province, the cost of which is to be recovered in the course of from 10 to 20 years by a system of tolls.

Indictment of Plumbers Follows Lockwood Investigation

Indictment of fifty-two members of an alleged plumbers "ring," maintained to defeat competitive bidding; the existence of an alleged combination that dominate the cast iron pipe field; and the promise of two of the three trade associations under fire from the Lockwood joint legislative committee on housing to "mend their ways" by returning to a competitive bid basis, are the high lights in the past week's work of the Lockwood committee, investigating the housing situation in New York City..

The fifty-two members of the alleged plumbing "ring" included twenty-seven corporations and twenty-five individuals, all members of the so-called Hettrick "code of practice" group. The indictment against them is a violation of the Donnelly anti-trust law. Hettrick, previously indicted, was again included among the indicted plumbers, and his $100,000 bail was continued. The plumbers appeared for arraignment, pleaded not guilty and were released under bail of $5,000 each.

Cast Iron Pipe Combine

The existence of a cast iron pipe combine, which fought legislation and plumbing innovations designed to save the building public thousands of dollars annually, was disclosed through the testimony of Charles F. Tuttle, a professional secretary, who had acted in that capacity for the Eastern Soil Pipe Association, the American Institute of Lead Manufacturers, and other trade organizations. His examination revealed the existence of an organization of ten pipe concerns, known as the Eastern Soil Pipe Association, working in conjunction with the Southern Soil Pipe Association. It was brought out in Tuttle's examination that the Central Foundry Co., the largest of the Eastern concerns, made all the discount prices for the other organizations, a practice that continued up to June 2, 1920.

The two trade associations that promised to return to a basis of competitive bidding are the Stone Mason Contractors' Association and the Composition Roofers' and Waterproof Association. The former association agreed to return at once to a basis of competitive bidding and the latter to eliminate from its practices "objectionable regulations," the chief one being a rule that prevented roofers from guaranteeing a composition roof for more than two years, when a guarantee for ten years was possible. According to the testimony of E. J. Lee, the roofers' association secretary, the Johns-Manville corporation was barred from membership because it guaranteed composition roofs for ten years. Included in the "reformation" of the stone masons' association, it was stated, would be the abrogation of an agreement that the association had with unions workers, whereby no union mason could work for a contractor not a member of the association.

Insurance Companies Lend Large Amounts to Aid Housing

According to Haley Fiske of the Metropolitan Life Insurance Co., New York City, life insurance companies of the United States, for the first ten months of 1920, loaned more than $230,000,000 on city and farm real-estate mortgages. The insurance companies have $2,082,000,000 invested in bonds and mortgages throughout the country, almost equally divided between farms and cities. Commitment for many millions more have been made, one company alone having promised approximately $50,000,000 in loans not yet closed. A great deal of this money loaned, it is pointed out, was used to aid housing propositions.

Wage Decrease Accepted by Textile Unions Under Protest

Nine of ten textile unions of New Bedford, Mass., recently voted to accept under protest, a 22½-per cent reduction in wages, rathen than strike. The tenth union voted to strike. Approximately 35,000 operators are affected.

Wage reductions among the textile workers were also noted in other sections of New England, according to press reports. At Fall River a wage reduction of 22½ per cent for the 35,000 cotton mill operatives in that city was announced Dec. 22 at a conference between the Fall River Cotton Manufacturers Association and the Textile Council. The reduction will become effective on Jan. 3 in all of the 100 mills controlled by the members of the association. Wage cuts of 22½ per cent in Holyoke and Boston were also announced. The Manufacturers Association of Boston recently announced that the decrease would occur and that the piece-work system of payment would be restored.

The Stanley Iron Works of Bridgewater, Mass., whose head offices are in New Britain, Conn., recently posted a notice of a 15 per cent reduction in wages, effective at once. The 5 per cent monthly bonus is also abolished and a drop from time and a half to straight time for all overtime is announced.

The directors of the Loyal Legion of Loggers and Lumbermen for Oregon has announced a cut in the minimum wage for legion workmen of 80c per day, making a new minimum wage of $3.60. Approximately 2,000 employees of a manufacturing establishment in Chicopee, Mass., announced a 22½-per cent reduction, beginning Jan. 10. The same reduction will be put into effect by two establishments in Sanford, Me., a week earlier, affecting 3,000 operatives. A wage reduction affecting more than 700 employees was announced recently by the Parkersburg Iron Co. of Parkersburg, W. Va. In order to save sixty of their number from being laid off, a proposal that 450 employees of the Great Northern R.R. Co. at Great Falls, Mont., each work shorter hours, has been made by the men themselves in a communication sent to the Great Northern headquarters in St. Paul. The sixty men were laid off Dec. 21. A Chicago hotel has announced a 20 per cent decrease in waiters' wages for the first of the year, other hotels contemplating the same thing.

Construction Company Makes Winter Provision for Old Employees

The Cement-Gun Construction Co., Chicago, Ill., facing inaction during the winter and unwilling to see its regular employees go jobless, has devised a plan which it recently propounded to its regular employees. The company is equipped to make concrete septic tanks during warm weather but not during winter. The plan involves fitting up the tank plant with heating apparatus for winter work, allowing regular employees to be given the chance to work at a reasonable wage, and to share in the profits resulting from the sale of the tanks if a market for those manufactured during the winter is found in the spring and summer. Acceptance of the proposition is entirely optional with the employee, and his non-acceptance does not injure his status with the construction company.

Lumber Production 60 Per Cent of Normal

According to a recent bulletin issued by the National Lumber Manufacturers Association, production of lumber is now about 60 per cent of normal. Shipments closely approach production so that the volume of stock is not substantially increasing. It is expected that further reduction in output will occur in the next few weeks through the closing of more mills in the South and West. However, the bulletin points out, the resumption of building early in 1921, it is believed, must result in an active demand on the sawmills, and operators for the most part are optimistic. The bulletin also says that hundreds of sawmills in the principal producing regions are making sales at prices at, near, or even below cost of production. The move is made in an effort to maintain organizations intact.

Original Road Tender Cut $35,000 in Readvertisement of Bids

According to information just received from the Alabama Highway Commission, a contract has been awarded to W. T. Taylor, Talladega, Ala., for grading and installing drainage structures on 18.2 miles of state highway, at a price $35,000 under the same contractor's bid submitted Nov. 10. At that time bids were advertised on the project, but, though several contractors bid, the state highway commission considered the bids excessive, readvertising on Dec. 21 with the above result.

Railroad Officials and Trainmen Discuss Labor Situation

Official representatives of the eleven union trainmen employed on the Pennsylvania R.R. recently consulted, at the invitation of President W. W. Atterbury, with operating officials of the Pennsylvania system upon methods of avoiding strikes and improving the general service of the company. A decision was reached by both officers and operatives to co-operate in the building up of machinery for the settlement of labor disputes over the entire system. The railroad was represented at the conference by virtually all the vice-presidents, general managers and general superintendents from all regions of the system. Approximately 200 official representatives of the union operatives, representing the four big union railroad bodies, were also present.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City, Jan. [illegible], 1921.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. 25-27.

ENGINEERING INSTITUTE OF CANADA, Montreal; Toronto, Feb. 1-3.

The Nashville Engineering Association, at its meeting Dec. 14, elected the following officers: President, F. E. Freeland; vice-president, C. M. Darden; second vice-president, Wilbur Nelson.

The Ottawa Branch, Engineering Institute of Canada, at its meeting Jan. 6 will be addressed by J. M. R. Fairbairn, chief engineer, Canadian Pacific Ry. The members were addressed, Dec. 16, by W. H. Boyd, chief topographer, Geological Survey of Canada on topographical surveying.

The Cleveland Engineering Society, at its noonday meeting, Dec. 31, will be addressed by Lieut. Col. P. S. Bond on "The Engineer and His Relation to National Defense."

The Engineers' Club of Philadelphia, at its Jan. 7 meeting, will discuss "The Development and Future of Handling Freight by Motor-Trucks." The subject of the Jan. 21 meeting will be "Symposium on Hydro-electric Power and Distribution."

The Engineering Society of Wisconsin will hold its annual meeting at Madison, Wis., Feb. 11-12. Secretary, Leonard S. Smith.

The Indiana Engineering Society will hold its annual meeting at Indianapolis,

Ind., on Jan. 27-28. Charles Brossman, Merchants Bank Building, is secretary.

The Technical Club of Madison, Wis., at a recent meeting passed a resolution urging upon President-elect Harding the appointment of Herbert C. Hoover as Secretary of the Interior.

The Highway Engineers' Association of Missouri will hold its annual meeting at the Planters Hotel, St. Louis, Mo., Jan. 6, 7, 8, 1921.

The Kansas Engineering Society, at its annual meeting, Dec. 16-17, elected the following officers: President, Dean P. F. Walker of the University of Kansas; vice-president, Lloyd B. Smith; secretary-treasurer, J. M. Averill.

Personal Notes

Charles E. Sloan has been appointed city engineer of Manteca, Cal.

Fred H. Schrieber, formerly assistant state highway engineer of South Dakota, has been appointed state highway engineer to succeed F. S. Peck, resigned.

W. G. Stromquist has left the U. S. Public Health Service to accept the position of sanitary engineer with the health department, Memphis, Tenn.

George G. Tyrrell, formerly with the Missouri State Highway Department, has been appointed resident engineer on the construction of federal-aid roads for the Mississippi State Highway Department.

W. H. Fairchild has resigned the position of city engineer to become general manager of the Public Utilities Commission, Galt, Ont., Canada.

Thomas N. Jacob has been appointed chief engineer of the East Side Levee and Sanitary District, East St. Louis, Ill. Elmer R. Rodenberg has been appointed resident engineer and J. E. Weinel, field engineer.

Burdette Woodyard has resigned the position of highway engineer of Wood County, W. Va.

S. R. Batson has resigned the position of highway engineer for Jefferson County, Ala.

Morris Forman, formerly draftsman and estimator with the Miami Conservancy District, Hamilton, Ohio, has accepted a position as assistant drainage engineer, Winnebago County, Iowa.

Arthur I. Heim has resigned his position with the State Highway Commission, Helena, Mont., to become office engineer for the Foote Engineering Co., Meridian, Miss.

Alexander A. Pomper, formerly assistant engineer and inspector on municipal improvement work for the Spanish River Pulp and Paper Mills, Espanola, Ont., Canada, and recently junior engineer, Public Service Commission of New York, has been appointed assistant highway engineer, Monroe County, Mo.

John H. Caton, 3d, formerly assistant general manager of the Industrial Chemical Co., Providence, R. I., has been appointed division engineer in the Bureau of Public Works, La Vega, Dominican Republic, engaged in the construction of the new road across the republic. Before the world war he was construction engineer in the Bureau of Public Works, Manila, and during the war was captain, 33d Engineers, and road engineer for Base Section 5 of the A. E. F. in France.

Richard Roberts, for the past five years employed in an engineering and executive capacity by the Guggenheim interests, has resigned to accept the position of sales engineer with the New York office of the Wayne Oil Tank & Pump Co.

Lloyd T. Emory, civil engineer, of Philadelphia, is in British Guiana engaged in professional work.

Gus A. Bracher has been appointed engineer of Washington County, Tex.

J. H. Hooper has been appointed chief engineer of the Standard Steel Construction Co., Welland, Ont., Canada.

E. J. Widman, formerly superintendent for the C. R. Cummins Co., Marysville, Mich., in charge of the erection of the power plant for the Detroit Edison Co., has been promoted to engineer in charge of work in the Detroit district.

J. M. Hannaford, after more than 48 years' continuous service with the Northern Pacific Ry., has retired from the presidency. He will continue as a director of the company.

Obituary

John W. Wolfe, division engineer, Board of Local Improvements, Chicago, died Dec. 12. He was born in Ireland in 1870 and had lived in Chicago since 1885.

H. B. Kelsey, manager, The Foundation Co., Pittsburgh, Pa., died in New York Dec. 13.

James P. Doran, for ten years connected with the engineering department of the Eastman Kodak Co., died at Rochester, N. Y., Dec. 10.

E. V. Smith, superintendent, Wheeling (W. Va.) division, Baltimore & Ohio R.R., died Dec. 8. He was born at Meadville, Pa. For several years he was connected with the Erie R.R., then entered the service of the Baltimore & Ohio R.R.

Business Notes

The American Foreign Steel Corporation announces its incorporation effective Jan. 1, 1921, for the purpose of doing a foreign and domestic business in iron and steel, steel products, coal, coke, pig iron, new and relaying rails. Main offices will be in the Woolworth Building, New York; foreign offices will be in Birmingham, England, and Rome, Italy. Plants will be located at Modena, Pa., Lackawanna, N. Y., and Jersey City, N. J., which were formerly operated by the Jos. Joseph & Bros. Co. Eli Joseph, for twenty years president of this company, will be president of the new organization. The Jos. Joseph & Bros. Co. will continue as proprietors of the Railway Supply & Mfg. Co., manufacturers of cotton and wool waste, and will continue their interests in the Ohio Falls Iron Co.

The Detroit Steel Products Co. has increased its capitalization to $5,250,000, and declared a common stock dividend of 300 per cent, thus distributing a portion of the company's surplus, which has accumulated during the last ten years. The management believes the time is opportune to strike an optimistic note, and at the same time to afford the stockholders control of their share of this surplus. During the existing dull period, everything possible is being done to give employment to employees, who would otherwise be idle, in a thorough overhauling of the plant and equipment so that increased efficiency may be isured.

The Engineering Business Exchange, of which Charles Whiting Baker, formerly editor of *Engineering News*, is director, announces the opening of a Pacific Coast branch with James T. Whittlesey as director and with offices in the Claus Spreckels Building, San Francisco. This will make available to the engineers and engineering industries of the coast states the same service in bringing together the buyers and sellers of engineering and technical business properties that is being rendered by the New York office. Mr. Whittlesey for a dozen years was chief engineer of the Public Service Electric Co. of New Jersey. He built a number of that company's large power stations and developed a comprehensive ten-year program for the unification of the various plants and systems in New Jersey, which has since been closely followed. Since his removal to California eight years ago, he has been engaged in general consulting practice.

The Alpha Portland Cement Co., Easton, Pa., has purchased three new properties—the Burt Cement Co. plant at Bellvue, Mich., the La Salle, at La Salle, Ill., and the Ironton Cement Co., Ironton, Ohio.